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An Economic Analysis of the Main Determinants of Gross Domestic Product in Rwanda (1995 -2017)

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Abstract: ***This study investigated the empirical study of the determinant of economic growth in Rwanda, utilizing time series data for the period 1995-2017. These data have been analyzed and interpreted using the statistical, analytical, synthetic methods as well as an econometrical approach was employed. The objective was to test the trends and relationship between public investment and economic growth in Rwanda. The growth of GDP has been accelerating in each successive period since the early 1995s.Three factors go into picking up the pace of growth, the two that have played role since 1996 are physical capital and human capital, the later measured in terms of the quality of the workforce and their skills level, The third factor, the efficiency of production technology, as measured by the total factor productivity (TFP), also contributed by growing at a slightly faster pace than before the 1995s. The investment in Rwanda shows a rise in public sector participation, this is a clear reflection of government policy towards public capital accumulation across country. The researcher tested and confirmed the following: the capital stock and, investment expenditure in human capital are main determinants of economic growth in Rwanda for the period. Based on the existence of a long run co-integrating relationship, the short run interactions. The researcher tested and confirmed that, there was short run and long run positive relationship between capital stock, lobour force and economic growth in Rwanda during working period. The study reveals that capital stocks have a positive and significant effect on gross domestic product in the long run. Thus capital stocks is encouraged as the government attempts to close the infrastructure gap, eliminate supply bottlenecks and provide an enabling environment for increased private investment and economic growth. Equally critical however are renewed attempts to improve the efficiency and management of capital investment, as these would ensure that its positive benefits begin to accrue in the shortest possible time. Furthermore the finding reveals that increased investment expenditure in human capital through improved education and health provision, as well as initiatives such as eliminating gender disparities and other initiatives contained in the MDG's and Vision 2020 may also be crucial in the process of economic growth.***

Keywords: Economic analysis, Domestic Gross Product

1. Introduction

Globally, economies of countries are grouped into two different blocs or groups when considering the level of development which consists on the level of life standards or conditions, the socio-political structure and the state of infrastructures in those different countries or economies (Bosk ,M.J et Lau,L.J.,1990). On one hand, the first bloc; that one of developed economies or developed countries is characterized by a high life standing and stable, effective socio-political conditions in addition with adequate equipment and infrastructures while on the other hand, the second bloc is characterized by a lower level of development, that means ,the bloc of less developed countries or developing countries or economies where we find life standards or conditions which are poor, unstable socio-political structures, less developed infrastructures and economy dominated by farm activities mostly done by the large population which is not unskilled or uneducated. According to the findings of the World Bank, a half of six billions of global habitants live from less than 2$ USD per day and one fifth among them; that means 1.2 billion of people do not even achieve to live from one dollar per day(World Bank 2015). As far as Rwanda is concerned; being a less developed country with the majority of its population (90%) living mostly from traditional agriculture and facing constraint of high population density which leads to the land to be atomized and overexploited which may cause the decrease of production, there still a lack of genuine policies on land use and investment

2. Statement of the Problem

Economically, our nation "Rwanda" is still being in developing countries where agriculture is the pillar of the economy done by the majority of the population (90%) and where importations exceed exportations which leads to a chronic problem of trade deficit that the country is facing all the time and make it being always in the lowest income countries with poverty as its per capita income is 738.60 $ USD(6% of the world average estimated)(World Bank 2016). To tackle on that persistent problem of poverty or underdevelopment since 1995 after the tragedy, decision-makers or economy policy-makers, have tried to set national priorities, decisions and policies leading to tempting economic growth through economic recovery intending to moving the country from those with lowest income to the middle income countries, but there still exist some loopholes and ruins in implementing priorities, decisions or policies which often lead to failure cause of a lack of clear orientation on influence of each drivers of production (capital, labor force and technology) on GDP evolution which would serve as guideline to those policy makers in their decision-making or setting national priorities in the process of growing economy.

