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THE MAIN DETERMINANTS OF ECONOMIC GROWTH IN RWANDA: AN ECONOMETRIC ANALYSIS

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C E R T I F I C A T E

This is to certify that the Project Work entitled "**The main Determinant of economic growth in Rwanda. An econometric analysis.**" is a record of the original work done by Desire MUNYAMASHARA, in the partial fulfillment of the requirement for the award of master of Science in Economics, in Kigali Independent University (ULK) during the academic year 2012-2014

Supervisor

…….. ……

Prof. Jeyakumar Rufus

DEDICATION

I dedicate this work to almighty God

To my lovely parents,

To my lovely brothers, sisters, relatives,

And all my friends.

Acknowledgement

This study would not have been possible without the support of many people. I gratefully acknowledge **Prof. Jeyakumar Rufus** for his dedicated supervision through out this thesis. I also thank my colleagues who despite their hectic schedules selflessly offered guidance and support, Mr. Roy Gasangwa, and last but not least, Mr.Roger Musafiri. Finally, I thank my girlfriend, and numerous friends who endured this long process with me, always offering support and love.

Declaration

I Desire MUNYAMASHARA, declare hereby that this study is a true reflection of my own research and that this work, or part thereof has not been submitted for a degree in any institution of higher education.

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Desire MUNYAMASHARA **Date**

ACRONYMS

ADF: Augmented Dickey-Fuller Schwarz

AIC: Akaike Information Criterion

AR: Autoregression

ARCH: Autoregressive Conditional Heteroscedasticity

BNR: Banque Nationale du Rwanda

D: difference

D1995: Dummy variable caused by Genocide against Tusti

ECM: Error Correction Model

EDPRS: Economic Development and Poverty Reduction Strategy

EXPG: Export to Gross Domestic product

FDI: Foreign Direct Investment

GDP: Gross Domestic Product

I: Integration

INVG: Gross Capital Formation to Gross Domestic Product

L: Logarithm

LDCs: Less Developed Countries

LM: Lagrange Multiplier

ML: Maximum Likelihood

MSE: Mean Sum of Errors

OLS: Ordinary Least Square

SD: Standard Deviation

SE: Standard Error

SIC: Schwarz Information Criterion

VAR: Vector Autoregression

VEC: Vector Error Correction

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ABSTRACT

This paper examines empirically the causal relationship among exports, gross capital formation, foreign direct investments and economic growth using a multivariate autoregressive VAR model for Rwanda over the period 1980-2012. The results of cointegration test suggested that there is three cointegrated vectors between the examined variables, while Granger causality tests showed that there is a bi-directional causal relationship between the per capita GDP and the ratio of gross fixed capital formation to GDP. Also There is a unidirectional causal relationship between the ratio of exports to GDP and the ratio of foreign direct investments to GDP with direction from exports to foreign direct investments, a unidirectional causal relationship between the ratio of foreign direct investments to GDP and the per capita GDP with direction from foreign direct investments to per capita GDP, and final a unidirectional causal relationship between the ratio of exports to GDP and the ratio of gross fixed capital formation to GDP with direction from exports to gross fixed capital formation .

The findings show that in the short-run an increase of 1% on ratio of exports to GDP will lead to an increase of 0.12% on per capita GDP, an increase of 1% on the ratio of gross fixed capital formation to GDP will lead to an decrease of 0.2% on per capita GDP, while increase of 1% on ratio of foreign direct investment to GDP will lead to an decrease of 0.051% on per capita GDP, but the speed of adjustment back to equilibrium is 3.7 percent annually adjustments in the short run however the value of coefficient is statistically significant at 10 percent but insignificant at 5 percent.

Chapter 1. INTRODUCTION

1.1 Background

The underlying theory relates to long term economic growth, and the precise timing between economic growth and its determinants is not well specified at the high frequencies characteristic of “business cycles”. For example, relationships at the annual frequency would likely be dominated by mistiming and, hence, effectively by measurement error.

Since the ratio of exports to gross domestic product denotes an open economy index, a higher ratio indicates a relatively higher open economy. On the other hand a lower ratio of exports to gross domestic product reflects to a limited trade policy and a more close economy.

Solow (1956) in his study suggests that the larger the investment and saving rate are the more cumulative capital per worker is produced. Tyler (1981) examining a sample of 55 developing countries resulted that exports and investments are the main determinants of economic growth.
New growth theories stress the importance of investments, human and physical capital in the long-run economic growth. The policies, which affect the level of growth and the investment efficiency determine the long-run economic growth.
Theoretically, the gross capital formation affects the economic growth either increasing the physical capital stock in domestic economy directly, Plossner (1992) or promoting the technology indirectly, Levine and Renelt (1992).

Recently, many empirical studies emphasized in diversified role of private and public investments in growth process. The public investments on infrastructure, in extent in which are

proved to be complementary to the private investments, can increase the marginal product of the private capital, augmenting the growth rate of a domestic economy.

Khan and Kumar (1997) supported that the effects of private and public investments on economic growth differ significantly, with private investment to be more productive than public one. Knight, Loyaza and Villanueva (1993) and Nelson and Singh (1994) confirmed that public investments on infrastructure have an important positive effect on economic growth over the period 1980-1990. Easterly and Rebelo (1993) evaluated that public investments on transportation and communications are positively correlated to economic growth, while there were negative effects of public investments of state-owned businesses on economic growth.

The effect of foreign direct investment on economic growth is dependent on the level of technological advance of a host economy, the economic stability, the state investment policy and the degree of openness. FDI inflows can affect capital formation because they are a source of financing and capital formation is one of the prime determinants of economic growth. Inward FDI may increase a host's country productivity and change its comparative advantage. If productivity growth were export biased then FDI would affect both growth and exports. A host's country institutional characteristics such as its legal system, enforcement of property rights, could influence simultaneously the extent of FDI and inflows and capital formation in that country.

Standard Keynesian theory suggests that the public spending have a larger impact upon the GDP than the transfers or to the level of autonomous taxes, because a part of the higher disposable income from a tax cut or transfers increase is saved, while public investment affect aggregate

demand directly. Theoretically, the public investment have a great short-term multiplying effect upon the aggregate demand and a long-term multiplying effect upon the aggregate offer, especially when they determine the decrease of the transaction costs.

Taylor J.B. and Wiel, V (2009)

Subsequent analyses argued that technological progress generated by the discovery of new ideas was the only way to avoid diminishing returns in the long run. In these models, the purposive behavior that underlay innovations hinged on the prospect of monopoly profits, which provided individud incentives to carry out costly research (Romer [1990], Aghion and Hewitt [1992], Grossman and Helpman [1991, Chs. 3,4]). Again, the equilibria need not be Pareto optimal, and there were some intriguing implications for policy, notably for subsidies to basic research.

In contrast to the weak effect of democracy on growth, there is a strong positive linkage from prosperity to the propensity to experience democracy (a relation called the Lipset [1959] hypothesis). Various measures of the standard of living real per capita GDP, life expectancy, and a smaller gap between male and female educational attainment are found to predict democracy. Additional effects considered include urbanization, natural resources, country size, inequality, colonial history, and religious affiliation.

The final essay details the link between inflation/monetary policy and economic growth. The basic finding is that higher inflation goes along with a lower rate of economic growth. Moreover, the adverse effect of higher inflation on economic outcomes is quantitatively important. This pattern shows up clearly for inflation rates in excess of 15–20% annually, but cannot be isolated statistically for the more moderate experiences. However, there is no evidence in any range of a

positive relation between inflation and growth. The analysis also suggests that the estimates isolate the direction of causation from inflation to growth, rather than the reverse.

After a lively debate in the late 1950and early 1960s about the merit of theory of social balance of economics profession dismissed admonitions about the perils of neglecting the public infrastructure. However, rekindled a great deal of interest in the efficiency of public capital spending by showing that additional spending by governments for nondefense capital goods apparently had a very large positive effect of private productivity and, hence, output. Although economists were not surprised that public infrastructure spending could promote output growth, the magnitude of the effect found by Aschauer was starting to most. Aschauer estimated that additional public capital spending would increase the output of private firms by more than 1.5 times as much as would an equivalent dollar increase in the firm's own capital stock2. Aschauer, David A. (1990)

Into the category of physical capital investment, but government also invests in its people. This type of investment produces human capital if it improves the job skills (potential and actual productivity) of its citizens. Investments in human capital may affect aggregate production possibilities in ways that are far more complicated than investments in physical capital. In the case of physical capital, it seems reasonable to assume that the government stock of physical capital enters an aggregate production function in a manner that is symmetric to, or at least quite similar to, private capital.

Rwanda has made substantial achievements in its recovery from the genocide and war of 1994. The government, through its expenditure program has played a crucial role in the process of promoting socio-economic reconstruction. Now, more than a decade after, the country is aiming

for medium to long-term development and poverty reduction as elaborated in vision 2020 and the (Economic Development and Poverty reduction strategy). (EDPRS)

Rwanda Development Board played a key role in private investment promotion, including public private partnership (PPP) .Strong investment coordination has been crucial to successfully meet the requirements of development needs in Rwanda. The national for the public investment policy is, therefore, to provide guidance and to ensure that the required public investment system, including the necessary PPP framework, is put in place in order to achieve adopted development and growth targets. Therefore my research topic deals with analysis the effect of public investment on economic growth in Rwanda.

1.2 Problem statement

Rwanda is land locked, with long distances from ocean ports, a factor that raises transportation costs for both exports and imports. The country lacks a link to regional railway networks ,which means most trade is conducted by road poor road quality creates high transportation costs leading to inflated prices of domestically manufactured products ,as raw materials used for manufacturing need to be improved .These natural barriers to trade hinder industrial and other forms of development Rwanda v. (2000)

Rwanda after the genocide that declined national economy and destroyed much of the social and physical capital ,is at present facing a situation where it is necessary to achieve huge efforts in rehabilitation and development .This requires exceptional efforts to mobilize and improve qualitatively the private and public investment with the objectives to get annual growth rate of at least 7% that necessary to reduce the poverty by 2015 and to achieve the pillars of the Rwanda vision 2020 strategy.

The economy of Rwanda is currently characterized by internal(budget deficit) and external (balance of payments deficit)macroeconomic disequilibrium a long side low saving and investment rates and high unemployment in addition ,Rwanda exports is low because of low productivity in our country in agriculture ,accounts for more than 80% of the labor force ,yet remains unproductive and largely on a subsistence level .Distribution of land now stands at one hectare for every 9 Rwandans and diminishing due to high birth rates.(Rwanda vision 2020)

Rwanda had a GDI rate of 17% in 2000 and 18% in 2001, GDP in real terms grew by 6.6% in 2005 compared to 4.6% in 2004 .This growth was backed by recovery of primary sector which registered a growth rate of 5.9% in 2005 against 1.5% in 2004 as well as performance of the secondary and tertiary sectors which increased by 10.9 % and 6.2% respectively .The real GDP at constant prices of 2006 grew by 6% in 2009 against 11.6%in 2008. This growth emanated mainly from recovery of agriculture and services sector which recovery respectively an increase of 7.7% and 5.7% of the value added. Industries sector also slightly grew by 1.3%. GDP per capital in nominal terms improved by 12.7% as it rose from rwf 262.6 thousands while in terms of USD GDP per capital registered an increase of 8.5%, from USD 479.6 in 2008 to 520.5 in 2009.the percentage of investment to GDP increased from 16% in 2006 to 21.9% in 2010/11 exceeding the target of 19% for 2010/11, the EDPRS target for 2012/13 is 23%. (BNR and MINECOFIN report, 2004, 2005, 2006, 2008, 2009, 2010, 2011, and 2012).

