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AGRICULTURE OUTPUT AND ECONOMIC GROWTH OF RWANDA

(Period under study 1966 to 2019)

A thesis submitted to the University of Rwanda.

In partial fulfillment of the academic requirements for the award of Degree of Master of Science in Economics

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Approval Sheet

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Dedications

This work is dedicated to

Natete

Nsanga

Ashimwe

My large Family.

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All thanks to God, the creator, who provided me with strength, wisdom, and health throughout the period of this program.

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Abstract

In most developing countries, mainly in sub-Saharan Africa, most of the population live in rural areas and earn their livelihoods primarily from agricultural activities. Agriculture is recognized as the engine for the growth of the economy of most developing nations of the world. However, the role of agriculture as key to economic growth has never stopped to be the subject of debates among economists. The purpose of this of this study is to determine the relationship between agriculture and economic growth and investigate the effect of agriculture g to the economic growth of Rwanda.

The study is conducted using annual time series data running from 1966 to 2019. The study employs Johansen cointegration test and Vector Error Correction model (VECM) as the estimation techniques. The results of the study reveal that the Gross Domestic Product growth, agriculture growth, export growth and gross capital formation growth have a long-run equilibrium relationship according to the Johansen cointegration test while the VECM result shows that the speed of adjustment of variables towards their long-run equilibrium path was low, estimated at 5.75%. Also, the results have shown that the impact of agriculture growth on gross domestic product growth is significantly important. This implies that Rwanda community continues to benefit from agriculture activities.

Keywords: Agricultural growth, Exports, Gross Capital Formation, Economic growth, Rwanda.

List of abbreviations

ADF: Augmented Dickey-Fuller

AGR: Agriculture

CAADP: Comprehensive African Agriculture Development Programme

EACSOF: East African Civil Society Organizations' Forum

ECT: Error Correction Term

EICV5: Integrated Household Living Survey

GCF: Gross Capital Formation

GDP: Gross Domestic Product

MINAGRI: Ministry of Agriculture and Animal Resources

NISR: National Institute of Statistics of Rwanda

SDG: Sustainable Development Goals

VECM: Vector Error Correction Model

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CHAPTER ONE: INTRODUCTION

1.1.Background to the study

The agriculture sector is said to be the backbone of an economy, which provides the basic ingredients to people and raw material for industrialization. Following the classical analyses of Kuznets, several contributions of agriculture to overall economic growth and development are usually acknowledged (KUZNETS, 1961).

Several authors have noted the existence of substantial multiplier effects from agriculture to other sectors, especially in Asia and in Sub-Saharan Africa (Steven HAGGBLADE, Peter B. R. HAZELL, and Paul A. DOROSH, 2007). The tangible fact for agriculture as an engine of the growth of the economy can be seen from the rapid transformation of traditional agriculture into a fast-growing modern sector by adopting science-based technology in the Asian green revolution period between 1965 and 1990 (Xinshen Diao, Peter Hazell, Danielle Resnick and James Thurlow, 2010).

According to Praburaj, Agriculture has made significant contributions to the economic growth of developed countries. The evidence is found in the history of England where agriculture revolution preceded the industrial revolution. In the United States and Japan, agricultural development has led to a higher extent of the industrialization process. Moreover, agriculture is still a sector of a pivotal role in the economic development of developing countries. To attain higher per capita income, many developing countries engaged in the process of economic development have emphasized on agriculture and other primary industries (Praburaj, 2018).

Economic growth does not depend only on the rate of overall economic growth, but also on the ability of poor people to participate in that growth, this rekindled interest in the specific role of agriculture in the development process (Luc Christiaensen, Lionel Demery, and Jesper Kuhl, 2010). The development of the agricultural sector improves the purchasing power of agriculturists, which would help the growth of the non-agricultural sector of the economy. Most poor people in the developing world depend on agriculture and it is they who must be able to afford to consume the goods produced. It was noted that the poor people stood to gain much more from GDP growth originating from the agriculture sector than from an equal amount of GDP growth generated by other sectors (Martin Ravallion & Shaohua Chen, 2003).

Agriculture heavily influences economic development in most countries in Sub-Saharan Africa. It contributes to major priorities of the continent, such as poverty eradication and hunger, boosting Africa investment and trade, rapid industrialization, and economic diversification, maintaining resource sustainability and environment, opportunity to employment creation and human security and accounts for more than 30% of GDP and 60% of total employment in Sub-Saharan Africa, excluding South Africa (Xinshen et al, 2010).

Rwanda's agriculture is central for creating growth, jobs, exports, and livelihoods necessary to transform the economy to knowledge based middle-income economy. The pace of agricultural transformation is important, as will measures to ensure that not only the large and medium sized farms, but also small holders are able to take part in and benefit from this structural change.

To boost agriculture, policies have been put in place such as increasing innovation and research, land husbandry and hill side irrigation, human resource capacity development, agriculture infrastructure, agriculture cooperatives, increasing market accessibility, land use consolidation and crop intensification, etc. and this serves as an indicator of how important agriculture is and would be essential in the development of Rwandan economy.

1.2.Statement of the problem

Some recent studies have concluded that the role of growth in the non-agricultural sector in poverty reduction is increasing (Luc Christiaensen, Lionel Demery, and Jesper Kuhl, 2010). The economic structure of Rwanda started to change , led by a declining share of agriculture and increasing share of services and this was due to the increase in services such as trade, transport Information Technology, Hospitality, Sports, Healthcare, tourism, etc. (Xinshen Diao, Godfrey Bahiigwa, Angga Pradesha, 2014).

The study curried out by Helen Parker highlighted that the agricultural sector is the primary source of employment, the main driver of income growth and the dominant sector for many people's revenue generation domestically, regionally and in international markets (Parker, 2015).

According to NISR, Rwanda's GDP has been growing on average rate of 7.4% in last decade and the agriculture contribution is 24% of GDP (NISR, 2019). This has conducted on the question

about whether agriculture continues to play its importance on economic growth in the country where it is now a smaller share of the GDP and the economy.

To better understand this, it is necessary to look at the sector and the best way to capture the effect of agriculture on economic growth, is to observe the variables over time. Therefore, this study will address this relationship considering the data captured overtime with time series approach for the case of Rwanda.

1.3.Research objectives

1.3.1. General objective

The main objective of this study is to determine the effect of agriculture sector on the economic growth of Rwanda as the sector occupying the big part of the population of the country. This objective will be achieved through some specific objectives.

1.3.2. Specific objectives

- Exploring the trend of agriculture and economic in the long run
- Determine the magnitude of agriculture to the economic performance of Rwanda.

1.4.Hypothesis

- The agriculture sector in Rwanda has a positive impact on the country's economic growth.
- The agriculture sector played a strategic role in economic performance of Rwanda.