In fact, by setting priorities, decisions or policies related to national economic planning in order to increase production or raise economy in general, some key questions related to key determinants of production should have clearly and precisely to be answered: To what extent do the capital equipment of the Rwandan production system have remarkable contribution in the process of producing goods and services? To what extent does labor force actively have

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devotion or dedication to production of goods and services? To what extent does the Rwandan system of production have in place relevant technology (techniques, skills, innovations or innovative capabilities). By considering great importance or great role of those elements in the economic planning especially in terms of production; a deep study or quantitative research on determinants of GDP evolution is necessary in order to tempt to provide answers to those key questions which will serve as guidelines to national economy policy makers or decision-makers otherwise in absence of it, they will make absurd policies or decisions which may ruin the economy or aspired goals or targets!

3. Research Objectives

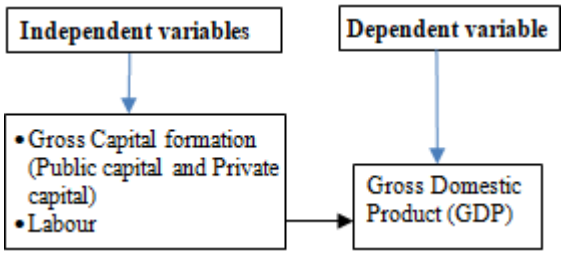
3.1 General Objective

The general objective of this research was to analyze the main economic determinants of gross domestic product in Rwanda.

3.2 Specific Objectives

1) To determine the influence of gross capital formation on GDP in Rwanda
2) To determine the influence of labor force on GDP evolution in Rwanda.

4. Conceptual Framework



5. Research Methodology

5.1 Study population

The study population of this research is the investigation of factors that drive economic growth in Rwanda. This study of population was chosen in the line of attempting to identify maindrivers which have influence on gross domestic product in Rwanda as this can be helpful in various domains.

5.2 Sample data and data sources

Sampling is used in research for efficient planning of survey because any good sample has to save money, to save time, and to avoid biased data, the sample represent the whole population. This study has a sample of 22annual periods from 1995-2017 with focus on GDP, capital stock, labour force as determinants of gross domestic product in Rwanda. The data for the period of 1995-2017 are from secondary data of MINECOFIN reports. All computations are performed using Eviews7 software.

5.3 Data Collection Methods and Tools

In this research the methods and tools used to collect are documentary and analytical where secondary data were collected from reading the reports and data of the World Bank, International monetary fund and different research papers. All computations are performed using Eviews7 software as technique of data analysis after being processed/organized in excel sheet.

5.4 Data processing

While investigating the determinants of saving model, a serious step to account is the problem identification. By this concept, I can only include the variables stated by normal theories. And in this point, I have to make an important supposition that the saving and its determinants are having a mutual influence.

5.5 Data analysis

This study will use the annual data from 1995 to 2017.The data is constructed and collected from various secondary data sources such as National Bank of Rwanda and NISR. The use of time series requires the econometric tests, in order to clarify the relationship between studied variables. Therefore, we first of all test for stationary in order to know whether the variables are stable over time to avoid spurious regression then after adopt Johnson co-integration test to verify if there is long run as well as short run relationship between variables. The economic estimation technique for this study used the following necessary and important tests for its relevancy and validity.

6. Summary of Research Findings and Discussion

6.1 Introduction

Literally interpreted, econometrics means ``economic measurement. It is a social science in which the tools of economic theory, mathematics, and statistics are applied to the analysis of economic phenomena. Econometrics has an objective to test the validity of economic theories and, then enables the econometrician to confirm or reject the relationship presumed between variables. According to Bourbonnais econometrics gives empirical content to most economic theory**.**

