THE EFFECT OF RENEWABLE ENERGY CONSUMPTION ON ECONOMC GROWTH.

Evidence from the East African Community

Thesis submitted to the African Center of Excellence in Energy studies for Sustainable Development (ACE-ESD)

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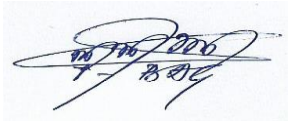
Declaration

I, the undersigned, declare that this thesis research is my original work, and has not been presented for a degree in University of Rwanda or any other universities. All sources of materials that will be used for the thesis work will have been fully acknowledged.



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Date of Submission: _____ _____

This thesis proposal has been submitted for examination with my approval as a university advisor.

……. _____ ____

Thesis Advisor Signature

Dedicated to

BAGUMA EMMANUEL & M' SHANKOMA

My Parents

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ABSTRACT

Achieving the goals of sustainable development and poverty reduction implies an important condition for access to electricity for the entire population. In the economic literature, the relationship between electricity consumption and economic growth has different perspectives. The lack of good governance within an economy, besides the deficiencies of energy resources, is a key issue in worsening energy issues for developing countries. These countries have failed to alleviate the energy crises that have hindered development prospects, amid flourishing corruption and inefficient governments.

Our research, using a panel methodology, analyzes the long-term relationship between energy consumption, economic growth and good governance for 6 East African Community countries over the period 2000 –2020.

The study demonstrates empirically that there is a causal relationship between electricity consumption and economic growth, underlining the fact that deficiencies in the energy system lead to slowing economic growth. The study also shows that good governance influences electricity and Gross Domestic Product (GDP) consumption, and the governments from East African Community countries have to restore good governance in the economy, creating an environment conducive to investment in the energy sector, which would increase competition and reduce inefficiencies in the production, transmission, and distribution of energy.

Keywords: Sustainable development; economic growth; governance; energy;

East African Community.

ACRONYMS

EAC: East African Community

ECS: Energy Charter Secretariat

FDI: Foreign Direct Investment

GDP: Gross Domestic Product

HDI: Human Development Index

IEC: International Energy Charter

ICRG: International Country Risk Guide

TI: Transparency International

UNDP: United Nations Development Programme's

WGI: World Governance Indicators

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CHAP 1: INTRODUCTION

1.1: BACKGROUND

Energy plays an essential role in an economy on both demand and supply. On the demand side, energy is one of the products a consumer decides to buy to maximize his or her utility. On the supply side, energy is a key factor of production in addition to capital, labor and materials and is seen to play a vital role in the economic and social development of countries, being a key factor in increasing economic growth and living standards. This implies that there should be a causal relationship running from energy consumption to national income or GDP and vice versa. [1]

Economic growth is among the most important factors to be considered in projecting changes in world energy consumption. In this regard, the analysis of the relationship between energy consumption and economic growth has received a great deal of attention during recent years. [2]

Indeed, whether the economic growth promotes energy consumption or energy itself is a stimulus for economic growth has motivated interest among economists and policymakers. Over the two last decades, there has been a large body of published research investigating the causal links between energy consumption and economic growth. This is because the direction of causality has significant policy implications. For instance, if energy consumption is a vital component in economic growth, energy conservation policies, which reduce energy consumption, may adversely affect real GDP. [3]

However, a unidirectional causality running from economic growth to energy consumption signifies a less energy dependent economy such that energy conservation policies may be implemented with little or no adverse effect on economic growth. [4]

Although energy is not included in the standard growth models as an input of economic growth, the importance of energy in a modern economy is unquestionable. For instance, Hall and Klitgaard (2012) [5] emphasized the role that energy has played in economic growth and the limit to continued growth given our reliance on fossil fuels. Stern (2010) opined that when energy is scarce it imposes a strong constraint on the growth of the economy but when energy is abundant, its effect on economic growth is much reduced [6]. This explains the industrial revolution as a releasing of the constraints on economic growth due to the development of methods of using coal and the discovery of new fossil fuel resources.