Basing on these figures highlighted above how public investment has increased from 2000 up to 2012. By studying the evolution of the public investment and the GDP which shows the level of economic growth, public investment is targeted to induce substantial private sector investment and foster growth in agriculture, manufacturing and the service sector. Investment is targeted at

developing skill and capacity for productive employment, improving the infrastructure, promoting science technology and innovation and strengthening the financial sector.

Thus, with regard to the present narrow private economy base of Rwanda, the public sector shall be the primary growth engine in consistency with the poverty reduction strategy. In order to remove the obstacles to accelerated growth, public investment should benefit all three productive sectors of the economy: agriculture, manufacturing and services. This will enable the nation to transform a subsistence agriculture economy to a knowledge-based society, with high level of savings and private investment, thereby reducing the country, dependence on external aid.

In this research, we are going to study the determinants of economic growth in Rwanda and how the Rwanda economic growth has been performing according to the effort of government in order to reach its target to achieve 7% of GDP which shows the reduction of the poverty and will increase the growth of the economy.

1.3 Purpose of the study

The general interest of this topic is to conduct a research and the results will help in understanding the effect of some macro variables on Rwandan economic growth.

In society, the level of some macro variables related to economic growth in developing countries are a great challenge even through, they are considered as the many points which may help those countries to arise from the poverty however, this work will develop a larger approach of modeling and measuring the determinants of economic growth in Rwanda.

1.4 Research objectives

The objective of the study are divided into general objectives and specific objectives

1.4.1 General objectives

The main objective is to determine the main determinants of economic growth in Rwanda for 1980-2013.

1.4.2. Specific objectives

This study has the following specific objectives:

- To determine the effect of public investment, private investment, labor force and interest rate on economic growth in Rwanda.

1.5 Research Questions

Rwanda has public investment program (PIP) that has been applied for poverty reduction which will help our economy growth, the study would examine the following questions:

1. What is the trend Rwanda have in economic growth for 1980-2013?
2. The increasing of investment (public or private) affect the economic growth to rise?
3. How the labor force and interest rate impacted on economic growth of Rwanda?

1.6 Scope of the study

This research like any other scientific works is limited in time, space and in the domain. In time and scope, this study is conducted on the Rwandan economy. This study takes the root from macroeconomics and economic development and in time this study will cover 34 years from 1980 up to 2013.

1.7 Significance of the study

This study sets itself apart from generic social science researches that have been done before because; it uses the tools of econometrics to analyze determinants of economic growth.

A major significance of this study lies in its ability to provide empirical content to the qualitative hypothesis advanced for this study; that is; the study will provide numerical estimates of all coefficients of explanatory variables which are included in the model.

This study will contribute immensely to the overall goal of our macroeconomic policy, in particular the policy change in development of Rwanda. The study will assist in highlighting the significance of different economic variables in the determination process of economic growth in Rwanda. The study will also statistically enrich and add to the already existing economic statistics wealth in the area of growing Rwanda economy for future. This study is vital in that it will further assist in recognizing the most significant variables in the model which can be taken into consideration in formulation of policies should make the country to develop quickly.

1.8 Definitions of key terms

The point gives definitions of key concepts in to help the readers to understand well the main terms of this study.

Economic growth means a sustained increase in per capita national output or net national product over a long period of time. It implies that the rate of increase in total output must be greater than the rate of population growth D N DWIVEDI (2002). Economic growth is the increase in the amount of the goods and services produced by economy over time. It is conventionally measured as the percent rate of increase in real gross domestic product, or real GDP. Growth is usually

calculated in real terms-i.e. inflation-adjusted terms-to eliminate the distorting effect of inflation on the place of goods produced. In economics, "economic growth theory" typically refers to growth of potential output, i.e., production at "full employment". Measure economic growth, economists use data on gross domestic product, which measures the total income of everyone in the economy. Ayres, Robert (1989), Lucas, R.E. (1988)

1.8.1 Economic growth versus the business cycle

Economists distinguish between short-run economic changes in production and long-run Economic growth. Short-run variation in economic growth is termed the business cycle. The business cycle is made up of booms and drops in production that occurs over a period of months or years. Generally, economists attribute the ups and downs in the business cycle to fluctuations in aggregate demand. In contrast, the topic of economic growth is concerned with the long-run trend in production due to structural causes such as technological growth and factor accumulation. The business cycle moves up and down, creating fluctuations around the long-run trend in economic growth. Galor o. (2005)

1.8.2 Historical sources of economics growth

Economic growth has traditionally been attributed to the accumulation of human and physical capital, and increased productivity arising from technological innovation. Economic growth was also the result of development new products and services, which have been described as "demand creating". Before industrialization technological progress resulted in an increase in population, which was kept in check by food supply and other resources, which acted to limit per capital income, a condition known as the Malthusian trap. The rapid economic growth that

occurred during the industrial revolution was remarkable because it was in excess of population growth, providing an escape from the Malthusian trap.

Increases in productivity are a major factor responsible for per capita economic growth- this has been especially evident since the mid-19th century. Most of the economic growth in 20th century was due to reduced inputs of labor, material, energy, and land per unit of economic output (less input per widget). The balance of growth has come from using more inputs overall because of the growth in output, including new kinds of goods and services (innovations). During the industrial Revolution, mechanization began to replace hand methods in manufacturing, and new processes streamlined production of chemicals, iron, steel and other products. Machine tools made the economical production of metal parts possible, so that parts could be interchangeable. During the second industrial revolution, a major factor of productivity growth was the substitution of inanimate power for human and animal labor, to water and wind power with electrification and internal combustion. Since that replacement, the great expansion of total power was driven by continuous improvements in energy conversion efficiency. Other major historical sources of productivity were automation, transportation infrastructures.

Lucas, Clark, Gregory (2007)

1.8.3. Economic growth per capita

The concern about economic growth often focuses on the desire to improve a country's standard of living, the level of goods and services that, on average, individuals purchase or otherwise gain access to. It should be noted that if the population grows along with economic Production, increases in GDP do not necessarily result in an improvement in the standard of living. When the

focus is on standard of living, economic growth is expressed on a per capita basis. Lucas, R, E. (1988)

At any moment the capital stock is a key determinant of the economy's output, but the capital stock can change over time, and those changes can lead to economic growth. In particular, two forces influence the capital stock: investment and depreciation. Investment refers to the expenditure on new plant and equipment, and it causes the capital stock to rise. Depreciation refers to the wearing out of old capital, and it causes the capital stock to fall. Like physical capital, human capital raises our ability to produce goods and services. Raising the level of human capital requires investment in the form of teachers, libraries, and students time. Policy-makers trying to stimulate economic growth must confront the issue of what kinds of capital the economy needs most. Mankiw (2003).

A high savings rate is also linked to the standard of living. Increased saving, in the long run, lead to a permanently higher output(income) per capita, as capital accumulation per individual also increases. Lucas, R, E. (1988)

1.8.4. Measuring economic growth

Economic growth is measured as a percentage change in the gross domestic product (GDP) or gross national product (GNP) .These two measures, which are calculated slightly differently, total the amounts paid for the goods and services that a country produced. As an example of measuring economic growth, a country which creates $9, 000,000,000 in goods and services in 2010 and then creates $9,090,000,000 in 2011, has a nominal economic Growth rate of 1 % for 2011. In order to compare per capital economic growth among countries, the total sells of the respected countries may be quoted in a single currency. This requires converting the value of

currencies of various countries into a selected currency, for example U.S. dollars. One way to do this conversion is too really on exchange rate among currencies, for example how many Mexican pesos buy single U.S dollars? Another approach is to use the purchasing power parity method. This method is based on how much consumers must pay for the same "basket of goods" in each country.

Inflation or deflation can make it difficult to measure economic growth. If GDP, for example, goes up in a country by 1% in year, was this due solely to rising prices(inflation), or because more goods and services were produced and saved? To express real growth rather than changes in prices for the same goods, statistics on economics growth are often adjusted for Inflation or deflation. For example, a table may show changes in GDP in the period from 1990 to 2000, as expressed in 1990 U.S. dollars. This means that the single currency being used in the U.S dollar with the purchasing power it had in the U.S in 1990.the table might mention that the figures are "infraction-adjusted “or real. If no adjustment were made for inflation, the table might make no Mention of inflation-adjustment or might mention that the prices are nominal Robert M. Solow Lawrence H.(1956, 2011)

1.8.5. The power of annual growth

Over a long periods of time, even small rates of growth, like a 2% annual increase, has large effects. For example, the United Kingdom experienced a 1.97% average annual increase in its inflation-adjusted GDP between 1830 and 2008. In 1830, the GDP was 41,373 million pounds. It grew to 1,330,088 million pounds by 2008. The large impact of a relatively small growth rate over a long period of time is due to the power of compounding. A growth rate of 2.5% per annum leads to a doubling of the GDP within 29 years, whilst a growth rate of 8% per annum (an

average exceeded by china between 2000 and 2010) leads to a doubling of GDP within 10 years. Thus a small difference in economic growth rates between countries can result in very different standards of living for their populations if this small difference continues for many years. Ayres, Robert U (2004).

1.8.5. Determinants of economic growth

There are four most important determinant of economic growth,

1.8.5.1. Human resources and its quality

Human resource of a country is the most crucial factor in its economic growth. Human resource is comprised of the available labor force and its quality. Quality of labor force depends on the level of its education, training, skills and its inventive and innovative abilities. Quantity and quality of manpower are both equally important. The labor force along with its skills is the source of all goods and services. A part from quantity and quality, an appropriate combination of labor with different skills is also very important in making optimum use of human resources.

1.8.5.2. Natural Resources

Natural resources of a country include the area of usable land, and resources on the land surface and underground. Land surface resources include sources of natural water (rivers and lakes), forest, landscape, etc. Underground resources include oil and natural gas and minerals. Favorable climatic and environmental conditions add to the natural resources endowments of a country. The countries with rich natural resource endowments have a much larger growth potential than those lacking natural resources. However, natural resources are passive factors of growth. The exploitation and use of natural resources depends on the quality of manpower, availability of

capital and technology. The countries endowed with rich natural resources and a highly skilled and motivated manpower can do miracles in economic growth. These are the factors which may be said to have contributed to rapid growth of the United States, France, Germany, U.K. Canada and Australia. Etc

1.8.5.3. Capital Formation

Capital is defined as man-made means of production. It includes machinery, plant and building, means of transport and communication, electricity, plants and social overheads like roads, railways, schools, colleges, hospitals, etc. building man-made means of production is known as capital formation or capital accumulation. Capital formation enhances the availability of capital per worker. Capital formation requires saving men and material resources from their use in consumer goods and transforming them into producer goods. In economic jargon, capital formation means sacrificing current consumption and saving incomes to be invested in capital goods (machinery, plant, building and equipment). In general, the countries with a high rate of saving and investment have a higher rate of economic growth.

1.8.5.4. Technology

Technology used in production is the fourth vital determinant of economic growth. Technology refers to scientific methods and techniques of production. In effect, technology means the amount of machinery and technical equipments used with a given amount of labor. Capital-labor ratio is a broad measure of technology. Technological development means improving the technique of production through research and innovation.