1.5.Justification of the study

In Rwanda, agriculture is still occupying the big part of the workforce and it is pivotal to the development of the country. However, as the number of people involved in agriculture reduces, its percentage contribution to GDP also gets reduced. This study will focus on agriculture contribution to the economy of Rwanda concerning general economic growth.

1.6.Scope of the study

This study is limited to the data from the World Bank and Rwanda national accounts as published by the National Institute of Statistics of Rwanda covering the period from 1966 to 2019.

1.7.Organization of the research

To study the impact of agriculture on economic growth, it is necessary to present some fundamental theories and principles, which enable us to understand the role that agriculture plays in an economy. This study is organized into five chapters: Chapter one is concerned with the general introduction, where the background of the study, problem statement, objectives, hypothesis, justification, scope, and organization of the study are detailed. Chapter two is concerned with literature review, where we will look at some theories developed by different economists and the situation of agriculture sector in Rwanda. Chapter three is concerned with the study methodological approach. Chapter four is the analysis and interpretation of the results from available data. Chapter five is made of conclusion and recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

In this chapter, we will look at some theories developed by different economists and the situation of the agriculture sector in Rwanda.

2.2. General literature review of agriculture and economic growth

Agricultural sector plays a primordial role in the process of economic development of a country. Significantly, agriculture has contributed much more to the advancement of developed countries and, it plays a vital role in the development of the economy of developing countries. In other words, the focus on agriculture and primary industries is dominant in countries where per capita income is low (Chikwama, 2014).

Kuznets highlighted the contribution of agriculture to creating markets. According to him, agriculture contributes to economic growth through the inter-transaction between agriculture and other economic sectors. On one hand, it purchases products from other sectors and one the other hand, its sales its products to other sectors and hence make the development of other sectors. The agricultural sector of developing countries is a major source of demand or market for industrial products. The farmers often produce cash crops such as sugar, jute, cotton and from their sales they obtain money incomes, which they can spend on industrial goods. Besides, farmers who have marketable surplus of food-grains (cereals and pulses) sell them in the market from which they get money incomes, which also become a source of demand for industrial goods (KUZNETS, 1961).

According to Lewis (1954) as developed by Leeson, in capitalism, the development of industry depends on the development of agriculture because there should be enough food first. In contrast, if the capitalist countries fail in terms of food, there will be the rise in prices, which in turn reduces profits. So, industry development and agriculture development should always go together. In contrast, there will be no industrial development where agriculture is neglected (LEESON, 1979).

In developing countries, agriculture is a major source of saving or capital for industrial growth as rural people with high incomes will use part of their income for saving and investment, which drive to industrial development. In many developing countries, agriculture still makes a substantial net contribution to government revenue (Gardner, 2000).

Agriculture makes important contribution to the development of the economy by earning foreign exchange required for importing industrial raw materials and capital goods required for expanding industries. The lack of foreign exchange acts as a great constraint on the growth process.

In developing countries, most poor people live in rural areas. Any strategy to boost agricultural growth plays an important role in developing the rural people. Agricultural growth increases productivity and revenues of small and marginal farmers and raises employment and wages of agricultural workers. Hence, it helps to improve lives by reducing poverty and disguised unemployment. Besides, a rise in agricultural productivity drives to the reduction in food prices and keeps inflation under control, which also contributes to reduce poverty (Gollin, 2009).

According to Mahmood, the rural poor largely depend on agriculture including fishing and forestry, and related small-scale industries and services and therefore, some policies that penalized agricultural sector have been contributing to the poverty of both rural and urban areas (Sunil, 2000).

From the experience of advanced world, Western Europe, the United States, Japan, and later in Taiwan, South Korea, China, and India, it was agreed that agricultural development was the precursor for subsequent industrial and service-based growth. Arguably, the agricultural surplus underpinned human development and economic factors necessary for subsequent economic and social development. In this perspective, Rwanda's agriculture is also the central engine for creating growth in the country's employment, exports, and livelihoods necessary to transform the economy to a knowledge-based middle-income economy (MINAGRI, 2018).

2.3. Agriculture as part of Rwandan Economy

Agriculture sector is the largest sector of Rwanda's economy and has a special position by employing a big part of its labor force and being the second sector to contribute to the gross domestic product just after the service sector. The overall growth rate of the economy depends upon the growth rate of this sector. As Rwanda modernizes into a knowledge-based economy, agriculture remains the backbone for sustained economic growth, providing high-quality livelihoods, and living standards for the population. The Rwandan economy is based on the largely rain-fed agricultural production with small land, semi-auto subsistence farming. There are few natural resources to exploit, and the industry is still small and non-competitive.

The development of agriculture is the key tool for poverty alleviation in rural areas, especially for people living in rural area including smallholder farmers, poor, and less educated people. According to Integrated Household Living Survey (EICV5), most workers in their main job works in agriculture sector (70%). Agriculture employs 80% of all workers in rural areas, while the corresponding proportion in urban areas is 23%. The distribution according to sex reveals that females represent 80% while males represent 58.5% employed by the agriculture sector. Moreover, agricultural sector is still critical to the growth of Rwandan economy and as the supply side to trade, a factor for integration into regional and global economy (NISR, National Accounts, 2018).

Principal crops of the country include coffee, pyrethrum, tea, flowers, beans, cassava, banana, Irish potatoes, rice, wheat, and sugarcane among others. Agriculture exports include coffee, tea, and some value added agricultural products such as canned tomatoes, honey, French beans, macadamia, mushrooms, and fruits such as passion fruit, avocado, etc. (www.rdb.rw).

After its independency Rwanda economy, like most of other African countries was mostly the primary sector especially agriculture products. Crop products were only for subsistence production while cash crops, namely, coffee and thee, which were sold at European markets. Since its 1994 genocide, Rwanda has achieved extraordinary results. As per the National accounts (2019), the average contribution of Agriculture on GDP is 30% occupying 76% of the national workforce and it remains the most predominant activity of the rural where is 82.79% of the national population (NISR, 2019)

Rwanda is party to the Comprehensive African Agriculture Development Programme (CAADP) as reinforced in the 2014 Malabo Declaration, which improves nutrition and food security, enhance private sector involvement and strengthen public-private partnerships that include smallholder farmers. At the regional level, Rwanda subscribes to the East African Community's Vision 2050, which enhances agricultural productivity for food security and a transformed rural economy under its pillar on Agriculture, Food Security and Rural development. Sustainable Development Goals (SDG) give a central place to agriculture with their focus on sustaining natural resources and overcoming hunger, malnutrition, and food insecurity. Rwanda's commitment to combating climate change through agriculture.