In addition, it was found that the elasticity of substitution between a capital-labor aggregate and energy is less than unity, which implies that when energy services are scarce they strongly constrain output growth resulting in a low-income steady state. When energy services are abundant, the economy exhibits the behavior of the 'modern growth regime' with the Solow model as a limiting case. [7]

The inconclusive nature of the relationship between energy consumption and economic growth led to four major views in the literature: The first view is the growth hypothesis, which suggests that energy consumption plays an important role in economic growth. It implies that economic growth is dependent on energy consumption just as a decrease in energy consumption may restrain economic growth.

The second is the conservative hypothesis, which argues for unidirectional causality from economic growth to energy consumption. It suggests that energy conservation policies may have little or no impact on economic growth. The

conservative hypothesis is supported if an increase in real GDP causes an increase in energy consumption. The third view is the neutrality hypothesis, which argues that there is no causality between energy consumption and economic growth. In other words, both energy consumption and economic growth are neutral concerning each other.

While the last view is the feedback hypothesis, which suggests that there is a bi-directional causal relationship between energy consumption and economic growth reflecting the interdependence and possible complementarities associated with energy policies and economic growth.

These peculiarities, considered a certainty for a long time, are given by the natural monopoly of transport and distribution activities within the energy sector, which allows the vertical integration of various activities in the form of monopolies. [8]

The essential role for the community that energy plays, either as a primary resource or as electricity, is a need for strict governmental control; the strategic nature, of any economy of the energy sector, especially electricity, gas, and, to a lesser extent, oil [9]

The structure of this model is dictated by: exclusive rights to build and operate in the energy sector, whether of the state or concession by it; lack of any form of competition; detailed regulations; high degree of planning and strict control; vertically integrated operation; costs based on production costs.

The European model has been functioning for a long time, but it is becoming increasingly apparent to consumers that they are not part of the decision-making process in any of the energy system's operating phases. [10]

Another important drawback was the fact that those who plan, lead, and operate the system do not take any risks and they did not suffer if they were wrong. Consumers, in their dual quality of consumers and taxpayers, [11] have always paid the cost of

incompetence or misconduct. This rigid, traditional relationship between, the government–energy industry, has for some time been affected by the change that seems irreversible at the community level.

Old certainties have begun to shake and the unconditional acceptance of centralized decisions has ceased to work, increasingly evident since the 1990s [12]. The new wave of centralized regulation is the regulation of competition.

Natural monopolies, either State-owned or under its control, operating in a centralized technical configuration, are beginning to fall apart and reorient to customers and competition.

The features of the new type of approach at the European level are different, namely: the separation of activities [13], allowing competition whenever possible (instead of vertical integration); the freedom to invest in competitive activities (instead of centralized planning); the freedom to contract at competitive rates (instead of the fixed tariff); access to the network and infrastructure; supervising the system by independent regulators (instead of the government); adaptation to information technology. [14]

Over the past two decades, there have been several papers dealing with the causality between economic growth and energy, especially energy consumption. [15]

The causality between growth and energy, especially total energy consumption and activity, has been the subject of a series of works over the last two decades, with the existence and direction still not established. [16]

The fieldwork involves two approaches: the first approach is positive (energy is a production factor and thus a requirement/inhibitor for economic and social development); the second approach is neutral (energy does not have a significant impact on economic growth. [17]

Good governance implies involvement in local or national processes to correctly formulate policies and key social, economic, technological, environmental, and political goals of a country or community and the proper management of resources by including the institutional framework. [18]

Good governance also means using the best ways to achieve the goals mentioned above through the ability to exercise power and make good decisions involving all aspects of a country. Worldwide, there are six key indicators of good governance developed by the World Bank, namely: (1): Corruption control, (2) Government effectiveness, (3) The rule of law, (4) Violence and accountability, (5) Regulation, (6) Political stability and absence of violence. We have chosen these indicators because they are most used in the literature; they have the most sources of information and show the most available data for the studied countries. [19]

As a consequence of economic globalization, many public goods, including the electricity market, have been privatized so that consumers can benefit from lower prices due to competition. [20]

Good governance is, however, of great importance for ensuring the uninterrupted, reliable, and cheap supply of electricity to the countries concerned.