1.8.5.5. Social and political factors

Social and political systems, organizations, institutions, social values etc. also play an important role in the development process of an economy. Social factors like customs, traditions, institutions, etc. furthermore, political stability has always proved conducive to economic growth by encouraging industrial endeavors. An honest, sincere and efficient government builds public confidence, optimism and the right kind of attitude towards the society and the country, and commitment towards the nation and public welfare. In contrast, if the government is dishonest and inefficient, manner by corrupt and dishonest ministers, bureaucrats and government administrative infrastructure, it promotes inefficiency even in the private business;an increase cost of production, encourages inefficient allocation of resources, profiteering, and black marketing and encourages malpractices in the private sector. All these hamper growth.D N DWIVEDI, (2002).

1.9 Structure of the dissertation

The study is organized in five chapters. Chapter 1 introduces the research problem, the objectives the significance, the purpose and the scope of the study. Chapter 2 focuses on the literature review including Theoretical Perspectives and empirical case studies done before. Chapter 3 shows the methodology used in this study. Chapter 4 deals with the modeling and quantitative component of this analysis and the last chapter 5 covers Conclusions drawn from this study and the recommendations

CHAPTER 2: LITERATURE REVIEW

Over the last two decades the determinants of economic growth have attracted increasing attention on in both theoretical and applied research.

2.1. Theoretical Perspectives

There are two main theories about economic growth: endogenous and exogenous growth theories that are based on either the factors responsible for economic growth are coming from inside or outside of the model.

Rao (2010) classifies the empirical studies based on these two broad theories using either cross-sectional or time-series data. One of the most significant models has been created by Robert Solow in 1956, an exogenous growth theory usually referred as neoclassical growth theory based on time-series data where growth is determined by technological progress as an exogenous factor (Rao, 2010).

In the same study Rao (2010) identifies endogenous growth theories where technology is an endogenous variable caused by human capital or knowledge. Based on this the main difference between the two theories is the following: according to endogenous growth theory economic growth can be influenced by a variety of tools and policies while in exogenous growth model it cannot be done as Solow assumed technological progress evolves at a given rate.

In his book Mankiw (1997) explains the basic Solow model. The model identifies technological progress as the responsible factor for rising living standards. Solow uses the basic production function to construct his model: $Y = f(K, L)$ where Y is the total output of the economy and it

is a function of K (capital) and L (labor). He assumes decreasing returns to capital. The rate of savings, population growth and technological progress are exogenous variables.

Focusing on the economies of developing countries, some economists pointed out that inflation contributes positively to economic growth as it induces savings and investment through a number of channels (Baer, 1967; Georgescu-Roegen, 1970; Taylor, 1983). Governments of developing countries, faced with inadequate public revenues often resort to borrowing from Central Banks to finance their budget deficits. This seigniorage or inflation tax resources may be used by Governments to increase capital formation by financing real investment; as long as this financing mechanism does not crowd out private sector investment, the inflationary finance would contribute to economic growth (Kalecki effect). Nominal wages lag behind prices, due to slowly adjusting expectations, sluggish wage bargaining or Government wage repression; as a result, it follows that inflation may boost economic growth by shifting income distribution from individuals to higher saving capitalists and hence increasing savings , investment and growth (Kaldor effect).

According to Solow, accumulation of capital by increasing savings rate leads to a larger amount of capital stock and higher output level but this growth is only temporary and lasts until the economy reaches a new and higher level of steady state which is the long run equilibrium of the economy. It shows that investment is a key determinant of growth that can be enforced by higher savings rate but it does not give an explanation for long run growth so the model has been extended by population growth and technological progress. Population growth means the growing labor force.

Solow finds that growing labor force cannot explain economic growth either because population growth reduces the accumulation of capital stock, meaning that the larger amount of labor spreads the capital more thinly among people.

According to Solow only technological development can explain persistently rising living standards and a stable growth.

To build a more precise model Mankiw and Romer and Weil (1992) include the accumulation of human capital into the Solow growth model in the form of education. They find that accumulation of human capital is correlated with savings and population growth.

They also show that the Solow growth model has valid predictions only the magnitude is needed to be adjusted. The authors conclude that if human capital is taken into account convergence of countries is persistent with the Solow model.

Another substantial category contains endogenous growth theories that have different sub-groups depending on how technological change is explained by different researchers.

The main point of endogenous theories is that they treat technology as an endogenous factor and they are trying to answer the question what causes technological development.

Romer (1986) builds his model of long-run growth including knowledge as a factor responsible for technological development. He attributes increasing marginal productivity to it.

It is a very important aspect of the theory because in exogenous growth theories economy would reach steady state at some level but with knowledge as a source of growth the author suggests that there is no steady state that would end growth describing an infinite horizon growth.

In the debate of whether countries should converge Romer (1986) states that because of knowledge is an essential factor of long-run growth it can be slower or may not even appear in poor countries. He identifies knowledge as an externality, if a firm invests in knowledge and develops a new technology it will be copied by other firms so knowledge cannot be kept in secret for a long time.

Lucas (1988) argues the validity of the Solow model and adds an extra variable, the human capital. By human capital he means the general level of skill of labor that cannot be generalized for all the countries. Technology is a kind of 'human knowledge' that is related to particular people. Human capital influences both physical capital and labor and by investing in it both can be improved.

Lucas (1988) suggests that differences between countries remain because production of different goods require and develop different skills so human capital is not necessarily will be the same in all countries.

Grossman and Helpman (1991) develop and endogenous growth model based on R&D. They argue that the success of an industry or firm is proportional to its resources in R&D. Entrepreneurs are competing to produce new products and innovation is a key element in the process.

According to the model R&D is a source of infinite expansion. Of course rich countries have more sources to invest in research but poorer countries can copy the original developments. Barro (1991) shows some regularity in GDP growth based on recent theories and data. He is also using human capital as a positive factor of growth. He presents that countries that are rich in human capital have low fertility rates and high private investment rates. He also investigates the

impact of political stability and finds a negative correlation between instability and growth. This issue can be connected to the lack of safe property rights and investment.

Solow (2001) emphasizes the importance of difference between countries and that they cannot be compared by a simple cross-country regression. He also suggests that researchers must pay attention to the non-technological part when analyzing the effects of total factor productivity on growth. The dependent variables that are used affect total factor productivity and through this economic growth.

Neoclassical growth theories do not include education as a factor of growth. Knowledge may appear but its source is not precisely defined. New growth theories build on this deficiency explaining the role of education in economic growth. Domestic investments, savings and growth have a strong connection according to a vast number of researches. The causality between them is not obvious though.

In neoclassical growth models with diminishing returns to capital, a country's per capita growth rate tends to be inversely related to its initial level of income per person. This convergence hypothesis seems to be inconsistent with the cross-country evidence, which indicates that per capita growth rates for about 100 countries in the post-World War II period are uncorrelated with the starting level of per capita product. However, if one holds constant measures of initial human capital-measured by primary and secondary school-enrollment rates - there is evidence that countries with lower per capita product tend to grow faster. Countries with higher human capital also have lower fertility rates and higher ratios of physical investment to GDP. These results on growth, fertility, and investment are consistent with some recent theories of endogenous economic growth. With regard to government, the cross-country data indicate that government

consumption is inversely related to growth, whereas public investment has little relation with growth. Average growth rates are positively related to political stability, which may capture the benefits of secure property rights. There is also some indication that distortions of investment-goods prices are adverse for growth. Finally, the analysis leaves unexplained a good deal of the relatively weak growth performances of countries in sub- Saharan Africa and Latin America.

Scmidt-Hebbel and Servén and Solimano (1996) try to explore the relation between these factors. Savings and investments have different determinants: income and wealth is crucial for savings and profitability and risk are factors of investment.

2.2. Relative case study

Based on recent studies and their own research the authors conclude that there is a strong link between savings and growth but identifying the causality is still a challenge, these factors reinforce each other. There is a strong correlation between savings and investments and both should be reinforced by government policies. Under the term investments both physical and human capital is understood.

Ahmed and Miller (2002) use data collected through 8 years of 93 countries. The countries are divided into three groups based on their income level. The study shows that investment share affects GDP growth positively while population growth has a negative impact on economic growth in low- and middle-income countries. In high-income countries investment share does not influence GDP growth in a positive way while technology has more important implications than in low- and middle-income economies.

One of the ambiguous factors that influence growth is inflation. Before the 1970's it was a widespread belief that inflation had no significant effect on GDP growth or if it had that was positive.

Tobin (1965) uses the Solow model but extends it with adding money as an asset. It is a substitute to capital assets. The author suggests that the opportunity cost of holding money is preferable to accumulate capital so inflation has a positive effect on growth. During the following decades it was observed that countries with high inflation rates had worse economic performance (Al-Marhubi, 1998). In his study Al-Marhubi (1998) shows negative relation between inflation volatility and economic growth. This relation is indirect because inflation uncertainty reduces the level of investments thus economic growth

Bruno and Easterly (1995) examine the determinants of economic growth using annual CPI inflation of 26 countries which experienced inflation crises during the period between 1961 and 1992. In their empirical analysis, an inflation rate of 40 percent and over is considered as the threshold level for an inflation crisis. They find inconsistent or somewhat inconclusive relationship between inflation and economic growth below this threshold level when countries with high inflation crises are excluded from the sample. In addition, the empirical analysis suggests that there exists a temporal negative relationship between inflation and economic growth beyond this threshold level. The robustness of the empirical results is examined by controlling for other factors such as shocks (e.g., terms of trade shocks, political crises, and wars). Finally, they find that countries recover their pre-crisis economic growth rates following successful reduction of high inflation and there is no permanent damage to economic growth due to discrete high inflation crises.

Malla (1997) conducts an empirical analysis using a small sample of Asian countries and countries belonging to the Organization for Economic Cooperation and Development (OECD) separately. After controlling for labor and capital inputs, the estimated results suggest that for the OECD countries there exists a statistically significant negative relationship between economic growth and inflation including its first difference. However, the relationship is not statistically significant for the developing countries of Asia. The crucial finding of this empirical analysis suggests that the cross-country relationship between inflation and long-term economic growth experiences some fundamental problems like adjustment in country sample and the time period. Therefore, inconclusive relationship between inflation and economic growth can be drawn from comparing cross country time-series regressions with different regions and time periods.

Alexander and Robert (1997) use a sample of OECD countries to show the relation between inflation and growth in their study. They construct a simple model by using marginal product of labor and capital as factors of growth. As a result of a pooled regression they conclude that even if inflation has any positive effects on growth it is outweighed by its negative effects. Paul and Kearney and Chowdhury (1997) conduct a research to show if there is causality between the real growth of GDP and inflation in the long run. They use a large sample of 70 countries including industrialized as well as developing countries with both high and low inflation economies during a 30 year period.

The main conclusion the researchers make is that we cannot use a single pattern to all of the countries for the relationship between inflation and growth. According to them around one third of the sample countries does not have a relationship between these two factors and in other cases this relationship is ambiguous.

The connection between trade openness and economic growth has been explored for a long time. Dar and Amilkhalkali (2003) explain in their study that if export expansion functions as the engine of growth the more open economies- the more dependent on international trade- should be more advanced. It has to be noted that openness is not only a result of a specific policy but geography and size of the state also determines the trade relations of a country. In their research the authors use data from 19 OECD countries during 1971-1999. The countries are ranked based on their level of openness. The results show that export is the least significant determinant of growth for those countries that are the least open but the effect of this factor increases as openness increases until a specific level. Besides, labor productivity and total factor productivity are positively related to trade openness.