Agriculture plays a key role in traditional exports and is also a fruitful area for export diversification. In 2016, exports of agricultural and Agri-processed goods were about $252 million, roughly 52%of total goods exports. Exports continued to be dominated by agriculture crops. Coffee and tea represent respectively 35 and 39 per cent of formal exports by value. Agri-processing exports (predominantly milled products) represent 18%of formal exports. Other agriculture exports were predominantly vegetables, with the emerging flowers as newly exportable commodity. Therefore, developing agriculture is likely to have a larger impact on poverty reduction and economic growth of Rwanda (MINAGRI, 2018).

The agro-industry has contributed to the country's economy in multiple ways such as employment, food, trade and export. In the very beginning, agro processing industry tends to be limited with agriculture raw resources, export crops since the high percentage of agriculture products are consumed without much processing activities where most of them are consumed by the farmer producers for their families (EACSOF, 2015).

Again, agriculture in Rwanda is the main source of raw materials to industry sector especially in agro-processing industry which is the most component of country's industry in Rwanda providing employment and income which enable people to afford basic needs and personal development.

The products of agro-processing industry consist of soft drinks, beer oil (cooking oil), milk, honey, etc. and it has contributed much more to Rwandan development for example the beer industry is also important agro industry in Rwanda. In 2015, its market was counted to 184.00

million USD and is expected. Until 2025, the beer market in Rwanda is forecast to reach 389.53 million USD in retail prices (Williams & Marshall Strategy 2021).

Rwanda Development Board counts 48 agro processing exporters among other industries. The government of Rwanda is committed to boost the agriculture sector growth by focusing on agribusiness industry and value chain to increased agricultural transformation and value addition, specialization, and trade with the support of government and the participation of the private sector in the sector. Through the ministry of Trade, the country is supporting agro processing industry capabilities equipment, skills development, rehabilitation, etc. (RDB, 2019).

Currently, the agricultural sector accounts for just under half of goods exports and provides employment for more than two thirds of the working population. The agriculture sector creates job opportunities in farming and non-farming sectors. Again, it has another important contribution which is the capital accumulation that is made with the agriculture surplus. The more the agriculture surplus increases, the better the welfare of rural people will increase. Therefore, it remains the backbone for a sustainable economic growth, providing livelihoods, and high standards of living for the population (MINAGRI, 2018).

CHAPTER THREE: METHODOLOGICAL APPROACH

3.1. Introduction

This study is based on the impact of agriculture productivity on economic growth in Rwanda for a period of1966 to 2019.

3.2. Model specification

Gross domestic product per capita is taken as dependent variable and the independent variables are agriculture value added, exports and gross capital formation. All economic variables are taken as annual growth rates. With the model used by S.M Karimou in his paper on the Impact of agricultural output on economic growth in West Africa where he used the model served below by Lewis economic theory in the field of economic growth (Karimou, 2018).

$$\mathrm{GDP_t} = \beta_0 + \beta_1 \mathrm{AOUT_t} + \beta_2 \mathrm{IOUT_t} + \beta_3 \mathrm{CAP_t} + \varepsilon_t \qquad (1)$$

Where $\mathrm{GDP_t}$ stands for Gross Domestic Product at time t, β_0 for Intercept, $\beta_1 \mathrm{AOUT_t}$ for Agriculture Output at time t, $\beta_2 \mathrm{OUTI_t}$ for Industry Output at time t, $\beta_3 \mathrm{CAP_t}$ for Capital at time t and ε_t for stochastic error term.

Served with his model and with the availability of data, we removed industry and replaced it with exports and kept the capital with the Gross capital Formation. Moreover, here variables will be taken as annual growth as said above. Therefore, our model is written as follows. Four variables are included in the model that is agriculture, exports, and gross capital formation.

$$\mathrm{GDP_t} = \beta_0 + \beta_1 \mathrm{AGR_t} + \beta_2 \mathrm{XP_t} + \beta_3 \mathrm{GCF_t} + \varepsilon_t \qquad (2)$$

Where $\mathrm{GDP_t}$ stands for percentage growth of per capita Gross Domestic Product at time t, β_0 for Intercept, $\beta_1 \mathrm{AGR_t}$ for percentage growth of Agriculture valued added at time t, $\beta_2 \mathrm{XP}$ for percentage growth of exports of goods and services at time t, $\beta_3 \mathrm{GCF_t}$ for percentage growth of gross capital formation at time t and ε_t for stochastic error term.

3.3. Definition of variables

Variables selected are defined as follows.

Gross domestic product (GDP): This study employed GDP per capita annual growth. GDP represents the sum of value added by all its producers. Value added is the value of the gross output of producers less the value of intermediate goods and services consumed in the production before accounting for the consumption of fixed capital in production.

Agricultural (AGR): Here, agriculture includes cultivation of crops and livestock production, forestry, and fishing. Value added corresponds to the net output after adding up all outputs and subtracting intermediate inputs.

Exports (XP): exports of goods and services are one of the two main components of international trade. They consist of transactions in goods and services from residents to non-residents.

Gross Capital Formation (GCF): Gross capital formation is measured by the total value of gross fixed capital formation, changes in inventories and acquisitions less disposals of valuables for a unit or sector.

3.4. Data Analysis

3.4.1. Types of data

Time series data of all economic variables taken from the World Bank Metadata of Rwanda. Data which are used here are secondary data.

To measure the impact of agriculture on economic growth, it will require the use of a traditional approach to estimate the relationship between the performance of the entire economy of the country and the performance of agriculture sector. Agriculture sector is taken as exogenous factor. This means to evaluate the effect of its development on other sectors of the economy, which are considered as endogenous factors. Further, in estimating the relation between agriculture and other sectors of the economy, the former should not be assumed to be exogenous; rather, this should first be established. Moreover, given that most time series are trended,

conventional regression techniques may yield spurious regressions and significance tests. To circumvent these various problems, we study the cointegration of the different sectors of the country's economy in a multivariate vector auto regression framework (Kanwar, 2000).

The evaluation of the impact of the agriculture sector on the economic growth of Rwanda is done using co-integration and estimation of the vector error correction model (VECM).

Determine the order of integration of the series using Augmented Dickey-Fuller test (ADF).

- Co-integration test (integrated nonstationary series of the same order).
- Estimation of VECM.
- Analysis of results of VECM: validation of hypothesis, Granger causality test, impulse response, and variance decomposition.

3.4.2. Stationary Test

Time series data are most of the times not stationary, which means that variance and covariance of such a data set are not time invariant. Non-stationary series pose threats to the econometrician, as they lead to spurious and misleading regression results. It is, therefore, essential to test for the stationarity of each variable to ascertain the characteristics of the series. The stationary test also gives us a chance to know whether both the regressor and regressand within the model are integrated at the same level (Gujarati 2009).