6.2 Overview of trends of aggregate income and its suspected determinants in Rwanda

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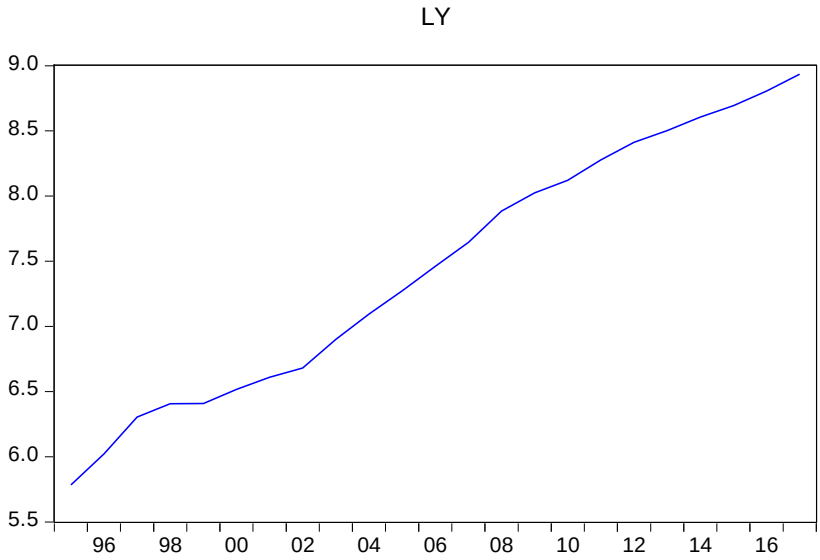


Figure 1: Aggregate income
Source: Author plotting (secondary data)

Rwanda like other countries, the post war economic recovery characterized by rapid economic growth, in the immediate post war period mid 1994 through 1995 emergency humanitarian assistance since 1996, Rwanda has experienced steady economic recovery. The Government of Rwanda remains dedicated to a strong and enduring economic climate for the country, focusing on poverty reduction, infrastructure development, privatization of government-owned assets, and expansion of the export base, trade liberalization, banking reform and low corruption also are favorable current trends. The tourism industry has potential for further growth given the current political stability, travel infrastructure, and extensive national parks as well as other potential tourist sites. Since growth rate in 1996 through improved collection of tax revenues, accelerated privatization of state enterprises to stop the drain on government resources, and continued improvement in export crop and food production Tea plantations and factories continue to be rehabilitated, and coffee, always a smallholder's crop is being more seriously rehabilitated and tended as the farmers' sense of security returns.

By mid-1997, the factories functioning before the war had returned to production and increased their capacities. Investments in the industrial sector continue to mostly be limited to the repair of existing industrial plants. Retail trade, devastated by the war, has revived quickly, with many new small businesses established by Rwandan returnees from Uganda, Burundi, Tanzania, Kenya and the Democratic Republic of Congo. Industry received little external assistance from the end of the war through 1995. Beginning in 1996-97, the government has become increasingly active in helping the industrial sector to restore production through technical and financial assistance, including loan guarantees, economic liberalization, and the privatization of state-owned enterprises.

In early 1998, the government set up a one-stop investment promotion center and implemented a new investment code that created an enabling environment for foreign and local investors. An autonomous revenue authority also has begun operation, improving collections and accountability. The country entered a high period of economic growth in 2006 Rwanda completed the Multilateral Debt Relief Initiative and the Heavily Indebted Poor Countries (HIPC) debt initiative, significantly lowering its foreign debt load, a record it has sustained since, turning it into one of the fastest-growing economies in Africa. This sustained economic growth has succeeded in reducing poverty; with growth between 2006 and 2011 reducing the percentage of the country's population living in poverty threshold .The country's infrastructure has also grown rapidly in 2013. These various factors increased gross domestic product, since1998, humanitarian relief aid began to shift to reconstruction and development assistance in infrastructures development, private investment development, increased investment in human capital. The public investment Programming over the 2010-2017 period concentrate on increased export receipts, ensuring continued strong agricultural performance, building the necessary infrastructure and reducing extreme poverty by undertaking integrated development programs to overcome the significant challenges in the year ahead which increased overall GDP growth in Rwanda.