Zhou and Li (2011) conduct a nonparametric research about openness and trade. They show that openness to make a significant contribution to growth the economy has to perform well and already be open otherwise trade openness does not have a positive impact on economic growth. There has been an ongoing debate about European Union membership and economic growth, whether it is beneficial for countries to be part of the EU or not.

Cuaresma and Ritzberger-Grünwald and Silgoner (2008) have conducted a research to answer the above question. According to neoclassical growth theory the EU should only have temporary effect on growth in its member countries before reaching the steady state level. The theory suggests converging economies. On the other hand endogenous growth theories predict as the integrated economies grow larger there will be more investment in research and development. As a consequence of knowledge spill-over growth rate will increase. Findings of the study show that EU membership has a positive effect on economic growth and it is increasing as the time spent in EU increases. The growth is greater for those countries that have had a lower initial income level indicating that EU membership is more beneficial for the less developed countries. The authors identify the responsible factors as following: technological diffusion, financial support that EU provides for its members, institutional stability and fiscal policy. There have been other researches about whether European countries behave according to neoclassical or endogenous growth model.

Karras (2001) points out that if a permanent change in any of the variables used causes a permanent change in growth the tested countries behave according to endogenous model because neoclassical model suggests achieving a new steady state with a temporary growth. He argues that most of the findings support neoclassical growth theory. One of the most important implications of this result is regional convergence.

Hishow (2007) is digging into the ambiguity why common currency has not resulted in the expected economic growth in Europe. The main goal of the EU was to achieve higher growth, create more jobs and establish balanced government budget but countries perform very differently in the Eurozone area. Instead of the initial expectation of the Economic and Monetary Union (EMU) of converging per capita income, it is actually diverging. One of the possible

explanations is that capital is moving from the richer to the poorer regions because the latter one offers higher returns. The author also points out that some of the member countries do not use the growing exports as a source of economic growth rather some governments increase budget spending that is not effective in triggering growth. The root of the problem is the heterogeneity of European economies that are forced to act according a common policy frame and also integration is working in theory institutional difficulties make the system function with mistakes.

O Zhang (1999) examines the causal relationship between foreign direct investment and economic growth with Granger causality analysis for 10 Asian countries. The results of this study suggested that there is a unidirectional causality between foreign direct investment and economic growth with direction from FDI to GDP in Hong Kong, Japan, Singapore, Taiwan, a unidirectional causality between exports and economic growth with direction from economic growth to exports for Malaysia and Thailand, also there is a bilateral causal relationship between FDI and GDP for Kina and Indonesia, while there is no causality for Korea and Philippines. Borensztein, De Gregorio and Lee (1998) highlight the role of FDI as an important vehicle of economic growth only in the case that there is a sufficient absorptive capability in the host economy. This capability is dependent on the achievement of a minimum threshold of human capital.

Maudos and Pastor and Seranno (1999) observe how economies of European countries change by expansion. They conclude that efficiency and total factor productivity of founder countries have increased by expansion of the EU.

Badinger (2008) points out that economic integration can influence growth in two ways: it can increase the overall efficiency of the economy- this is the technology-led growth and by generating greater investment opportunities- investment-led growth. The study focuses on the period 1960-2000 and finds a significant connection between integration and growth triggered by both investments and technology.

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Chapter 3: METHODOLOGY

3.1. Data and Variables

The objective of this paper is to explore the causal nexus between macro-variables (Foreign Direct Investment (FDI), Gross capital formation and Export) and economic growth in Rwanda using the annual data for the period, 1980 to 2012 which includes the 33 annual observations. The two main variables of this study are economic growth, Foreign Direct Investment (FDI), Gross capital formation and Export. The real Gross Domestic Product (GDP) is used as the proxy for economic growth in Rwanda and we represent the economic growth rate by using the constant value of Gross Domestic Product (GDP) measured in Rwanda franc. All necessary data for the sample period are obtained from International Monetary Fund (IMF). All the variables are taken in their natural logarithms to reduce the problems of heteroscedasticity to maximum possible extent. Using the time period, 1980 to 2012 for Rwanda, this study aims to examine the long-term and causal dynamic relationships between the level of Export, Gross capital formation and FDI flowing into Rwanda and economic growth. The estimation methodology employed in this study is the cointegration and error correction modeling technique. The entire estimation procedure consists of three steps: first, unit root test; second, cointegration test; third, the error correction model estimation.

3.2. Econometric specification:

3.2.1 Hypothesis:

The paper is based on the following hypotheses for testing the causality and co-integration between GDP and explanatory variables in Rwanda.

(i) Whether there is bi-directional causality between GDP growth, FDI, Gross capital formation and Export

(ii) Whether there is unidirectional causality between the two by two variables,

(iii) Whether there is no causality between GDP and FDI, Gross capital formation and Export in Rwanda

(iv)Whether there exists a long run relationship between GDP and explanatory's variables in Rwanda.

3.2.2.Model Specification

The choice of the existing model is based on the fact that it allows for generation and estimation of all the parameters without resulting into unnecessary data mining. The growth model for the study takes the form:

$$GDPN = f(FDIG, INVG, EXPG) \cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

where:

GDPN=per capita GDP

EXPG= Exports of goods and services (% of GDP)

INVG= Gross capital formation (% of GDP)

FDIG= the ratio of foreign direct investments to GDP

The link between Economic growth (measured in terms of GDP growth) and foreign direct investment, Gross capital formation and export in Rwanda can be described using the following model in linear form:

$$LGDPN_t = \beta_0 + \beta_1 LFDIG_t + \beta_3 LINVG_t + \beta_3 LEXPG_t + \varepsilon_t \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (1.1)$$

The variables remain as previously defined with the exception of being in their natural log form. ε_t is the error term assumed to be normally, identically and independently distributed. Here, $GDPN_t$, $FDIG_t$, $INVG_t$ and $EXPG_t$ show the per capita Gross Domestic Product, the ratio of foreign direct investments to Gross Domestic Product, the percentage of Gross capital formation to Gross Domestic Product and the percentage of Exports of goods and services to Gross Domestic Product at a particular time respectively while ε_t represents the "noise" or error term; β_i *where i=0,1,2,and 3* represent the slope and coefficient of regression. The coefficient of regression, *β's* indicates how a unit change in the independent variable (foreign direct investment, Gross capital formation and Exports of goods and services) affects the dependent variable (gross domestic product). The error ε_t, is incorporated in the equation to cater for other factors that may influence GDP. The validity or strength of the Ordinary Least Squares method depends on the accuracy of assumptions. In this study, the Gauss-Markov assumptions are used and they include; that the dependent and independent variables are linearly co-related, the estimators (β_i *where i=0,1,2,and 3*) are unbiased with an expected value of zero i.e., $E(\varepsilon_t) = 0$,

which implies that on average the errors cancel out each other. The procedure involves specifying the dependent and independent variables; in this case, GDPN is the dependent variable while $GDPN_t$, $FDIG_t$, $INVG_t$ and $EXPG_t$ the independent variables. But it depends on the assumptions that the results of the methods can be adversely affected by outliers. In addition, whereas the Ordinary Least squares regression analysis can establish the dependence of either GDP on independent variables or vice versa; this does not necessarily imply direction of causation. Stuart Kendal noted that "a statistical relationship, however, strong and however suggestive, can never establish causal connection." Thus, in this study, the method of Granger causality test, is used to further test for the direction of causality.

This study aimed to examine the long-term relationship between foreign direct investment, gross capital formation, export and gross domestic product in Rwanda between 1980 and 2012. Using co-integration and Vector Error Correction Model (VECM) procedures, we investigated the relationship between these four variables. The likely short-term properties of the relationship among economic growth and foreign direct investment, exportation level and gross capital formation were obtained from the VECM application. Next, unit root, VAR, cointegration and Vector Error Correction Model (VECM) procedures were utilized in turn. The first step for an appropriate analysis is to determine if the data series are stationary or not. Time series data generally tend to be nonstationary, and thus they suffer from unit roots.

Due to the non-stationarity, regressions with time series data are very likely to result in spurious results. The problems stemming from spurious regression have been described by Granger and Newbold (1974). In order to ensure the condition of stationarity, a series ought to be integrated to the order of 0 [I(0)]. In this study, tests of stationarity, commonly known as unit root tests, were

adopted from Dickey and Fuller (1979, 1981) and Phillips-Perron test. As the data were analyzed, we discovered that error terms had been correlated in the time series data used in this study.

*Step –I**: The Stationarity Test (Unit Root Test)***

When dealing with time series data, a number of econometric issues can influence the estimation of parameters using OLS. Regressing a time series variable on another time series variable using the Ordinary Least Squares (OLS) estimation can obtain a very high R2, although there is no meaningful relationship between the variables. This situation reflects the problem of spurious regression between totally unrelated variables generated by a non-stationary process. Therefore, prior to testing Cointegration and implementing the Granger Causality test, econometric methodology needs to examine the stationarity; for each individual time series, most macro economic data are non stationary, i.e. they tend to exhibit a deterministic and/or stochastic trend. Therefore, it is recommended that a stationarity (unit root) test be carried out to test for the order of integration. A series is said to be stationary if the mean and variance are time-invariant.

A non-stationary time series will have a time dependent mean or make sure that the variables are stationary, because if they are not, the standard assumptions for asymptotic analysis in the Granger test will not be valid. Therefore, a stochastic process that is said to be stationary simply implies that the mean [(E(Y_t)] and the variance [Var (Y_t)] of Y remain constant over time for all t, and the covariance [covar (Y_t, Y_i)] and hence the correlation between any two values of Y taken from different time periods depends on the difference apart in time between the two values for all t≠i. Since standard regression analysis requires that data series be stationary, it is

obviously important that we first test for this requirement to determine whether the series used in the regression process is a difference stationary or a trend stationary. The Augmented Dickey-Fuller (ADF) test is used.

To test the stationary of variables, we use the Augmented Dickey Fuller (ADF) test which is mostly used to test for unit root. Following equations checks the stationarity of time series data used in the study:

$$\Delta y_t = \beta_0 + \beta_1 t + \alpha Y_{t-1} + \gamma \sum \Delta Y_{t-1} + \varepsilon_t \cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

And

$$\Delta y_t = \alpha_0 + \rho y_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta y_{t-i} + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where ε_t is white nose error term in the model of unit root test, with a null hypothesis that variable has unit root. The ADF regression test for the existence of unit root of Y_t that represents all variables (in the natural logarithmic form) at time t. The test for a unit root is conducted on the coefficient of Y_{t-1} in the regression. If the coefficient is significantly different from zero (less than zero) then the hypothesis that *Y* contains a unit root is rejected. The null and alternative hypothesis for the existence of unit root invariable Y_t is H0; $\alpha = 0$ versus H1: $\alpha < 0$. Rejection of the null hypothesis denotes stationarity in the series.