A multitude of reasons generate the need to adopt good energy governance in Eastern European countries: in a broader sense, it inspires a sense of trust among people based not only on the adoption of better but ethical decisions, allowing public services to make more efficient for all citizens; in a more restricted, energy-specific sense, it is imperative for the constant supply of clean energy to mitigate pollution and to conserve the natural resources of those countries. [21]

For the East African community, except for some works, which involve different methodologies, few studies are addressing the causal relationship between energy and

economic growth, and studying the relationship with good governance is nonexistent. [22]

1 .2: STATEMENT OF THE PROBLEM

The ultimate objective of any country is to achieve and sustain economic growth in both the present generation and the upcoming generation. Economic growth is highly dependent on the efficient utilization of the economy's factors of production.

Several factors have been identified, and foreign direct investment (FDI) is one of them. FDI is a way to increase the host country's physical and human capital, which then potentially increases the real GDP. Furthermore, FDI helps in generating technological spillovers, transferring knowledge development of new enterprises, and provides opportunities for the host countries to integrate into the global economic trade. Apart from FDI, the institutional quality also plays an important role in the economic growth of the country. The weak institutional quality brings in adverse economic problems like low investment, slow productivity, and low GDP per capita, which ultimately slow down the economic growth process. On the contrary, good institutional quality ensures high investment, efficient factor allocation, minimizes uncertainty, and eases economic agents' coordination, which results in economic growth. The determinants of institutional quality also play an important role in the FDI inflows. Foreign investors also value further, institutional quality because it decreases the implementation cost and ensures the ease of doing business.

1 .3: OBJECTIVES

1. 3. 1: Major Objectives

The purpose of this thesis is to study the existence and direction of causality between energy consumption (total economy, industry, and households), economic growth, and good governance.

1. 3. 2: Specific objectives

The specific objectives of this research will be:

- To determine the relationship between energy consumption and economic growth in the Esten African Community;
- To analyze the degree of access to the renewable energy in the East African communities;

1 .4: SCOPE OF THE STUDY

This thesis refers to 6 Partner States countries from The East African Community (EAC) ; the Republics of Burundi, Kenya, Rwanda, South Sudan, the United Republic of Tanzania, and the Republic of Uganda in the period 2000 - 2020.

The EAC is home to 177 million citizens, of which over 22% are urban population. With a land area of 2.5 million square kilometers and a combined Gross Domestic Product of US$ 193 billion. Its realization bears great strategic and geopolitical significance and prospects for the renewed and reinvigorated EAC. The work of the EAC is guided by its Treaty, which established the Community. It was signed on 30 November 1999 and entered into force on 7 July 2000 following its ratification by the original three Partner States - Kenya, Tanzania, and Uganda. The Republic of Rwanda and the Republic of Burundi acceded to the EAC Treaty on 18 June 2007 and became

full Members of the Community with effect from 1 July 2007. The Republic of South Sudan acceded to the Treaty on 15 April 2016 and become a full Member on 15 August 2016. As one of the fastest-growing regional economic blocs in the world, the EAC is widening and deepening cooperation among the Partner States in various key spheres for their mutual benefit. These spheres include political, economic, and social.

Now, the regional integration process is in full swing as reflected by the encouraging progress of the East African Customs Union, the establishment of the Common Market in 2010 and the implementation of the East African Monetary Union Protocol.

1 .5: EXPECTED OUTCOMES

Through this research, we expect to investigate the relationship between electricity consumption and economic growth for the East African Community with the introduction of a new component, good governance and to analyze the impact of this on the initial variables.