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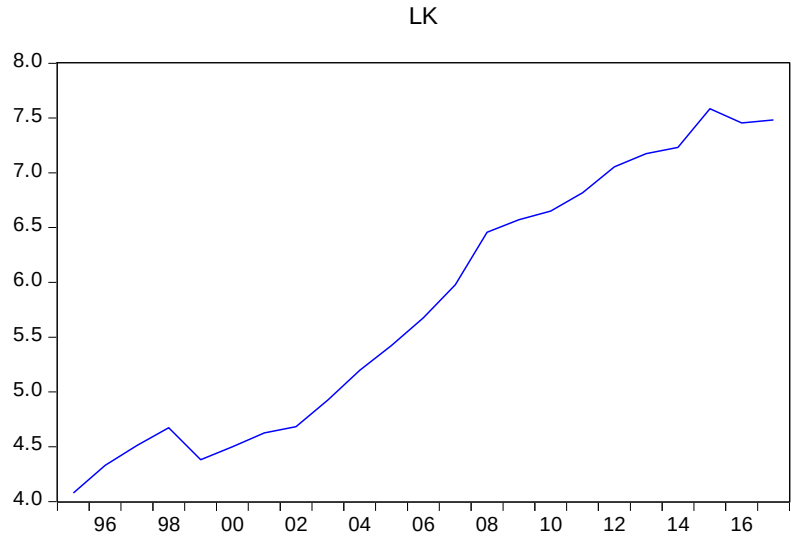


Figure 2: Capital stock
Source: Author plotting (for data, see appendix No 1)

Normally, Rwanda has significant rise in capital investment after genocide, early of 1999 public infrastructures felt due to insecurity was occur in north and western province caused by extremist which are destroyed persistent infrastructures in those regions and share reduction government investment in national budget consequently increase unproductive expenditures. Government-wide review of infrastructure and capital investment policy led by the Department of Public Expenditure and Reform from 2003, since 1995 to 2003 there was a lower level of resources available for capital investment this is the reality of the fiscal challenge which the Government faces. The values of public capital investment increased predominantly from 2005 to 2017 due to the government program of enhancing public capital investment, different aids toward public infrastructures across country and much of part in national budget occupied by government investment. As the figure above illustrates review represents a significant reprioritizing public investment plans due to the trend share upward tandance.

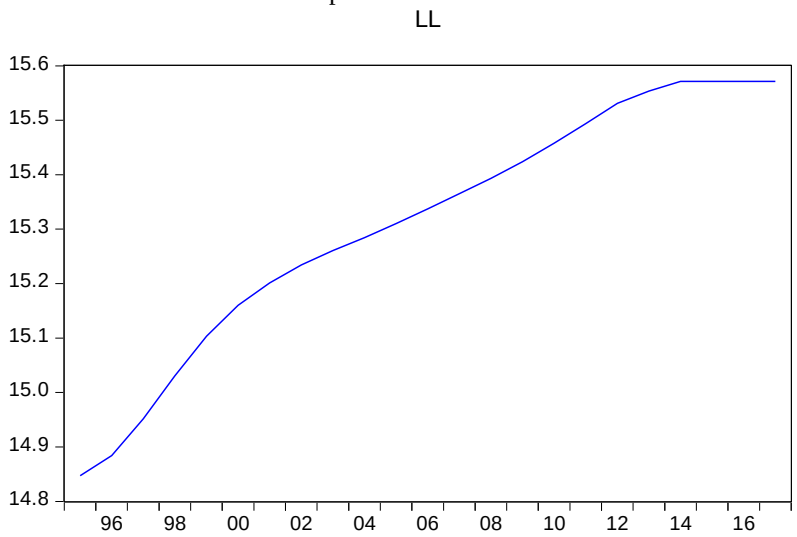


Figure 3: Nominal interest rate in Rwanda
Source: Author plotting (for data, see appendix No 1)

The investment in human capital has consistently rise after genocide, many people start to study ,trainings and many universities started to offer many graduates which have large share in labor force. With solid security Rwanda receive returned refugees and many foreign employees which significantly contribute in labor force. Formation of human capital in only possible through capital formation, the expenditures incurred on health, education, social services, and social welfare play central role in investment expenditures in human capital, by investing in capital workers, to enhance efficient increases. Due to the effort of government of Rwanda mainly investing in human capital as the important low material, the human capital has an impressive evolution after the war and genocide of 1994.Hance investment expenditure in human capital had positive and steady fluctuation trend during the period under study.