If the ADF test-statistic (t-statistic) is less (in the absolute value) than the Mackinnon critical t-values, the null hypothesis of a unit root can not be rejected for the time series and hence, one

can conclude that the series is nonstationary at their levels. The unit root test tests for the existence of a unit root in two cases: with intercept only and with intercept and trend to take into the account the impact of the trend on the series. The PP tests are non-parametric unit root tests that are modified so that serial correlation does not affect their asymptotic distribution. PP tests reveal that all variables are integrated of order one with and without linear trends, and with or without intercept terms. Phillips–Perron test (named after Peter C. B. Phillips and Pierre Perron) is a unit root test. That is, it is used in time series analysis to test the null hypothesis that a time series is integrated of order 1. It builds on the Dickey–Fuller testof the null hypothesis $\delta = 0$ in $\Delta Y_t = \delta Y_{t-1} + u_t$, here Δ is the first difference operator. Like the augmented Dickey–Fuller test, the Phillips–Perron test addresses the issue that the process generating data for Y_t might have a higher order of autocorrelation than is admitted in the test equation - making Y_{t-1} endogenous and thus invalidating the Dickey–Fuller t-test. Whilst the augmented Dickey– Fuller test addresses this issue by introducing lags of ΔY_t as regressors in the test equation, the Phillips–Perron test makes a non-parametric correction to the t-test statistic. The test is robust with respect to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test equation.

Once the number of unit roots in the series was decided, the next step before applying Johansen's (1988) cointegration test was to determine an appropriate number of lags to be used in estimation. Second, Eagle-Granger residual based test tests the existence of co integration among the variables-FDIG, INVG, EXPG and GDPN at constant prices for the economy. Third, if a co integration relationship does not exist, VAR analysis in the first difference is applied, however, if the variables are co integrated, the analysis continues in a cointegration framework. Several tests of non-stationarity called unit root tests have been developed in the time series econometrics

literature. In most of these tests the null hypothesis is that there is a unit root, and it is rejected only when there is strong evidence against it. Most tests of the Dickey-Fuller (DF) type have low power (see Dejong et al. 1992). Because of this Maddala and Kim (1998) argue that DF, ADF (augmented Dickey-Fuller) and PP (Phillips and Perron) tests should be discarded. We, therefore, use the KPSS (Kwiatkowski, Phillips, Schmidt and Shin 1992) test which is considered relatively more powerful (Bahmani- Oskooee et.al.,1999). The KPSS Lagrange Multiplier tests the null of stationarity (H0: $\rho < 1$) against the alternative of a unit root (H1: $\rho = 1$). In econometrics, Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests are used for testing a null hypothesis that an observable time series is stationary around a deterministic trend. The series is expressed as the sum of deterministic trend, random walk, and stationary error, and the test is the Lagrange multiplier test of the hypothesis that the random walk has zero variance. KPSS type tests are intended to complement unit root tests, such as the Dickey–Fuller tests. By testing both the unit root hypothesis and the stationarity hypothesis, one can distinguish series that appear to be stationary, series that appear to have a unit root, and series for which the data (or the tests) are not sufficiently informative to be sure whether they are stationary or integrated. The KPPS (1992) Test is based on the residuals (ε_t) from an ordinary least square regression of the variable of interest on the exogenous variable(s) as follows:

$$Y_t = X_t\beta + \varepsilon_t \cdots\cdots\cdots\cdots\cdots\cdots\cdots (4)$$

where Y_t is the variable of interest and X_t is a vector of exogenous variable(s). The Lagrange Multiplier (LM) statistic used in the test as follows:

$$LM = T^{-2} \sum_{i=1}^{T} S(t)^2 \ \ /f_0 \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5)$$

where T is the sample size, S(t) is the partial sum of residuals which is calculated as

$$S(t) = \sum_{i=1}^{t} S_r \ \ .$$

Here ε_t is the estimated residual from (3). f_0 is an estimator of the residual spectrum at frequency zero. This statistic has to be compared with KPSS et al. (1992) critical values.

Step-II: ***Testing for Cointegration Test (Johansen Approach)***

Cointegration, an econometric property of time series variable, is a precondition for the existence of a long run or equilibrium economic relationship between two or more variables having unit roots (i.e. Integrated of order one). The Johansen approach can determine the number of cointegrated vectors for any given number of non-stationary variables of the same order. Two or more random variables are said to be cointegrated if each of the series are themselves non – stationary. This test may be regarded as a long run equilibrium relationship among the variables. The purpose of the Cointegration tests is to determine whether a group of non – stationary series is cointegrated or not. Having concluded from the ADF results that each time series is non-stationary, i.e it is integrated of order one I(1),we proceed to the second step, which requires that the two time series be co-integrated. In other words, we have to examine whether or not there

exists a long run relationship between variables (stable and non-spurious co-integrated relationship). In our case, the mission is to determine whether or not the ratio of foreign direct investments to Gross Domestic Product, the percentage of Gross capital formation to Gross Domestic Product and the percentage of Exports of goods and services to Gross Domestic) and per capita Gross Domestic Product variables have a long-run relationship in a bivariate framework. Engle and Granger (1987) introduced the concept of cointegration, where economic variables might reach a long-run equilibrium that reflects a stable relationship among them. For the variables to be co-integrated, they must be integrated of order one (non-stationary) and the linear combination of them is stationary I(0). The crucial approach which is used in this study to test r cointegration is called the Johansen cointegration approach. The Johansen approach can determine the number of cointegrated vectors for any given number of nonstationary variables of the same order.

Step-III: ***The Granger Causality test :***

Causality is a kind of statistical feedback concept which is widely used in the building of forecasting models.

Historically, Granger (1969) and Sim (1972) were the ones who formalized the application of causality in economics. Granger causality test is a technique for determining whether one time series is significant in forecasting another (Granger. 1969). The standard Granger causality test (Granger, 1988) seeks to determine whether past values of a variable helps to predict changes in another variable. The definition states that in the conditional distribution, lagged values of Y_t add no information to explanation of movements of X_t beyond that provided by lagged values of X_t

itself (Green, 2003). We should take note of the fact that the Granger causality technique measures the information given by one variable in explaining the latest value of another variable. In addition, it also says that variable *Y* is Granger caused by variable *X* if variable *X* assists in predicting the value of variable *Y*. If this is the case, It means that the lagged values of variable *X* are statistically significant in explaining variable *Y*. The null hypothesis (H0) that we test in this case is that the *X* variable does not Granger cause variable Y and variable Y does not Granger cause variable X. In summary, one variable (X_t) is said to granger cause another variable (Y_t) if the lagged values of X_t can predict Y_t and vice-versa. FDIG, INVG, EXPG and GDPN are, in fact, interlinked and co-related through various channel. There is no theoretical or empirical evidence that could conclusively indicate sequencing from either direction. For this reason, the Granger Causality test was carried out on FDIG, INVG, EXPG and GDP. The spirit of Engle and Granger (1987) lies in the idea that if the two variables are integrated as order one, I(1), and both residuals are I(0), this indicates that the two variables are cointegrated. The Granger theorem states that if this is the case, the two variables could be generated by a dynamic relationship from Y to X and, vise versa. Therefore, a time series *X* is said to Granger-cause *Y* if it can be shown through a series of F-tests on lagged values of *X* (and with lagged values of *Y* also known) that those *X* values predict statistically significant information about future values of *Y*. In the context of this analysis, the Granger method involves the estimation of the following equations:

If causality (or causation) runs from X to Y, we have:

$$dY_{it} = \eta_i + \sum \alpha_{11}\, dY_{i,t-1} + \sum \beta_{11}\, dX_{i,t-1} + \varepsilon_{1t} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (6)$$

If causality (or causation) runs from Y to X, it takes the form:

$$dX_{it} = \eta_i + \sum \alpha_{12}\, dX_{i,t-1} + \sum \beta_{12}\, dY_{i,t-1} + \lambda ECM_{it} + \varepsilon_{2t} \cdots\cdots\cdots\cdots\cdots\cdots (7)$$

Where Y_t and X_t represent the two variables in your model, ε_{it} is uncorrelated stationary random process, and subscript *t* denotes the time period. In equation 4, failing to reject: H0: α_{11}= β_{11} = 0 implies that X does not Granger cause Y. On the other hand, in equation 4, failing to reject H0: α_{12}= β_{12} = 0 implies that economic growth via GDP growth does not Granger cause foreign direct investment. The decision rule: From equation (6), $dX_{i,t-1}$Granger causes $dY_{i,t}$ if the coefficient of the lagged values of X as a group (β_{11}) is significantly different from zero based on F-test (i.e., statistically significant). Similarly, from equation (7), $dY_{i,t-1}$ Granger causes $dX_{i,t}$ if β_{11} is statistically significant.

Step V: ***Error Correcting Model (ECM) and Short Term Causality Test :***

Error correction mechanism was first used by Sargan (1984), later adopted, modified and popularized by Engle and Granger (1987). By definition, error correction mechanism is a means of reconciling the short-run behaviour (or value) of an economic variable with its longrun behaviour (or value). An important theorem in this regard is the Granger Representation Theorem which demonstrates that any set of cointegrated time series has an error correction representation, which reflects the short-run adjustment mechanism. Co- integration relationships just reflect the long term balanced relations between relevant variables. In order to cover the

shortage, correcting mechanism of short term deviation from long term balance could be cited. At the same time, as the limited number of years, the above test result may cause disputes (Christpoulos and Tsionas, 2004). Therefore, under the circumstance of long term causalities, short term causalities should be further tested as well. Empirical works based on time series data assume that the underlying time series is stationary. However, many studies have shown that majority of time series variables are nonstationary or integrated of order 1 (Engle and Granger, 1987). The time series properties of the data at hand are therefore studied in the outset. Formal tests will be carried out to find the time series properties of the variables. If the variables are *I* (1), Engle and Granger (1987) assert that causality must exist in, at least, one direction.

Chapter 4. DATA ANALYSIS

Economic theory scarcely provides some guidance for which variables appear to have a stochastic trend and when these trends are common among the examined variables as well. For the analysis of the multivariate time series that include stochastic trends, the Augmented Dickey-Fuller (1979) (ADF) unit root test is used for the estimation of individual time series with intention to provide evidence for when the variables are integrated. This is followed by multivariate cointegration analysis.

4.1 Unit root test

We used the augmented Dickey-Fuller procedure to test for stationarity. The ADF tests are conducted using the ADF regressions of the forms in equations (2), which is with a constant and with a time trend, and equation (3) which is with a constant and no time trend. In testing the hypothesis that ρ=0, k is the lag order used to remove any possible serial correlation in the residuals.The cointegration test among the variables that are used in the model (1) requires previously the test for the existence of unit root for each variable and especially, for per capita gross domestic product (GDP) and the ratio of exports to GDP, the ratio of gross fixed capital formation to GDP, the ratio of foreign direct investment to GDP, using the Augmented Dickey-Fuller (ADF) (1979) test on the following regressions:

$$\Delta y_t = \alpha_0 + \alpha_1 t + \rho y_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta y_{t-i} + u_t \qquad (2)$$

And

$$\Delta y_t = \alpha_0 + \rho y_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta y_{t-i} + u_t \qquad (3)$$

The results of these tests appear in Table 1. The minimum values of the Akaike (AIC) and Schwartz (SC) statistics have provided the better structure of the ADF equations as well as the relative numbers of time lags, under the indication "Lag". As far as the autocorrelation disturbance term test is concerned. The Eviews7, econometric package that was used for the estimation of ADF test, provides us the simulated critical values.