1 .6: SIGNIFICANT OF THE STUDY

The usefulness of the analysis is due to the following reasons: firstly, amid tensions in the international energy market, there is a continuing debate at the level of the European Union on the causality between energy consumption, on the one hand, and GDP growth, on the other hand; secondly the contribution of institutional quality through respect for democratic principles and legislative authority is an important element in relation with the energy consumption and sustainable economic growth; thirdly, in the context of the East African community goal of increasing energy efficiency, it is important to know what this goal would mean for GDP growth in the short and long term and which are the factors of influence.

The organization of the paper is as follows: Section 1 represents the Introduction Section 2 presents the literature about the role of energy and good governance in economic growth; Section 3 describes econometric methodology; Section 4 shows the empirical results obtained; the final section contains the conclusions.

Chap 2: LITTERATURE REVIEW

2 .1: INTRODUCTION

The theoretical basis for the study is presented in this chapter, along with an analysis of the commonalities between various scholars' findings on the issue. The chapter also features a review of pertinent academic works.

2. 2: THEORETICAL FRAMEWORK

GDP, the traditional measure of economic growth, is the overall output of a nation, including the value of its services. A country's economy generates the total production. GDP can be conceptualized as a function of saving, investment, government spending, and the difference between exports and imports. This can be written mathematically as $GDP(Y) = f(C+I+G+(X-M)$ [23] .

It can be demonstrated that Gross Domestic Product (Y) is a function of Consumption (C), Investment (I), Government expenditure (G) and the net of exports and imports (X-M). This consumption represents the total private consumption of products and services at the household, individual, and business levels. At all levels, this total consumption includes electricity use. Keynes (1936) said that although the rates of growth between the two variables are different, consumption levels rise as income rises. This assumes that as long as the economy is expanding, consumption in general and electricity in particular should rise as well.

The Keynes model of consumption refers to the fact that the average level of consumption decreases as earnings rise and that the present consumption expenditure is a function of the current amount of disposable income.

However, according to other theorists that employ the theory of interest, such Irving Fisher (1965), consumers make decisions based on the present as well as the future to maximize their lifelong pleasure. He pointed out that even if human beings are constrained by their existing financial situation, they will always borrow to meet their immediate demands [24]

Keynes and Fisher agree to some extent that income is the primary determinant of consumption, but Keynes assumes that current consumption depends simply on current income without taking the time of revenues into account. [25]

The other two theories on consumption are attributed to Milton Friedman and Ando & Modigliani (1963). (1957). According to Franco Modigliani's theory later known as the Life-Cycle Hypothesis—income varies systematically over the course of a consumer's life cycle, allowing him to use his savings to control his consumption. According to this idea, customers allocate their resources equally over the course of their lifetimes while paying no interest. On the other hand, Friedman assumes that people use borrowing and savings to control their spending. This suggests that individuals with high incomes have higher short-term incomes than individuals with low incomes. [26]

The consumption patterns that influence people's spending patterns have been the subject of numerous theories. Baldric (2013) and Huang (1993) both recently used it to investigate how economic growth movements and the Keynes theory interact.

Different theorists have traced the consumption behavior that dictates the pattern of expenditure by individuals. This research will espouse the Keynes theory as also used by Huang (1993) and recently by Baldric (2013) to examine its relationship with economic growth movements.

2 .3: EMPIRICAL RELATIONSHIP

The empirical link between energy use and the elasticity of economic development is not clear-cut. Granger causality was applied to annual U.S. statistics from 1947 to 1974 by Kraft and Kraft (1978) to determine the association between electricity consumption and Gross National Product (GNP). They noticed that economic growth and power use are correlated, indicating that over the studied periods, rising GNP was associated with rising energy consumption. [27]

For instance, in Ghana and Malawi, respectively, Akinlo (2008) and Jumbe (2004) looked at the connection between electricity use and economic growth. Both of them employed Granger causality, and the results they obtained indicated a two-way relationship between the two nations. Odhiambo (2009b) and Odhiambo (2014), who used the same variables and methods, came to the opposite conclusion and found that there was a one-way relationship between power consumption and economic growth in Ghana and Malawi, respectively. This further demonstrates how dynamic this relationship may be, despite the fact that the research periods were distinct.