6.3 Result of Co-integration Test

After testing for stationarity, accordingly, there should be a co-integration test as indicated by Engle and Granger (1987). The existence of co-integration between the variables means that there is a long run relationship between

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the variables. The co-integration test is performed using Engel and Granger two-step residual based test. The results are presented in tables……

6.3.1 Selection of Lag Length

The criterion for selecting the lag length is an important step. There are different tests that would indicate the optimal number of lags. The study uses the AI criterion to ensure sufficient power to the Johansen procedure as it is what has lower value for the whole system. The results of the Lag length criterion selection are presented in the following table:

VAR Lag Order Selection Criteria
Endogenous variables: LY LK LL
Exogenous variables: C
Date: 05/04/18 Time: 12:00
Sample: 1995 2017
Included observations: 22

Lag	LogL	LR	FPE	AIC	SC	HQ
0	24.13866	NA	2.94e-05	-1.921696	-1.772918	-1.886649
1	119.5856	156.1859*	1.15e-08*	-9.780509*	-9.185395*	-9.640318*
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Table above indicates that the appropriate lag length criteria are 1. This is based on the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Final Prediction Error (FPE) and Hannan-Quinn Information Criterion (HQ). Accordingly, the VAR model uses four lag lengths.

6.3.2 Result of the VAR Models

The co-integration test shows that the variables are co-integrated. The results of the co-integration test are presented in the following tables:

Date: 05/04/18 Time: 12:01
Sample (adjusted): 1998 2017
Included observations: 20 after adjustments
Trend assumption: Linear deterministic trend
Series: LY LK LL
Lags interval (in first differences): 1 to 2
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.662328	30.71687	29.79707	0.0391
At most 1	0.359560	9.003270	15.49471	0.3651
At most 2	0.004554	0.091279	3.841466	0.7625
Trace test indicates 1 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 *	0.662328	21.71360	21.13162	0.0414
At most 1	0.359560	8.911991	14.26460	0.2935
At most 2	0.004554	0.091279	3.841466	0.7625

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

These results give an indication for the existence of a long-run relationship between aggregate income, capital and labor

1 Cointegrating Equation(s):	Log likelihood	146.3859
Normalized cointegrating coefficients (standard error in parentheses)		
LY	LK	LL
1.000000	-0.743049	-0.340201
	(0.04689)	(0.33060)

Based on the results shown in Table above, the co-integrating vector representing the long-run savings function is as follows:

$Y = 0.74\ K_t + 0.34 L_t$ in this equation, all the estimates of the coefficients of the variables have the positive sign. The coefficient 0.74 shows that one percent increase in gross capital formation causes aggregate income to increases by 0.74 percent in long-run, ceteris paribus; The coefficient 0.34 shows that one percent increase in lobour force causes 0.34 percent increases in aggregate income in long-run, ceteris paribus; Researcher advocates that all estimated coefficients are corresponding to expected signs of parameters

6.2.3 Vector error correction models

An vector correction model is a dynamic mode in which the movement of the variables in any periods is related to the previous period‘s gap from long run equilibrium. The short-run evolution of the variables is taken into consideration, especially since the equilibrium can rarely be observed .The major reason why relationships are not always in equilibrium centers on the inability of economic agents to adjust to new information directly (lag in adjustment). After the determination of the co integrating relationship, the next step is to estimate the short-run gross saving function using Vector error correction model (VECM). The short-run model coefficients measure the dynamics of the model, the VECM measures the speed of adjustment to the long run equilibrium which is taking place and the results are presented in the table below