Table 1: Results of the Unit Root Tests: Using Augmented Dickey-Fuller Tests

VARIABLES	ADF TEST STATISTICS					CONCLUSION
		With drift		With trend and drift		
		T-STATISTICS	Maximum lag	T-STATISTICS	Maximum lag	
LGDPN	Level	0.501390	8	-2.312816	8	
	ΔLevel	-6.650451	8	-6.902490	8	I(1)
LINVG	Level	-2.080772	8	-2.733278	8	
	ΔLevel	-9.117832	8	-6.410355	8	I(1)
LEXPG	Level	-2.055598	8	-2.219116	8	
	ΔLevel	-4.919484	8	-5.495192	8	I(1)

LFDIG	Level	-3.808894	8	-3.766979	8	I(0)
Auxiliary Regression with Drift						
Test critical values:		1% level		-3.615588		
		5% level		-2.941145		
		10% level		-2.609066		
Auxiliary Regression with Drift and Trend						
Test critical values:	1% level		-4.219126			
	5% level		-3.533083			
	10% level		-3.198312			

The results of Table 1 show that, no time series appear to be stationary in variable levels except the ratio of foreign direct investments to GDP (FDIG) this explain that the foreign direct investment increase on the same proportion of the gross domestic product. However, when the logarithms of the time series are transformed into their first differences, they become stationary and consequently the related variables can be characterized integrated of order one, I(1).

These results confirm what the graphs shown in appendix A2 and A3.

4.2 Johansen Cointegration test

If the time series (variables) are non-stationary in their levels, they can be integrated with integration order 1, when their first differences are stationary. These variables can be cointegrated as well if there are one or more linear combinations among the variables that are

stationary. If these variables are being cointegrated then there is a constant long-run linear relationship among them.

Since it has been determined that the variables under examination are integrated of order 1 except FDIG which is integrated at order zero, the cointegration test is performed. The testing hypothesis is the null of non-cointegration against the alternative that is the existence of cointegration using the Johansen (1988) maximum likelihood procedure Johansen and Juselious (1990, 1992). An autoregressive coefficient is used for the modelling of each variable (that is regarded as endogenous) as a function of all lagged endogenous variables of the model.

Given the fact that in order to apply the Johansen technique a sufficient number of time lags is required, we have followed the relative procedure, which is based on the calculation LR (Likelihood Ratio) test statistic (Sims, 1980). The results showed that the value ρ=3 is the appropriate specification for the above relationship. Further on we determine the cointegration vectors of the model, under the condition that matrix Π has an order $r < n\,(n = 4)$. The procedure of calculating order r is related to the estimation of the characteristic roots (eigenvalues), which are the following:

Table 2: Johansen Test for Co integration

Sample (adjusted): 1985 2012

Trend assumption: Linear deterministic trend (restricted)

Series: LGDPN LFDIG LEXPG LINVG

Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test **(Trace)**

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.932564	168.0469	63.87610	0.0000
At most 1 *	0.893542	92.54256	42.91525	0.0000
At most 2 *	0.514989	29.82239	25.87211	0.0153
At most 3	0.289298	9.562061	12.51798	0.1485

Trace test indicates 3 cointegratingeqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Unrestricted Cointegration Rank Test **(Maximum Eigenvalue)**

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.932564	75.50429	32.11832	0.0000
At most 1 *	0.893542	62.72017	25.82321	0.0000
At most 2 *	0.514989	20.26033	19.38704	0.0373

At most 3	0.289298	9.562061	12.51798	0.1485

Max-eigenvalue test indicates 3 cointegratingeqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Table 2 presents the Johansen Co-integration result. All tests (trace and Maximum Eigen value) show that there are three co-integrating (CI) equations in the analysis. Only one of the CI equations was chosen. The CI equation chosen was based on the conformity of the coefficients with economic theory and its statistical significance which is

1Cointegrating Equation(s):

Normalized cointegrating coefficients (standard error in parentheses)

LGDPN	LFDIG	LEXPG	LINVG	@TREND(81)
1.000000	0.047087	-0.029331	-1.998185	-0.062115
	(0.02450)	(0.08422)	(0.22031)	(0.00312)

GDPN=per capita GDP

EXPG= Exports of goods and services (% of GDP)

INVG= Gross capital formation (% of GDP)

FDIG= the ratio of foreign direct investments to GDP

The coefficient having positive sign is significant at 1 percent level of significance suggesting that 1 percent increase in the ratio of foreign direct investments to GDP leads to 0.047 percent decrease in per capital GDP on the average in the long run. As expected, the ratio of Exports of goods and services to GDP at 1 percent level of significance implying that per capital GDP will increase by 0.03 percent due to 1 percent increase in the ratio of Exports of goods and services to GDP on the average in the long run. As expected, the ratio of Gross Capital Formation to GDP at 1 percent level of significance implying that per capital GDP will increase by 1.99 percent due to 1 percent increase in the ratio of Gross Capital Formation to GDP on the average in the long run.

Table 3: Residual test

Null Hypothesis: RESID01 has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.747763	0.0000
Test critical values:	1% level	-2.644302	
	5% level	-1.952473	
	10% level	-1.610211	

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

The unit root tests show that the residuals are stationary at order zero. This conclusion is a sufficient indication of the existence of a long-run relationship between economic growth,

Foreign Direct Investment (FDI), Gross capital formation and Export; therefore we can estimate an error correction model for economic growth in Rwanda.

4.3 Estimation of short-run Model

After determining that the logarithms of the model variables are cointegrated, we must estimate then a VAR model in which we shall include a mechanism of error correction model (MEC). The error correction model arises from the long-run cointegration relationship and has the following form:

$$\Delta LGDPN_t = lagged(\Delta LGDPN_t, \Delta LEXPG_t, \Delta LINVG_t, LFDIG_t) + \lambda\, u_{t-1} + V_t (3)$$

whereΔ is reported to first differences of variables

$u_{t-1}$are the estimated residuals from the cointegrated regression (long-run relationship) and represents the deviation from the equilibrium in time period *t*.

$-1 < \lambda < 0$ short-run parameter

$V_t$white noise disturbance term.

One difficulty, which a researcher faces with the estimation of an autoregressive VAR model, is the appropriate specification of the model. Specially, the researcher has to decide which deterministic components should be included and which number of lags should be used as well.

Since arbitrarily selected specifications of the autoregressive VAR model are possible to produce unreliable results, we use the selection criterion of a database model in order to specify the autoregressive VAR model for Rwanda economy. Among the different selection criteria of the model the one that suggested by Schwartz (1978), known as Schwartz Bayesian information

criterion, seems to outperform other alternative solutions (Mills and Prasad 1992). Therefore, the specification of the autoregressive VAR model is based on the Schwartz Bayesian information criterion. Also, first order specification of the model VAR (1) is selected with a constant and a time trend.

The final form of the Error-Correction Model was selected according to the approach suggested by Hendry (Maddala 1992). The initial order of time lag for the model is 2 because it is large enough to enclose the system's short-run dynamic. We also apply a number of diagnostic tests on the residuals of the model. We apply the Lagrange test for the residuals' autocorrelation, the heteroscedasticity test and the Bera-Jarque normality test. We also test the functional form of the model according to the Ramsey's Reset test. Error correction model is appeared in table 3.

Table 4 : Error Correction Model

Dependent Variable: DLGDPN

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLGDPN(-1)	0.373514	0.144532	2.584301	0.0163
DLEXPG(-1)	0.121399	0.081711	1.485711	0.1504
DLINVG(-1)	-0.198016	0.186749	-1.060335	0.2995
LFDIG(-1)	-0.051959	0.013611	-3.817456	0.0008
D1994	-0.503596	0.098121	-5.132375	0.0000
ECT(-1)	-0.037806	0.020991	-1.801076	0.0843
R-squared	0.756426			

Adjusted R-squared	0.705681
S.E. of regression	0.092979

We do not reject the estimations, which are based on the results of table 4 according to the statistical and diagnostic tests in 10% level of significance (except the variable of exports). The percentage of the total variation of the dependent variable that is described in our model is high enough (75.6%). The most important thing in the short run results is speed of adjustment term or Error-Correction Term. It shows that how much time would be taken by the economy to reach at long run equilibrium. Negative sign of speed of adjustment term shows that the economy will converge towards long run equilibrium after taking 3.7 percent annually adjustments in the short run however the value of coefficient is statistically significant at 10% but insignificant at 5%.

From the results of table 4 we can infer that in the short-run an increase of 1% on ratio of exports to GDP will lead to an increase of 0.12% on per capita GDP, an increase of 1% on the ratio of gross fixed capital formation to GDP will lead to an decrease of 0.2% on per capita GDP, while increase of 1% on ratio of foreign direct investment to GDP will lead to an decrease of 0.051% on per capita GDP.

4.4. Diagnostic tests

Having presented the result from the empirical analysis, it is also necessary to examine the statistical properties of the estimated model. The model was tested for normality, serial correlation, autoregressive conditional heteroscedasticity. The results, reported in Appendix B,

suggest that the model is well specified. The diagnostics indicate that the residuals are normally distributed, homoscedasticity, and serial uncorrelation.

4.5 Granger causality test

The study has found interesting results of granger causality in table 4 based on significant probability values less than or equal to 0.10. The results relating to the existence of Granger causal relationships between the variables: the per capita GDP, the ratio of exports to GDP, the ratio of gross fixed capital formation to GDP, the ratio of foreign direct investment to GDP appear in Table 5.

Table 5: Granger Causality Tests

Pairwise Granger Causality Tests

Sample: 1980 2012

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LEXPG does not Granger Cause LFDIG	31	5.95876	0.0074
LFDIG does not Granger Cause LEXPG		0.72588	0.4934
LGDPN does not Granger Cause LFDIG	31	0.68090	0.5150
LFDIG does not Granger Cause LGDPN		10.1284	0.0006

LINVG does not Granger Cause LFDIG	31	0.10251	0.9029
LFDIG does not Granger Cause LINVG		0.24678	0.7831
LGDPN does not Granger Cause LEXPG	31	2.01782	0.1532
LEXPG does not Granger Cause LGDPN		0.99526	0.3833
LINVG does not Granger Cause LEXPG	31	0.58056	0.5667
LEXPG does not Granger Cause LINVG		3.81329	0.0353
LINVG does not Granger Cause LGDPN	31	4.06245	0.0292
LGDPN does not Granger Cause LINVG		3.26189	0.0545

From the results of table 5 we can infer that:

There is a bi-directional causal relationship between the per capita GDP and the ratio of gross fixed capital formation to GDP. Also There is a unidirectional causal relationship between the ratio of exports to GDP and the ratio of foreign direct investments to GDP with direction from exports to foreign direct investments, a unidirectional causal relationship between the ratio of foreign direct investments to GDP and the per capita GDP with direction from foreign direct investments to per capita GDP, and final a unidirectional causal relationship between the ratio of exports to GDP and the ratio of gross fixed capital formation to GDP with direction from exports to gross fixed capital formation .

Chapter 5. **CONCLUSION AND RECOMMENDATION**

5**.1 Conclusion**

In this paper an effort was made in order to examine the relationship among the per capita GDP, the ratio of exports to GDP, the ratio of gross fixed capital formation to GDP, the ratio of gross fixed capital formation to GDP and the ratio of foreign direct investments to GDP, using annual data over the period 1980-2012.

The empirical analysis suggested that the examined variables present a unit root except the ratio of foreign direct investments to GDP (FDIG) . On this basis the Johansen cointegration test analysis was used to lead to long-run equilibrium relationships among these variables. Then the methodology of error correction model was applied to estimate the short-run. The selected cointegrated vectors gave us the appropriate error correction terms, which proved to be statistically significant at a 5% level of significance during their inclusion to the short-run dynamic equations.