Several techniques are used to test stationarity including graphical inspection of the series, which gives a glimpse of the nature of the series, Partial Autocorrelation Function (PACF) correlogram techniques, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. However, this study used the ADF technique, which consists of estimating the following regression:

$$\Delta Y_t = \beta_1 + \beta_{2_t} + \delta Y_{t-1} + \sum_{i=1}^{n} \Delta Y_{t-1} + \varepsilon_t$$

Where εt is a pure white noise error term, Y_{t-1}represents each variable and where Y_{t-1}= (Y_{t-1}− Y_{t-2}), ΔY_{t-2}= (Y_{t-2}− Y_{t-3}) , etc.

The hypotheses of this test are:

Null hypothesis: H_0: $\delta = 0$ (i.e., there is a unit root, or the time series is nonstationary).

Alternative hypothesis: H_1: $\delta < 0$ (i.e., the time series is stationary).

The decision rule is that the null hypothesis be rejected only if augmented Dickey Fuller statistic is less than MacKinnon critical values. Rejecting null hypothesis implies that the process is stationary.

3.4.3. Johansen Cointegration Test

This is the other way of checking stationarity within variables. In time series, it makes no sense to proceed with regressions if variables are not stationary or predictable in another way. This is because any regression model for non-stationary time series variables would generate results which are useless. Ignoring the cointegration aspect in time series variables may lead to a spurious regression problem, which occurs if arbitrarily trending or non-stationary series are regressed on each other.

The hypothesis is stated as:

Null hypothesis: H_0: no cointegrating equation.

Alternative hypothesis: H_1: H_0 is not true.

Our decision rule is that we reject the null hypothesis if the value of the Trace and Max statistics are greater than 5% critical value, otherwise, fail to reject the null hypothesis.

3.4.4. Vector Error Correction Model (VECM)

The principal objective of this study is to evaluate the impact of agricultural growth on economic growth. With long-term or equilibrium, relationship among the variables, the Error Correction Mechanism (ECM) is used to correct for short run disequilibrium. VECM is used to evaluate the short-term dynamics in estimating the impact of agricultural output on economic growth. The model is expressed as follow:

$$\Delta GDP_t = \alpha_0 + \alpha_1 \Delta AGR_t + \alpha_2 \Delta XP_t + \alpha_3 \Delta GCF_t + \alpha_4 ECT_{t-1} + \varepsilon_t$$

Where αs are the coefficients to be estimated, ECT_{t-1} is then is the error correction term and ε is a white noise error term. The error correction coefficient is expected to be negative.

CHAPTER FOUR: DATA FINDINGS AND DISCUSSION

4.1. Description of data

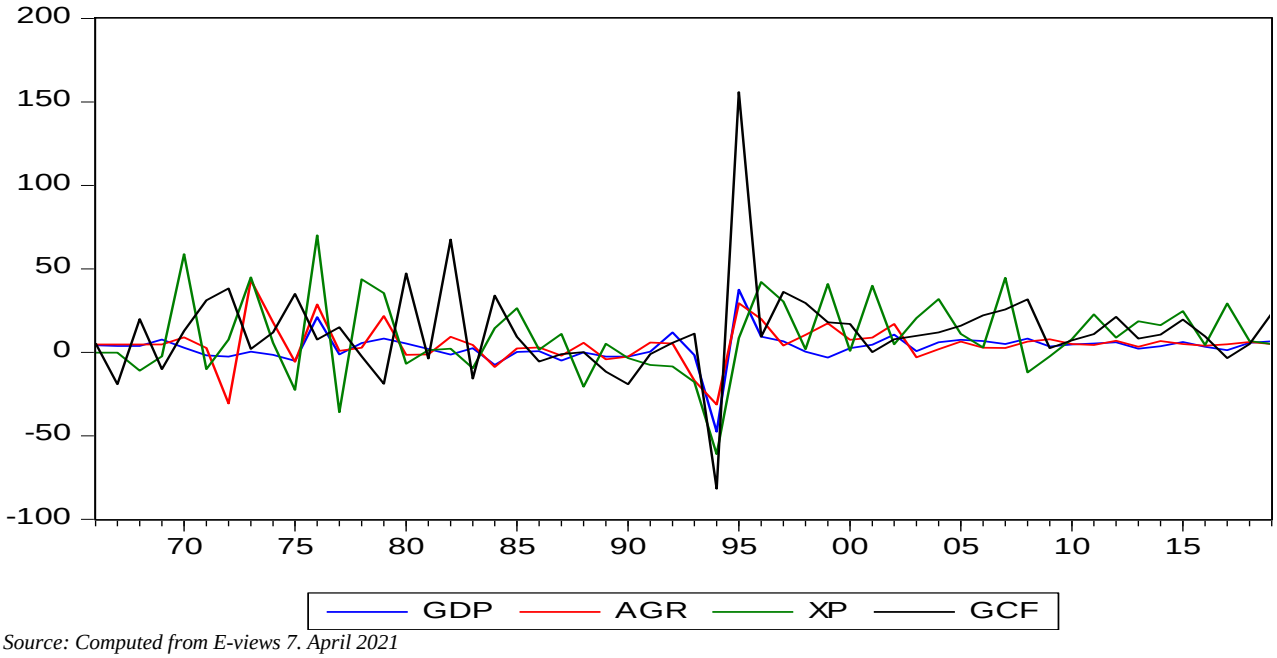
Analysis was focused and limited to the relationship between GDP, Agriculture, Exports, and Gross Capital Formation.

Table 1. Description of data

Metric	GDP	AGR	XP	GCF
Mean	2.770857	4.927615	9.620242	12.38759
Median	3.351462	4.712044	5.453201	9.662056
Maximum	37.53553	43.28382	70.02187	155.7849
Minimum	-47.5033	-31.3229	-61.0634	-81.7722
Std. Dev.	9.68963	11.87538	23.40758	29.01217
Sum	149.6263	266.0912	519.4931	668.9298
Observations	54	54	54	54

Graph illustration

Figure 1. Graphical illustration of observations time series of GDP, Agriculture, Exports and Gross Capital Formation



Source: Computed from E-views 7. April 2021

The graph (Figure 1) illustrates the series of the four variable GDP per Capita growth, Agriculture growth, Exports Growth and Gross Capital Formation Growth in Rwanda over 54 years.

4.2. Testing for stationarity

Table 2. ADF unit root test in level

Augmented Dickey Fuller Test				
Variables	**Critical value**	**T-statistic**	**P value**	**Accept or reject Unit root**
GDP	-2.91765	-9.19235	0	reject Ho
AGR	-2.918778	-7.0819	0	reject Ho
XP	-2.91765	-8.36708	0	reject Ho
GCF	-2.91765	-10.2549	0	reject Ho

Source: Computed from E-views 7. April 2021

From the analysis in table 2, comparing the ADF test- statistic with the critical values, we find that we reject the unit root hypothesis at 5% level for GDP per capita, Agriculture, Exports and Gross Capital Formation because ADF is less than the critical value and probability is less than 5%.