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Error Correction:	D(LY)	D(LK)	D(LL)
CointEq1	-0.625421	-1.731636	-0.013820
	(0.16211)	(0.50888)	(0.02479)
	[-3.85806]	[-3.40285]	[-0.55743]
D(LY(-1))	-0.628349	-1.193076	0.075604
	(0.44036)	(1.38235)	(0.06735)
	[-1.42690]	[-0.86308]	[1.12259]
D(LY(-2))	-0.550734	-1.990333	0.044967
	(0.43963)	(1.38006)	(0.06724)
	[-1.25272]	[-1.44221]	[0.66879]
D(LK(-1))	0.372758	0.869832	-0.013277
	(0.18769)	(0.58919)	(0.02871)
	[1.98600]	[1.47631]	[-0.46253]
D(LK(-2))	0.173486	0.482236	-0.003604
	(0.16228)	(0.50941)	(0.02482)
	[1.06907]	[0.94665]	[-0.14522]
D(LL(-1))	3.613708	12.28118	0.903751
	(2.54733)	(7.99643)	(0.38959)
	[1.41862]	[1.53583]	[2.31977]
D(LL(-2))	-4.335442	-12.86909	-0.043757
	(2.39813)	(7.52806)	(0.36677)
	[-1.80784]	[-1.70948]	[-0.11930]
C	0.243377	0.427947	-0.012836
	(0.06911)	(0.21694)	(0.01057)
	[3.52169]	[1.97266]	[-1.21449]
R-squared	0.693438	0.650341	0.945674
Adj. R-squared	0.514610	0.446373	0.913984
Sum sq. resids	0.018945	0.186688	0.000443
S.E. equation	0.039734	0.124729	0.006077
F-statistic	3.877679	3.188445	29.84128
Log likelihood	41.24067	18.36171	78.79496
Akaike AIC	-3.324067	-1.036171	-7.079496
Schwarz SC	-2.925774	-0.637878	-6.681203
Mean dependent	0.131553	0.148563	0.030996
S.D. dependent	0.057031	0.167633	0.020720
Determinant resid covariance (dof adj.)		4.08E-10	
Determinant resid covariance		8.81E-11	
Log likelihood		146.3859	
Akaike information criterion		-11.93859	
Schwarz criterion		-10.59435	

*, ** and *** indicates rejection of the null hypothesis at 10%, 5% and 1% significant level, respectively. The negative coefficient of the error correction term (-0.62.) is significant at level of 10%, assuring that the co integration relationship between the included variables is valid. The error correction model demonstrates that this previous disequilibrium is progressively corrected in order to re-establish the long- run equilibrium situation among co integrating variables. **VECM** presents the convergence of the model towards equilibrium by its negative sign and the value,-0.62,-1.73, and-0.01 for, Y, K and L respectively show that aggregate income adjusts to restore 63 percent of disequilibrium from the previous year to the current year. Now, all the estimated coefficients of included variables are consistent with economic theory, which is, gross capital formation, labor force positive elasticity with gross aggregate income. R^2 =69 and showing that the total variation of dependent variable is explained by explanatory variables at 69%,