In fact, these nations implemented a number of initiatives to preserve energy and lessen their reliance on imported foreign oil. Concerns have been voiced, nevertheless, about the negative consequences conservation policies may have on economic expansion.

The literature on energy economics has been heavily debating the connection between energy consumption and economic growth for the last three decades, highlighting the significance of energy as a production input. [28]. Supporters of the energy-led growth theory demonstrate that energy, which is currently present in all production activities, is a critical factor in fostering growth; opponents of conventional economic growth theories contend that there are only three major production factors—labor, capital, and

nature and that energy consumption is therefore not a factor in the determination of economic growth. [29]

The main energy consumption is used as an indicator of energy consumption and real GDP is used as an indication of economic growth in the majority of the previous articles' analyses of this connection [30]; analyzing data in accordance with the growth hypothesis, conservation hypothesis, feedback hypothesis, and neutrality hypothesis.

The conservation hypothesis assumes that economic growth increases energy consumption, with the opposite link being invalid. However, unlike the first hypothesis, increasing waste management, CO2 emissions reduction, and energy efficiency does not always result in a decline in GDP [31]; Energy conservation measures have no adverse effects on economic growth since economic growth is not a direct result of energy use.

According to the feedback hypothesis, economic growth and energy consumption are interdependent, with each factor having the potential to stimulate the other. A change in energy consumption will always result in a change in economic development. Energy-saving measures will slow economic growth, and higher rates of economic growth will be accompanied by higher rates of energy consumption.

According to the neutrality hypothesis, energy consumption and economic growth are unrelated and have no impact on one another. Likewise, energy conservation efforts have no bearing on economic growth [32].

Access to energy is a key for human wellbeing, economic development, and poverty as well as unemployment alleviation and hence energy and economic development are strongly connected. The level and status of secure energy supply are largely depending on the level of economic advancement and vice versa.

Mina BALIAMOUNE-LUTZ and Léonce NDIKUMANA (2009) [33], in his research conclude that Governance quality is an important variable to explain investment rate which means one way to promote economic growth is improving the capital market and investment climate. Léonce Ndikumana (December 2005) [34]; conclude that bureaucratic professionalization encouraging investment in public facilities reduction of corruption and encouraging productive investment.

Campos et al. 1999; Dahlström et al. 2012 [35]; studied The impact of corruption on investment: Predictability matters and conclude that a good economic power structure promoting the optimization of resource allocation a political power structure affecting economy system and economic policy. Rahman et al (1999) [36]examined the effects of corruption on economic growth and gross domestic investment for Bangladesh. This study extended the earlier studies by Baro (1991). Unlike the previous studies, the authors modified Mauro's model by including two regional dummy variables. They find that corruption is significantly and negatively associated with cross-country differences in economic growth and gross domestic investment. In addition, they suggest that corruption retards economic growth by reducing foreign direct investment. They caution that endogeneity must be looked at more seriously in investing the relationship between corruption and economic growth.

Chap 3: METHODOLOGY

3 .1: INTRODUCTION

The explanation of the data source and estimating methods that will be used to achieve the study's goals is introduced in this chapter. The research report's sections 4.1 and 4.2 cover the data selection process and sample size, while sections 4.3 to 4.5 discuss the strategies used to get accurate estimates, including econometric modeling techniques and estimations.

3 .2: DATA TYPE AND SOURCE

Over the years 2000-2020, we use annual data spanning a total of 20 years. Data for the real GDP, the total population, the labor force participation rate, the gross fixed capital formation (percentage of GDP) as a proxy investment and energy consumption (kg of oil equivalent per capita) are all from the years 2000 to 2020. The World Development Indicators and Global Development Finance database is where the information is obtained (World Bank, 2020). Gross fixed capital creation and real GDP are both expressed as constants. Using the perpetual inventory approach, the physical capital stock series is built with an initial capital stock equal to 1.5 times the real GDP in 1962. A 5% depreciation rate is envisioned. The labor supply is calculated as the product of the population for each year multiplied by the average participation rate, which between 1990 and 2016 was 58.7%. For consistency and due to the series' various starting points, the sample from 2020 to 2020 is used for the analysis.