ADF test-statistic values are highly negative than the critical values i.e., in absolute value, the t-statistic is greater than the critical value or equivalently looking at the p-value is less than 0.05 hence concluding stationarity at level and we reject the null hypothesis.

4.3. Regression Model

According to the above table, all variables are stationary at level. Therefore, as they are all stationary at the same level, we run the regression model.

Table 3. Regression results

Dependent Variable: GDP Method: Least Squares Date: 04/26/21 Time: 15:20 Sample: 1966 2019 Included observations: 54				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.545031	0.953237	-1.620825	0.1113
AGR	0.325214	0.085258	3.814480	0.0004
XP	0.074891	0.041858	1.789145	0.0796
GCF	0.160878	0.029908	5.379108	0.0000
R-squared	0.631215	Mean dependent var		2.770857
Adjusted R-squared	0.609088	S.D. dependent var		9.689630
S.E. of regression	6.058240	Akaike info criterion		6.511903
Sum squared resid	1835.114	Schwarz criterion		6.659235
Log likelihood	-171.8214	Hannan-Quinn criter.		6.568723
F-statistic	28.52684	Durbin-Watson stat		1.984584
Prob(F-statistic)	0.000000			

Source: Computed from E-views 7. April 2021

From table 3, the model is written as follows:

$$\mathrm{GDP_t} = -1.545031 + 0.325214\mathrm{AGR_t} + 0.074891\mathrm{XP_t} + 0.160878\mathrm{GCF_t} + \varepsilon_t$$

From the above relationship, for a unity change in annual % growth of agriculture, export and gross capital formation there is an increase in GDP per capita annual growth by 0.325 and 0.074 and 0.16 respectively. They all influence the growth of GDP positively. Moreover, agriculture has significant impact on GDP.

4.4. Johnsen Co-integration test

The results of the Johnsen cointegration test show that there are four cointegrating equations indicating a long run relation between GDP per capita growth, agricultural growth, exportgrowth, and gross capital formation growth in Rwanda.

Table 4. Cointegration results

Date: 04/29/21 Time: 15:39
Sample (adjusted): 1968 2019
Included observations: 52 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP AGR XP GCF
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.591571	121.4420	47.85613	0.0000
At most 1 *	0.520556	74.87931	29.79707	0.0000
At most 2 *	0.378538	36.65264	15.49471	0.0000
At most 3 *	0.204813	11.91729	3.841466	0.0006

Trace test indicates 4 cointegratingeqn(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		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.591571	46.56271	27.58434	0.0001
At most 1 *	0.520556	38.22666	21.13162	0.0001
At most 2 *	0.378538	24.73536	14.26460	0.0008
At most 3 *	0.204813	11.91729	3.841466	0.0006

Max-eigenvalue test indicates 4 cointegratingeqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Computed from E-views 7. April 2021

From the above table it is observed that there exist four cointegrating vectors in the model. Since we could reject the null hypothesis, which states is no cointegrating vector, otherwise we accept the alternative of there is three cointegrating vector equations. This implies we can deduce there

is a long run relationship between GDP per capita which is the dependent variable in the model and the three independent variables: agriculture, exports, and gross capital formation. Hence, this qualifies us to run the restricted VECM.

4.5. Vector Error Correlation

Table 5. Error correction results

Vector Error Correction Estimates Date: 04/29/21 Time: 15:41 Sample (adjusted): 1969 2019 Included observations: 51 after adjustments Standard errors in ( )				
Cointegrating Eq:	CointEq1			
GDP(-1)	1.000000			
AGR(-1)	-6.58853			
	(1.20942)			
XP(-1)	1.141343			
	(0.52599)			
GCF(-1)	1.615271			
	(0.41278)			
C	-2.54638			
Error Correction:	D(GDP)	D(AGR)	D(XP)	D(GCF)
CointEq1	-0.0575	0.163789	-0.02207	-0.22433
	(0.05919)	(0.05784)	(0.12839)	(0.14545)
D(GDP (-1))	-1.114	-0.30799	0.230497	-1.5903
	(0.26369)	(0.25766)	(0.57193)	(0.64793)
D(AGR (-1))	0.011828	0.165539	-0.19126	-0.3529
	(0.29262)	(0.28594)	(0.63469)	(0.71904)
D(XP (-1))	0.017133	-0.16421	-0.93761	0.253037
	(0.09841)	(0.09616)	(0.21344)	(0.24180)
D (GCF (-1))	0.142540	-0.15426	0.206877	-0.40971
	(0.11452)	(0.11190)	(0.24838)	(0.28139)
C	0.033399	0.213297	0.667723	0.071751
R-squared	0.514756	0.659798	0.576711	0.691756
Adj. R-squared	0.408239	0.585120	0.483793	0.624093

Source: Computed from E-views 7. April 2021

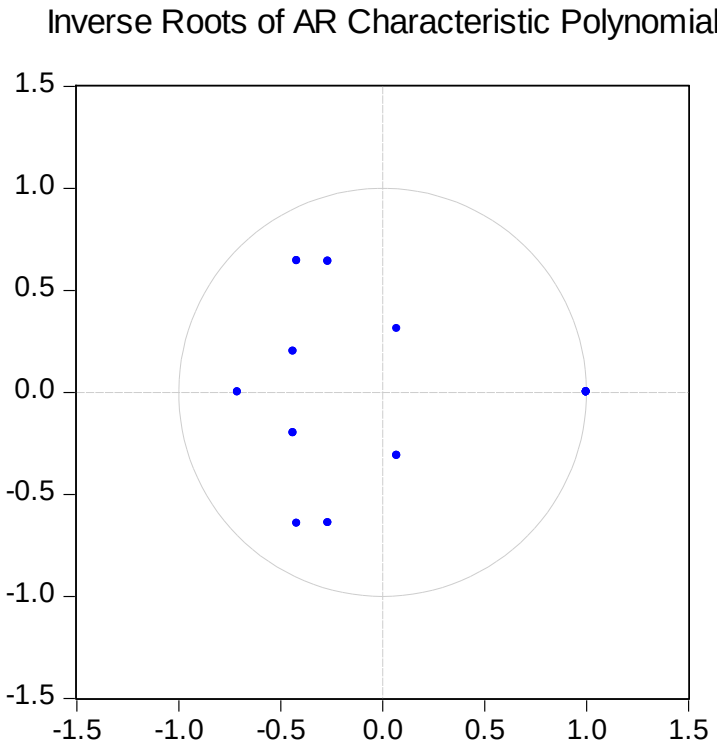
The value of the error correction term tells the rate at which it corrects the previous period disequilibrium of the system. The error correction term guides the variables (GDP per capita growth, Agriculture growth, Export growth and Gross Capital Formation growth) of the system

to restore back to equilibrium. The sign of the error correction term should be negative and significant.