6.2.4 Granger Causality tests

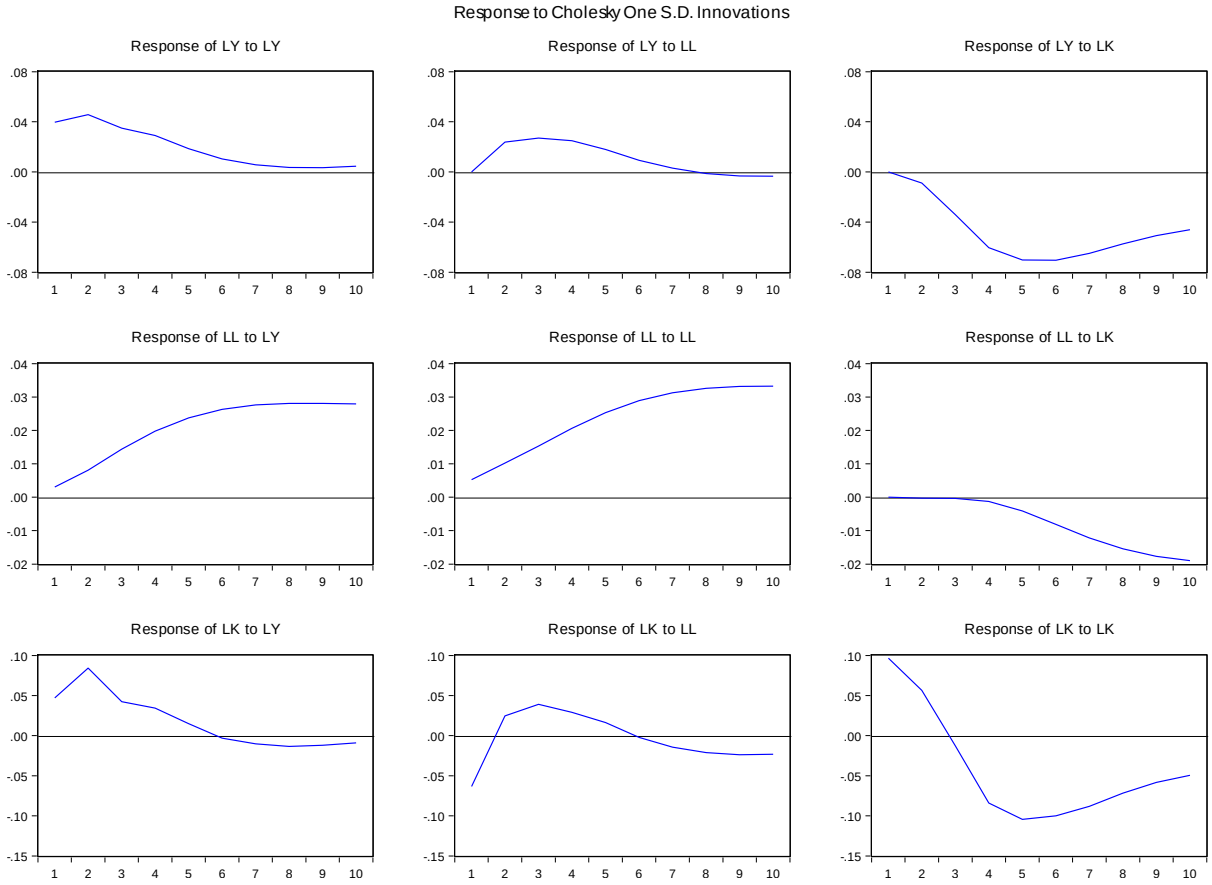
Pair wise Granger Causality Tests			
Date: 05/11/18 Time: 10:29			
Sample: 1995 2017			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
LL does not Granger Cause LY	21	6.08909	0.0108
LY does not Granger Cause LL		12.1111	0.0006
LK does not Granger Cause LY	21	0.56119	0.5814
LY does not Granger Cause LK		7.83505	0.0042
LK does not Granger Cause LL	21	9.50509	0.0019
LL does not Granger Cause LK		2.06330	0.1595

Engle and Granger (1987) determine the duality between cointegration and the vector error correction models (VECM).

Furthermore, they show that the application of causality should be done by the VECM since it is the ideal instrument for causality examination because among other things, it determines the speed of convergence of the relevant variables to their equilibrium.

Since we found evidence of co-integration, there must be either unidirectional or bidirectional Granger causality, because at least one of the error correction terms should be significantly different from zero by the definition of co-integration. The VECM approach, apart from showing the direction of Granger-causality among the variables, enables to distinguish between 'short-run' and 'long-run' Granger causality.

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The researcher use E-views 7 performed test of Correlogram squared residual and found the following results:

Date: 05/11/18 Time: 09:38						
Sample: 1995 2017						
Included observations: 23						
Auto correlation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |* . |	. |* . |	1	0.129	0.129	0.4318	0.511
.**| . |	.**| . |	2	-0.228	-0.249	1.8583	0.395
. | . |	. | . |	3	-0.028	0.044	1.8808	0.598
.**| . |	.**| . |	4	-0.240	-0.326	3.6308	0.458
. *| . |	. | . |	5	-0.138	-0.046	4.2400	0.515
. | . |	. *| . |	6	0.044	-0.093	4.3063	0.635
. | . |	. | . |	7	0.067	0.032	4.4658	0.725
. *| . |	.**| . |	8	-0.106	-0.244	4.8926	0.769
. *| . |	. *| . |	9	-0.177	-0.199	6.1744	0.722
. | . |	. | . |	10	0.047	-0.038	6.2715	0.792
. | . |	. | . |	11	0.067	-0.051	6.4872	0.839
. |* . |	. | . |	12	0.086	0.015	6.8781	0.866

Source: E-views7

The results emphasize that there is no serial correlation of residuals up to 12 lag due to the probability is greater than 1% significance level.