Final, through Granger causality test we can infer that There is a bi-directional causal relationship between the per capita GDP and the ratio of gross fixed capital formation to GDP. Also There is a unidirectional causal relationship between the ratio of exports to GDP and the ratio of foreign direct investments to GDP with direction from exports to foreign direct investments, a unidirectional causal relationship between the ratio of foreign direct investments to GDP and the per capita GDP with direction from foreign direct investments to per capita GDP, and final a unidirectional causal relationship between the ratio of exports to GDP and the ratio of gross fixed capital formation to GDP with direction from exports to gross fixed capital formation.

5.2 RECOMMENDATIONS

The results discussed in chapter 4 have several implications for Rwanda: it is suggested that economic growth in Rwanda is only significantly influenced by Foreign Direct Investment in the long run and short run.

The government of Rwanda should put more effort to attract the investors in place of raising the economic growth especially those investors investing in agricultural sector reforms to increase the productive capacity of the country and the government of Rwanda make the effort in improving the infrastructure to attract the investors.

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APPENDIX

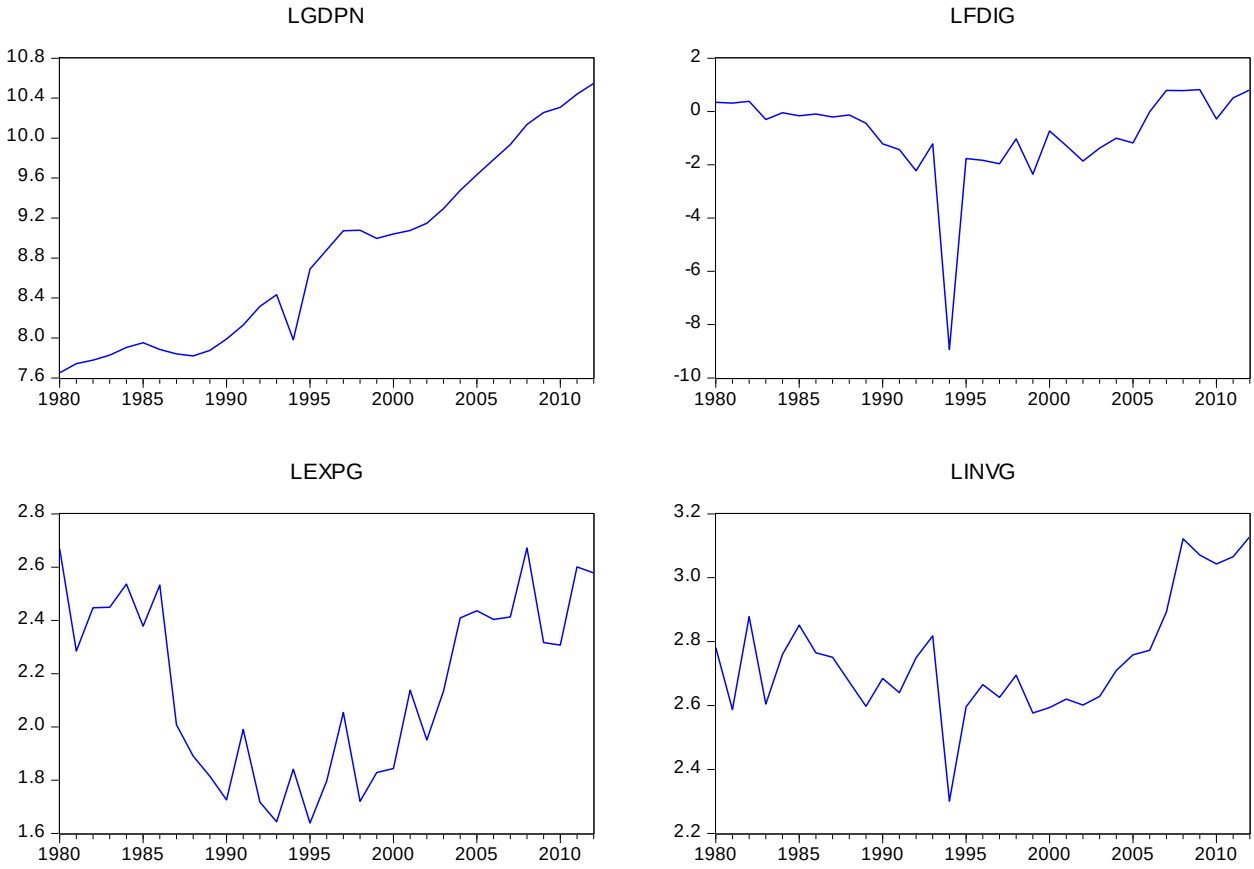
Appendix A

Appendix A1. Data used

Years	Gross capital formation (% of GDP)	Exports of goods and services (% of GDP)	fdi %gdp	per capita GDP	D1994
1980	16.14	14.44	1.41	2100.67	0.00
1981	13.30	9.83	1.36	2308.08	0.00
1982	17.78	11.55	1.47	2387.41	0.00
1983	13.53	11.58	0.74	2509.09	0.00
1984	15.81	12.63	0.95	2708.83	0.00
1985	17.31	10.78	0.85	2841.64	0.00
1986	15.87	12.58	0.90	2658.92	0.00
1987	15.66	7.45	0.82	2543.14	0.00
1988	14.49	6.62	0.88	2492.65	0.00
1989	13.43	6.14	0.64	2633.30	0.00
1990	14.65	5.61	0.30	2947.50	0.00
1991	14.02	7.32	0.24	3394.18	0.00
1992	15.63	5.57	0.11	4088.15	0.00
1993	16.75	5.18	0.30	4599.99	0.00
1994	9.98	6.30	0.00	2925.52	1.00
1995	13.41	5.15	0.17	5941.01	0.00

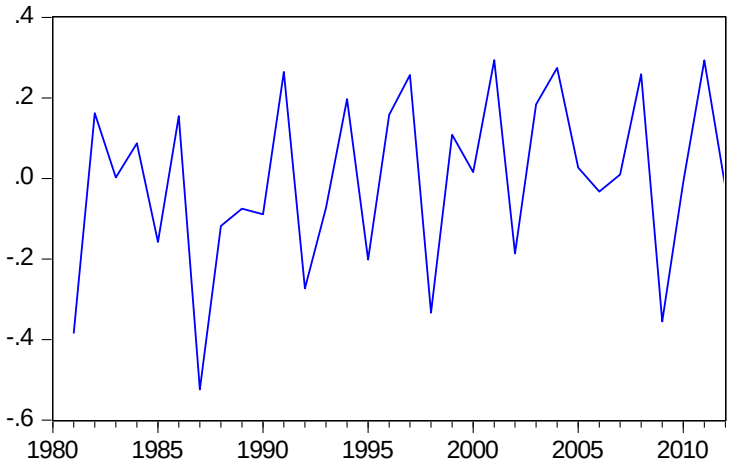
1996	14.37	6.03	0.16	7187.28	0.00
1997	13.81	7.80	0.14	8707.29	0.00
1998	14.81	5.59	0.36	8749.95	0.00
1999	13.15	6.22	0.09	8064.40	0.00
2000	13.38	6.32	0.48	8443.33	0.00
2001	13.74	8.48	0.28	8747.94	0.00
2002	13.48	7.04	0.16	9387.70	0.00
2003	13.85	8.45	0.25	10876.38	0.00
2004	15.03	11.12	0.37	13034.17	0.00
2005	15.78	11.42	0.31	15269.46	0.00
2006	16.00	11.06	0.98	17767.23	0.00
2007	18.04	11.16	2.20	20610.15	0.00
2008	22.69	14.46	2.19	25226.99	0.00
2009	21.57	10.14	2.26	28416.09	0.00
2010	20.97	10.05	0.75	30009.05	0.00
2011	21.44	13.47	1.67	34223.73	0.00
2012	22.85	13.17	2.25	38078.86	0.00

Appendix A2. Log-linear Graph of all variables

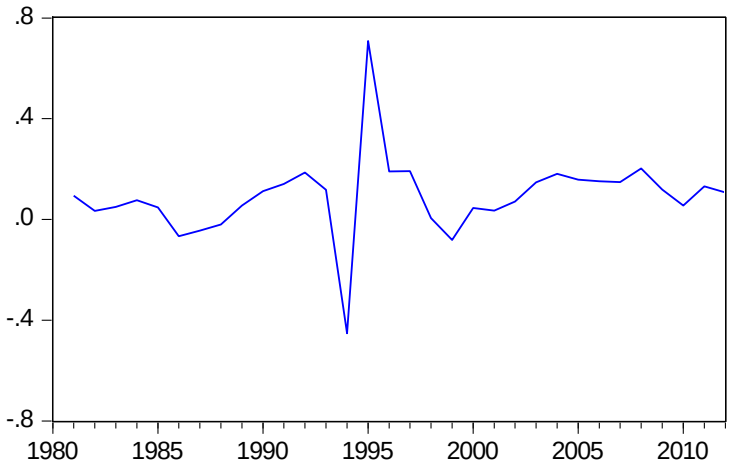


Appendix A3. First-Differenced log-linear graph of the variable not stationary at level

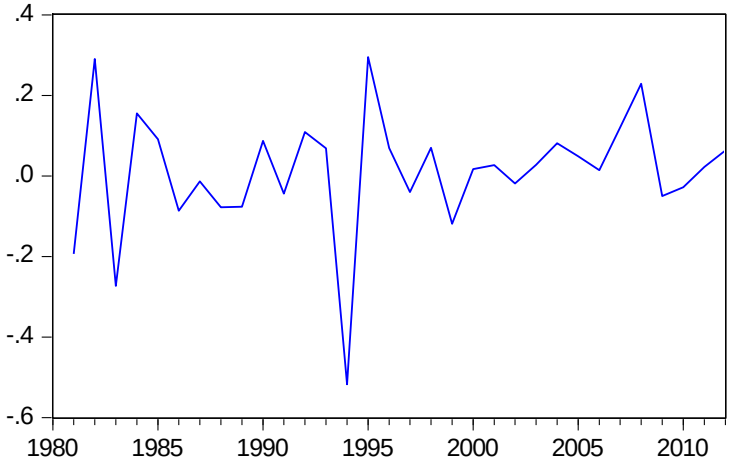
DLEXPG



DLGDPN



DLINVG



Appendix A4: **Vector Autoregression Estimates**

Sample (adjusted): 1982 2012

Included observations: 31 after adjustments

Standard errors in ( ) & t-statistics in [ ]

	LGDPN	LEXPG	LFDIG	LINVG
LGDPN(-1)	1.557067	0.198485	2.699918	0.732842
	(0.30144)	(0.49428)	(3.40012)	(0.25637)
	[5.16548]	[0.40156]	[0.79406]	[2.85855]
LGDPN(-2)	-0.504394	-0.084198	-2.122952	-0.674281
	(0.30523)	(0.50050)	(3.44287)	(0.25959)
	[-1.65252]	[-0.16823]	[-0.61662]	[-2.59747]
LEXPG(-1)	0.157388	0.500476	1.767297	0.130965
	(0.12442)	(0.20402)	(1.40344)	(0.10582)
	[1.26495]	[2.45304]	[1.25926]	[1.23763]
LEXPG(-2)	0.096492	0.306820	2.698127	0.172772
	(0.13231)	(0.21696)	(1.49247)	(0.11253)
	[0.72926]	[1.41415]	[1.80782]	[1.53531]
LFDIG(-1)	-0.099701	0.021839	-0.098140	-0.033039