From the table above, the ECT, technically named as the speed of adjustment, is 5.75% The ECT is estimated as negative and statistically significant at 1%, indicating that the short run value of GDP per capita growth will converge to its long run value by 5.75% per annum by the contributions of the agriculture growth exports growth and gross capital formation growth as explanatory variables. The coefficient of determination was for 51% of the variation in real gross domestic product per capita growth as explained by agriculture growth, export growth and gross capital formation growth. Hence it is suggested that the remaining 49% is determined by other factors not included in the model.

To avoid multicollinearity and specification errors in the vector error correction model, lag selection criteria were computed. The following inverse roots graph shows that all roots are in the circle, implying that the estimated model is dynamically stable.

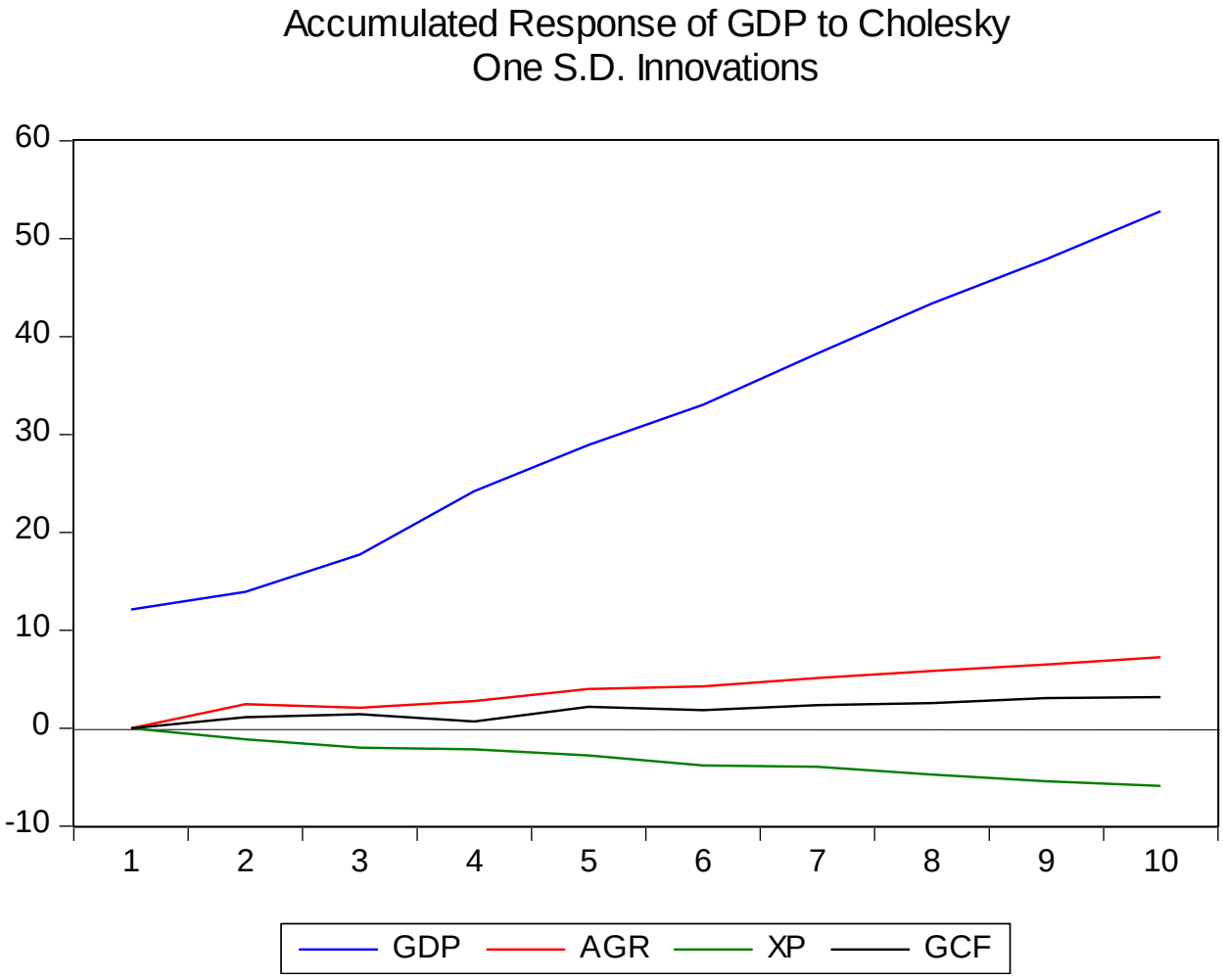
Figure 2. Inverse Roots of AR Characteristic Polynomial



Source: Computed from E-views 7. April 2021

Also, to understand the relationship shocks transmission between GDPs per capita growth, Agriculture growth, export growth and gross capital formation growth or impulse response check and variance decomposition were computed.

Figure 3. Impulse response of GDP



Source: Computed from E-views 7. April 2021

The impulse composition is necessary for policy simulation as it enables policy makers to identify the response of variables. From the above, 54 observations are summarized in 10 periods.

As indicated from the result of the impulse check, in ten periods, the analysis shows that GDP per capita responds positively to shocks in agriculture and gross capital formation but negatively to exports. The shocks from agriculture have higher impact on GDP than gross capital formation shocks. Hence, both agricultural and gross capital formation have positive influence on GDP, but in this context, agriculture has higher influence on economic growth of Rwanda. GDP per capita growth had a small increase the first three periods. However, after that the GDP per capita growth have a rapid increase with the growth of the two economic sectors.

For the case of agriculture and gross capital formation, there was a small increase for the first two periods and a fall in the third and fourth periods. However, from the fifth period, there has been a rapid increase for the two sectors. Looking at exports, there has been a decrease as indicated by the graph. Furthermore, it is seen from the impulse responses that agriculture and gross capital formation growth have positive impact on GDP per capita growth

4.6. Variance decomposition

Table 6. Variance decomposition results

Period	S.E.	GDP	AGR	XP	GCF
1	12.11468	100.0000	0.000000	0.000000	0.000000
2	12.59092	94.63101	3.776408	0.826803	0.765777
3	13.18962	94.54895	3.517712	1.182724	0.750615
4	14.72033	95.16837	3.028484	0.959809	0.843338
5	15.59349	93.99301	3.328605	1.014048	1.664335
6	16.17116	93.93737	3.126548	1.348189	1.587894
7	17.02523	94.18366	3.074215	1.224805	1.517324
8	17.80538	94.31714	2.971211	1.311222	1.400429
9	18.40016	94.33819	2.910637	1.363361	1.387812
10	19.06718	94.50609	2.860710	1.337382	1.295822

Source: Computed from E-views 7. April 2021

From the above, the contribution of agricultural output to shocks in GDP per capita growth is between 0% and 3.8% within the entire 10 periods that is under 2.5 for the first three periods and

less than 3.1% in ten periods. exports growth contribution is between 0% and 1.4% throughout the ten-year periods. Gross capital formation growth contribution lies between 0% and 1.7 % for the ten-year periods. Therefore, among the three variables, agriculture is the most variable influencing GDP per capita growth.