RAMSEY RESET test

Ramsey RESET Test			
Equation: UNTITLED			
Specification: LY LK LL C			
Omitted Variables: Squares of fitted values			
	Value	df	Probability
t-statistic	0.096663	19	0.9240
F-statistic	0.009344	(1, 19)	0.9240
Likelihood ratio	0.011308	1	0.9153

Source: E-views7

Referring to the above results, the probability of the lag likelihood ratio is equal to **0.91**less to critical value of 1%, H_O is not rejected, and the model is correctly specified.

7. Summary and Conclusions

More successful developing countries owe much of their success to having been able to maintain the high rate of capital stock and labour force. A country's capital stock and labor force is an important determinant of the growth of its cross the country .They do react to some macroeconomic variables and to know those variables can help a country to improve its competitiveness within region and international level. The main target of this study was an attempt to analyze empirically the Cobb Douglas production function in Rwanda during 1995-2017 using econometrics. This research was used secondary data collected from the reports of Ministry of finance, National bank of Rwanda. The researcher preoccupation was to analyze, test the contribution of Cobb Douglas in Rwanda; in order to arrive at the econometric results much of tests were to know stationary where series become stationary after first difference and the co-integration of the variables take place at 10% level of significance. The long run and short run model showed that capital stock and labour force , has short run a certain extent on output as well as in the long run. The diagnostic tests showed that the model do satisfy the assumptions of the classical normal linear regression model. The stability tests, namely the Ramsey RESET test and the CUSUM test respectively suggest that there is misspecification error and that parameters are stable.

The coefficient 0.74shows that one percent increase in gross capital formation causes aggregate income to increases by 0.74percent in long-run, ceteris paribus. The coefficient

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0.34shows that one percent increase in labor force causes 0.34percent increases in aggregate income in long-run, ceteris paribus. The model was precisely good because all classical assumption were verified through diagnostic tests. Basing on the above findings the second hypothesis that there is long-run and short run relationship between capital stock, labor force and aggregate income in Rwanda is approved and confirmed

8. Policy Recommendations

This study examined the determinants of economic growth in Rwanda 1995-2017. The long run results indicated that gross capital formation and labor force exerts positive and significant effect on aggregate income.

1) With increased gross capital formation, it can be assured that such public investments crowd in private sector investment and increase gross domestic product of the Rwandan economy in the long run.
2) Renew policy attempts to improve the efficiency and management of capital. Thus going forward, a five pronged approach is recommended to Rwandan public policymakers:
   - Firstly the study points to the fact that gross capital formation has the potential to greatly increase GDP and promote the much needed growth of the Rwandan economy. Thus fiscal space must be created in the government budget to finance greater public investments. This can arise by way of broadening the tax base, reducing exemptions and simplifying the tax system so as to include elements in the informal sector not currently captured bythe tax system.
   - Secondly the study points to an important route through which private sector investment can be encouraged. The link between domestic credit and private investment can be potentially exploited so as to stimulate increased gross capital formation. Improved credit creation initiatives to the private sector specifically in the banking sector are also to be encouraged and implemented.
   - Where possible, public policy makers are advised to substitute consumption expenditure with appropriate investment expenditure so as to increase both gross capital formation and real GDP of the Rwandan economy.
   - Fourthly, initiatives embarked on to improve the efficiency and quality of public investment must be bolstered andrevamped. This will help to ensure that the potential benefits of capital stock accrue within the shortest possible time. This can come about owing to initiatives in various stages of the capital stock process;
   - Government should enhance human capital development by increasing the training centers contribute too much in gross domestic product.

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