	(0.02707)	(0.04439)	(0.30532)	(0.02302)
	[-3.68332]	[0.49204]	[-0.32143]	[-1.43517]
LFDIG(-2)	0.050345	0.023584	0.381027	0.042685
	(0.03118)	(0.05113)	(0.35171)	(0.02652)
	[1.61461]	[0.46127]	[1.08336]	[1.60961]
LINVG(-1)	-0.329809	-0.227466	-4.113687	-0.081250
	(0.26933)	(0.44163)	(3.03791)	(0.22906)
	[-1.22458]	[-0.51506]	[-1.35412]	[-0.35471]
LINVG(-2)	-0.110781	-0.310538	-1.538326	0.336110
	(0.26817)	(0.43974)	(3.02493)	(0.22808)
	[-0.41309]	[-0.70618]	[-0.50855]	[1.47366]
C	0.197679	0.915970	-0.003612	0.843706
	(0.63008)	(1.03317)	(7.10708)	(0.53587)
	[0.31374]	[0.88656]	[-0.00051]	[1.57445]
R-squared	0.986306	0.718483	0.530510	0.764118
Adj. R-squared	0.981327	0.616113	0.359786	0.678343
Sum sq. resids	0.342645	0.921308	43.59534	0.247845
S.E. equation	0.124799	0.204640	1.407695	0.106140
F-statistic	198.0714	7.018510	3.107419	8.908374

Log likelihood	25.84116	10.51011	-49.27202	30.86148
Akaike AIC	-1.086526	-0.097426	3.759485	-1.410418
Schwarz SC	-0.670207	0.318893	4.175804	-0.994099
Mean dependent	8.887856	2.135852	-0.935097	2.749704
S.D. dependent	0.913272	0.330285	1.759325	0.187147

Determinant resid covariance (dof adj.)	2.52E-06
Determinant resid covariance	6.39E-07
Log likelihood	45.12316
Akaike information criterion	-0.588591
Schwarz criterion	1.076685

Appendix A5 : Lag Order Selection

Endogenous variables: LGDPN LEXPG LFDIG

LINVG

Sample: 1980 2012

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-62.81422	NA	0.001389	4.772445	4.962759	4.830626
1	35.95615	162.2656	3.82e-06	-1.139725	-0.188151	-0.848819
2	46.75626	14.65729	5.99e-06	-0.768304	0.944530	-0.244674
3	63.52842	17.97017	7.02e-06	-0.823459	1.650636	-0.067103
4	100.4001	28.97061*	2.53e-06	-2.314294	0.921060	-1.325214
5	145.7371	22.66847	8.50e-07*	-4.409790*	-0.413176*	-3.187985*

* 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

Appendix A6 : Selection of cointegration model

Sample: 1980 2012

Included observations: 28

Series: LGDPN LFDIG LEXPG LINVG

Lags interval: 1 to 4

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	4	4	3	4
Max-Eig	3	4	4	3	4

*Critical values based on MacKinnon-Haug-Michelis (1999)

Informatio

n Criteria

by Rank

and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	77.78636	77.78636	81.13281	81.13281	94.07609
1	109.1813	110.2426	113.4304	118.8850	125.5007
2	129.4825	130.5438	133.0100	150.2450	150.7230
3	139.0037	140.4441	142.2880	160.3752	160.7262
4	141.0027	145.7371	145.7371	165.1562	165.1562
	Akaike Information Criteria by Rank (rows)				

	and Model (columns)				
0	-0.984740	-0.984740	-0.938058	-0.938058	-1.576863
1	-2.655806	-2.660185	-2.673600	-2.991782	-3.250052
2	-3.534461	-3.467414	-3.500714	-4.588931	-4.480212
3	-3.643121	-3.531724	-3.591999	-4.669657*	-4.623303
4	-3.214476	-3.266933	-3.266933	-4.368302	-4.368302

	Schwarz Criteria by Rank (rows) and Model (columns)				
0	2.060299	2.060299	2.297296	2.297296	1.848805
1	0.769863	0.813062	0.942384	0.671780	0.556247
2	0.271838	0.434042	0.495899	-0.497160*	-0.293283
3	0.543807	0.797940	0.785244	-0.149678	-0.055744
4	1.353082	1.490941	1.490941	0.579886	0.579886

Appendix A7: Johansen cointegration test

Sample (adjusted): 1985 2012

Included observations: 28 after adjustments

Trend assumption: Linear deterministic trend (restricted)

Series: LGDPN LFDIG LEXPG LINVG

Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.932564	168.0469	63.87610	0.0000
At most 1 *	0.893542	92.54256	42.91525	0.0000
At most 2 *	0.514989	29.82239	25.87211	0.0153
At most 3	0.289298	9.562061	12.51798	0.1485

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 *	0.932564	75.50429	32.11832	0.0000
At most 1 *	0.893542	62.72017	25.82321	0.0000

At most 2 *	0.514989	20.26033	19.38704	0.0373
At most 3	0.289298	9.562061	12.51798	0.1485

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

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LGDPN	LFDIG	LEXPG	LINVG	@TREND(81)
-13.30983	-0.626720	0.390387	26.59551	0.826747
2.321083	2.238046	-5.274156	6.884778	-0.348486
8.218734	-1.346168	12.01654	-22.03911	-0.404058
-7.297778	2.310054	2.325150	-16.11640	0.748333

Unrestricted Adjustment Coefficients (alpha):

D(LGDPN)	0.025414	0.003121	0.042468	0.010939
D(LFDIG)	0.362566	0.342924	0.604018	-0.142611
D(LEXPG)	-0.118986	-0.028488	0.023678	0.007299
D(LINVG)	0.014066	0.035151	0.037766	0.015000

1	CointegratingLog	118.8850

Equation(s): likelihood

Normalized cointegrating coefficients (standard error in parentheses)

LGDPN	LFDIG	LEXPG	LINVG	@TREND(81)
1.000000	0.047087	-0.029331	-1.998185	-0.062115
	(0.02450)	(0.08422)	(0.22031)	(0.00312)

Adjustment coefficients (standard error in parentheses)

D(LGDPN)	-0.338261
	(0.26531)
D(LFDIG)	-4.825699
	(4.03675)
D(LEXPG)	1.583679
	(0.23827)
D(LINVG)	-0.187217
	(0.29595)

2 CointegratingLog

Equation(s): likelihood 150.2450

Normalized cointegrating coefficients (standard error in parentheses)

LGDPN	LFDIG	LEXPG	LINVG	@TREND(81)

1.000000	0.000000	0.085825	-2.253062	-0.057596
		(0.08174)	(0.22561)	(0.00333)
0.000000	1.000000	-2.445600	5.412903	-0.095977
		(0.59261)	(1.63557)	(0.02412)

Adjustment coefficients (standard error in parentheses)

D(LGDPN)	-0.331017	-0.008942
	(0.26898)	(0.04627)
D(LFDIG)	-4.029743	0.540253
	(3.82679)	(0.65829)
D(LEXPG)	1.517556	0.010813
	(0.20901)	(0.03595)
D(LINVG)	-0.105628	0.069854
	(0.26019)	(0.04476)

---

3 CointegratingLog

Equation(s): likelihood 160.3752

Normalized cointegrating coefficients (standard error in parentheses)

				@TREND(81
LGDPN	LFDIG	LEXPG	LINVG	)
1.000000	0.000000	0.000000	-2.293357	-0.056955
			(0.16910)	(0.00309)

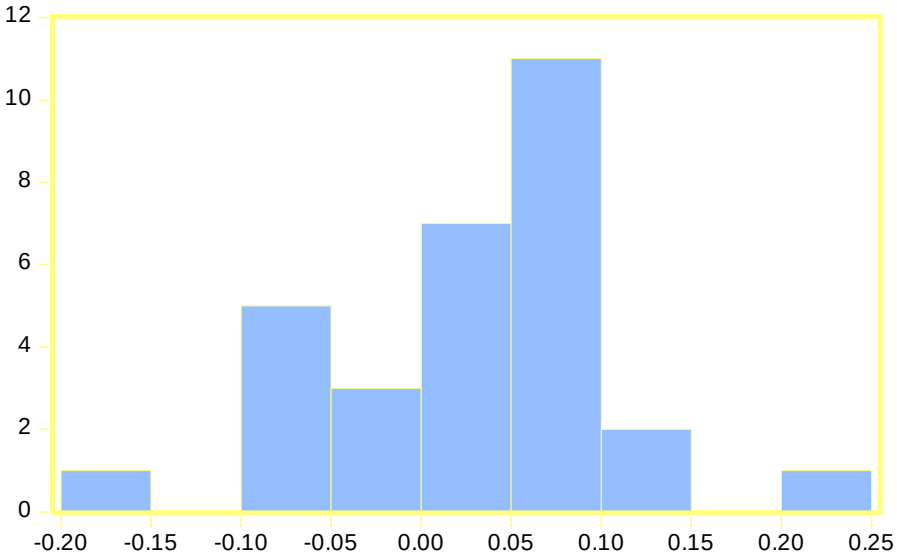
0.000000	1.000000	0.000000	6.561104	-0.114242
			(2.40800)	(0.04406)
0.000000	0.000000	1.000000	0.469497	-0.007469
			(0.78333)	(0.01433)

Adjustment coefficients (standard error in parentheses)

D(LGDPN)	0.018014	-0.066111	0.503775
	(0.23242)	(0.03947)	(0.19295)
D(LFDIG)	0.934523	-0.272858	5.591115
	(3.30745)	(0.56173)	(2.74584)
D(LEXPG)	1.712156	-0.021061	0.388322
	(0.21408)	(0.03636)	(0.17773)
D(LINVG)	0.204756	0.019015	0.273911
	(0.23892)	(0.04058)	(0.19835)

Appendix B: Diagnostics Tests

Appendix B1: Normality Test



Series: Residuals	
Sample 1983 2012	
Observations 30	
Mean	0.024358
Median	0.021523
Maximum	0.214152
Minimum	-0.194088
Std. Dev.	0.080875
Skewness	-0.358201
Kurtosis	3.661907
Jarque-Bera	1.189191
Probability	0.551786

Appendix B2: Heteroskedasticity Test: White

F-statistic	0.247529	Prob. F(6,23)	0.9554
Obs*R-squared	1.819685	Prob. Chi-Square(6)	0.9355
Scaled explained SS	1.264558	Prob. Chi-Square(6)	0.9736

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Sample: 1983 2012

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008906	0.003211	2.773170	0.0108
DLGDPN(-1)^2	-0.000467	0.027658	-0.016879	0.9867
DLEXPG(-1)^2	-0.023631	0.039273	-0.601709	0.5533
DLINVG(-1)^2	-0.036198	0.094638	-0.382488	0.7056
LFDIG(-1)^2	0.000869	0.000888	0.979224	0.3377
D1994^2	-0.008050	0.011641	-0.691493	0.4962
RESID03(-1)^2	-0.002314	0.002648	-0.873955	0.3912

Appendix B3: Heteroskedasticity Test: ARCH

F-statistic	0.291697	Prob. F(1,27)	0.5936
Obs*R-squared	0.309956	Prob. Chi-Square(1)	0.5777