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Discussion

This study was based on data taken from the World Bank Metadata of Rwanda for a period of 1966 to 2019. The % GDP per capita was taken as dependent variable representing the economic growth. Three independent variables were also used. The first independent variable is agriculture as non transformed primary outputs such as cultivation of crops and livestock production, forestry, and fishing. The second independent variable is Exports and the third independent variable is gross capital formation. The effect of agriculture on other sectors of the economy was not considered here. This means that to better understand the effect of agriculture in wider range, there is a need extend studies on industry, agro-processing, employment and other sectors.

In some previous research it is found that Rwanda has made considerable progress in improving agricultural productivity and in reducing poverty, but much more needs to be done to increase the dynamism of the economy and the rate of poverty reduction and for sure this gives room to researchers. For example, it is indicated that the role of agriculture must be considered in the broader development strategy for its role is not only the contribution on GDP but also in poverty reduction and economic transformation (Xinshen at al. 2014). Also, research and Innovation in agriculture for growth and poverty eradication have shown that Rwanda agricultural can reduce the poverty rate for Rwanda 2018 (Abdullah Al-Mamun, Derek Apell, David Laborde, William John Martin, 2018).

The present study focused on agriculture as primary sector, which is the production of agricultural products on farms. However, the impact of agriculture on the Rwandan economy is much broader than it can be seen in this study as it has backward and forward linkages. The input sector such as fertilizer, the processing sector for example beer, juice, cheese, etc. The impact of Agribusiness on GDP is very large and it should to be taken into account when discussing the impact and role of agriculture in a country's economy.

The study used time series approach for fifty four periods. Factors such as external effects of agricultural output and public goods produced by agriculture, adaptation of new technologies and innovation were not studied her. Therefore, other statistical approach can be used again in the context to study the effect of agriculture on economic growth.

5.2. Conclusion

The study emphasized on the contribution of agriculture sector to economic growth in Rwanda over 54 years. The study also queries if there exists a long-run relationship among the variables. Unit root results, which reveal that all variables were stationary at their level form. This means that all variables are integrated in the same order. Johansen cointegration test displays the existence of four cointegrating vectors, which depict the existence of a long run relationship among the variables of interest in this study. That is, in the long run all the variables will converge together. Moreover, the short run relationship was examined. It was shown that the speed of adjustment to correct the short run equilibrium is 5.75%. The positive impact of agriculture growth on GDP per capita growth confirms that agricultural sector plays a significant role in economic growth of Rwanda.

5.3. Recommendation

Rwanda is a developing country and strived in agrarian activities that is, agricultural production. However, different agriculture reforms have been put in place to boost agriculture from an agrarian to market-oriented agriculture.

In that regard, research institutions should also put much effort in agriculture for innovation and development of agriculture to bridge the gap that exists between the local farmers and research institution for the dissemination of innovation. This will in no small measure restore the lost glory of the agricultural sector in Rwanda.

To boost the country's economic growth, the government should increase its support on agriculture in both policy and budget invested in the sector as this is an important pillar of the economy.

Capital formation is needed to boost economic growth of Rwanda but first should be invested in agricultural production.

The country should invest in applied agricultural research, innovation, and agriculture infrastructure.

The productivity of agriculture and its value-added portion should be enhanced at higher level through the adoption of new agriculture technologies as well as the use of improved seeds and other inputs.

Moreover, as more capital invested in agriculture by government and the private sector will help to increase agriculture contribution to Rwandan economy since there is a long-run relationship between GDP and agriculture.

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APPENDICES

Descriptive statistics

	GDP	AGR	XP	GCF
Mean	2.770857	4.927615	9.620242	12.38759
Median	3.351462	4.712044	5.453201	9.662056
Maximum	37.53553	43.28382	70.02187	155.7849
Minimum	-47.50332	-31.32285	-61.06338	-81.77223
Std. Dev.	9.689630	11.87538	23.40758	29.01217
Skewness	-1.670038	-0.121854	0.038554	1.740149
Kurtosis	17.45152	6.450437	3.870599	14.06633
Jarque-Bera	495.0058	26.92105	1.718748	302.7965
Probability	0.000000	0.000001	0.423427	0.000000
Sum	149.6263	266.0912	519.4931	668.9298
Sum Sq. Dev.	4976.114	7474.304	29039.50	44610.43
Observations	54	54	54	54

Cointegration results

Date: 04/29/21 Time: 15:39
Sample (adjusted): 1968 2019
Included observations: 52 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP AGR XP GCF
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.591571	121.4420	47.85613	0.0000
At most 1 *	0.520556	74.87931	29.79707	0.0000
At most 2 *	0.378538	36.65264	15.49471	0.0000
At most 3 *	0.204813	11.91729	3.841466	0.0006

Trace test indicates 4 cointegratingeqn(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 *	0.591571	46.56271	27.58434	0.0001
At most 1 *	0.520556	38.22666	21.13162	0.0001
At most 2 *	0.378538	24.73536	14.26460	0.0008
At most 3 *	0.204813	11.91729	3.841466	0.0006

Max-eigenvalue test indicates 4 cointegratingeqn(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):

GDP	AGR	XP	GCF
-0.085972	-0.114023	0.030769	0.001507
-0.114370	0.086884	0.036639	-0.041333
-0.132171	0.124332	-0.061545	0.013465
-0.162832	0.016769	0.043886	0.056760

Unrestricted Adjustment Coefficients (alpha):

D(GDP)	6.344366	2.638761	5.391131	0.666646
D(AGR)	10.77155	-3.747705	2.461361	0.627721
D(XP)	5.652846	-11.90394	13.33551	-1.549502
D(GCF)	13.45504	13.79491	6.991250	-7.479166

1 Cointegrating Equation(s): Log likelihood -850.9683

Normalized cointegrating coefficients (standard error in parentheses)

GDP	AGR	XP	GCF
1.000000	1.326281	-0.357902	-0.017533
	(0.24892)	(0.12318)	(0.09531)

Adjustment coefficients (standard error in parentheses)

D(GDP)	-0.545436
	(0.13892)
D(AGR)	-0.926050
	(0.14173)

D(XP)	-0.485985		
	(0.35306)		
D(GCF)	-1.156754		
	(0.37875)		

2 Cointegrating Equation(s):		Log likelihood	-831.8549

Normalized cointegrating coefficients (standard error in parentheses)

GDP	AGR	XP	GCF
1.000000	0.000000	-0.334031	0.223398
		(0.06545)	(0.06083)
0.000000	1.000000	-0.017999	-0.181659
		(0.06283)	(0.05840)

Adjustment coefficients (standard error in parentheses)

D(GDP)	-0.847232	-0.494135
	(0.22440)	(0.22483)
D(AGR)	-0.497424	-1.553819
	(0.22223)	(0.22265)
D(XP)	0.875469	-1.678818
	(0.53122)	(0.53224)
D(GCF)	-2.734479	-0.335620
	(0.55914)	(0.56021)

3 Cointegrating Equation(s):		Log likelihood	-819.4873

Normalized cointegrating coefficients (standard error in parentheses)

GDP	AGR	XP	GCF
1.000000	0.000000	0.000000	0.011667
			(0.05333)
0.000000	1.000000	0.000000	-0.193067
			(0.05736)
0.000000	0.000000	1.000000	-0.633867
			(0.15528)

Adjustment coefficients (standard error in parentheses)

D(GDP)	-1.559785	0.176153	-0.039899
	(0.26336)	(0.25656)	(0.10540)
D(AGR)	-0.822746	-1.247794	0.042638
	(0.29416)	(0.28657)	(0.11773)

D(XP)	-0.887105	-0.020793	-1.082945
	(0.61345)	(0.59762)	(0.24551)
D(GCF)	-3.658523	0.533613	0.489168
	(0.73424)	(0.71530)	(0.29385)

Vector error correction estimate

Vector Error Correction Estimates
Date: 04/29/21 Time: 15:41
Sample (adjusted): 1969 2019
Included observations: 51 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
GDP(-1)	1.000000
AGR(-1)	-6.588525
	(1.20942)
	[-5.44766]
XP(-1)	1.141343
	(0.52599)
	[2.16991]
GCF(-1)	1.615271
	(0.41278)
	[3.91319]
C	-2.546383

Error Correction:	D(GDP)	D(AGR)	D(XP)	D(GCF)
CointEq1	-0.057500	0.163789	-0.022071	-0.224326
	(0.05919)	(0.05784)	(0.12839)	(0.14545)
	[-0.97142]	[2.83183]	[-0.17191]	[-1.54232]
D(GDP(-1))	-1.114003	-0.307992	0.230497	-1.590304
	(0.26369)	(0.25766)	(0.57193)	(0.64793)
	[-4.22471]	[-1.19534]	[0.40302]	[-2.45442]
D(GDP(-2))	-0.645850	-0.103379	0.213850	-2.106008
	(0.26634)	(0.26025)	(0.57769)	(0.65446)
	[-2.42488]	[-0.39722]	[0.37018]	[-3.21794]
D(AGR(-1))	0.011828	0.165539	-0.191258	-0.352902
	(0.29262)	(0.28594)	(0.63469)	(0.71904)

	[0.04042]	[0.57894]	[-0.30134]	[-0.49080]
D(AGR(-2))	-0.017926	-0.129680	-0.373088	0.133822
	(0.18894)	(0.18462)	(0.40981)	(0.46428)
	[-0.09488]	[-0.70239]	[-0.91038]	[0.28824]
D(XP(-1))	0.017133	-0.164212	-0.937613	0.253037
	(0.09841)	(0.09616)	(0.21344)	(0.24180)
	[0.17411]	[-1.70777]	[-4.39288]	[1.04646]
D(XP(-2))	-0.037638	-0.206227	-0.474900	0.230368
	(0.08606)	(0.08409)	(0.18666)	(0.21146)
	[-0.43735]	[-2.45241]	[-2.54421]	[1.08939]
D(GCF(-1))	0.142540	-0.154260	0.206877	-0.409709
	(0.11452)	(0.11190)	(0.24838)	(0.28139)
	[1.24473]	[-1.37858]	[0.83291]	[-1.45603]
D(GCF(-2))	0.118606	-0.048822	0.231565	0.178578
	(0.08579)	(0.08383)	(0.18608)	(0.21080)
	[1.38252]	[-0.58240]	[1.24446]	[0.84713]
C	0.033399	0.213297	0.667723	0.071751
	(1.69846)	(1.65963)	(3.68390)	(4.17346)
	[0.01966]	[0.12852]	[0.18125]	[0.01719]
R-squared	0.514756	0.659798	0.576711	0.691756
Adj. R-squared	0.408239	0.585120	0.483793	0.624093
Sum sq. resids	6017.387	5745.422	28308.35	36332.20
S.E. equation	12.11468	11.83775	26.27637	29.76829
F-statistic	4.832614	8.835196	6.206717	10.22350
Log likelihood	-194.0157	-192.8364	-233.5026	-239.8660
Akaike AIC	8.000617	7.954367	9.549121	9.798668
Schwarz SC	8.379406	8.333156	9.927910	10.17746
Mean dependent	0.056471	0.006163	0.312457	0.067142
S.D. dependent	15.74848	18.37840	36.57241	48.55272
Determinant resid covariance (dof adj.)		1.78E+09		
Determinant resid covariance		7.42E+08		
Log likelihood		-810.2984		
Akaike information criterion		33.50190		
Schwarz criterion		35.16857		

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/ School of Economics MSc. Economics Batch 10 AGRICULTURE OUTPUT AND ECONOMIC GROWTH OF RWANDA (Period under study 1966 to 2019) A thesis submitted to the University of Rwanda. In partial fulfilment of the academic requirements for the award of Degree ofMaster of Science in Economics Presented by Isaie KUBWIMANA Reg.

No 218015763 Supervior: Dr Liberata MUKAMANA July 2021 Dedications This work is dedicated to Natete Nsanga Joshua My large Family. SUBMISSION AUTHORIZATION FORM / Acknowledgement All thanks to God, the creator, who provided me with strength, wisdom, and health throughout the period of this program. My Profound and endless gratitude goes to the tutor of this thesis my supervisors Dr. MUKAMANA Liberata for her coaching and guidance through my thesis stage.

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This is also an opportunity to me to express my gratitude to my family for her encouragement and support during the entire period of this program. My parents and brothers deserve much more thanks too. Abstract In most developing countries, mainly in sub-Saharan Africa, most of the population live in rural areas and earn their livelihoods primarily from agricultural activities. Agriculture is recognized as the engine for the growth of the economy of most developing nations of the world.

However, the role of agriculture as key to economic growth has never stopped to be the