3 .3: MODEL

The estimation method in this article should analyze the causal relationships between the variables considered, meaning the energy consumption, economic growth, and good governance, allowing for the simultaneous determination of these three variables. The existing literature on energy–economic growth includes in the production function the physical capital and the labor force, but very few studies include good governance in this equation. In the production function, energy consumption is considered as a factor similar to those previously set forth. [37]

The analysis in this thesis refers to 6 Partner States countries from The East African Community (EAC) ; the Republics of Burundi, Kenya, Rwanda, South Sudan, the United Republic of Tanzania, and the Republic of Uganda in the period 2017- 2021

The variables, which will be taken into account; will be the following:

- GDP (dependent/independent): natural logarithm of real gross domestic product;
- ELEC (independent/dependent): natural logarithm of final energy consumption
- GOV (independent): Good governance measured by averaging the six indices of governance (Kaufmann et. Al., 2010) [43] control of corruption, rule of law, political instability, governmental efficiency, voice and accountability, and regulatory quality. The benefits of using the World Government indicators are given by the most sources of information and show the most available data for the studied countries. The shortcomings of using the World Government indicators will be given by the discrepancy between actual and observed field data; appropriate selection of experts and their training in the field; distrust and cultural differences of respondent ordinary citizens.
- GFCF (independent): Gross fixed capital formation;
- URB (independent): The urban population (% of total population)

- INF (control): Inflation (year to year %)
- UNEM (control): Unemployment (year to year %)

In the baseline equation, the dependency variable is the GDP (model 1) and ELEC (model 2), following that the independent variables be all other indicators, which could change from model to model, relative to energy consumption: total or at the branches levels, industry, households, transport. The data source is WORLD BANK, REG, statistical office of Rwanda infrastructure, and for the good governance indicators the source used is the World Bank; the frequency of the data is annual. In turn, good governance is involved in a capital-related variable, because an efficient banking system (capital) requires functional government institutions. Thus, the classic Cobb–Douglas production function can be written in the following way [44]

$$Y = A \times K \propto 1 \times L \propto 2 \times E \propto 3 \quad (1)$$

Where: Y represents GDP; A the productivity of all production factors; K physical capital; L human capital; and E represents total energy consumption.

If we logarithm the previous equation, the production function for the country i at the term t becomes:

$$yit = gdpit = ait + \propto 1kit + \propto 2lit + \propto 3eit \quad (2)$$

But the overall productivity of production factors is also influenced by the quality of government institutions (firms and citizens, under the pressure of generalized corruption of weak institutions and state interventionism, react negatively because of instability and insecurity felt, unable to reach its maximum potential) [45] and the previous equation becomes:

$$ait = \propto 0 + \propto 4(good\ governance) + \propto 5(control\ variables) + \varepsilon 1, it \quad (3)$$

Combining Equations (2) and (3), we obtain the following formula:

$gdpit = ait + \propto 1kit + \propto 2lit + \propto 3eit + \propto 4(good\ governance) + \propto 5(control\ variables) + \varepsilon 1, it$ (4)

Therefore, the equation will be:

$$GDP = f(ELEC, GOV, GFCF, URB, INF, UNEM)\ (5)$$

And by using natural logarithms (for resolving the problem of heteroscedasticity), it will become:

$$lnGDPit = \propto 0 + \propto 1 \ln ELEC + \propto 2lnGOV + \propto 3lnGFCF + \propto 4lnURB + \propto 5lnINF + \propto 6lnUNEM + \varepsilon 1, it\ (6)$$

As can be seen, good governance is included in the final form of the equation, taking into account the still-unclear effects by which this indicator influences GDP. Because physical capital, human capital, and energy are factors of production and directly influence GDP, it is assumed that $\propto 1, \propto 2\ and\ \propto 3$ are positive; in terms of good governance, negative results are expected (the poor quality of public institutions has negative effects on economic growth).

Also, we write an equation for electricity consumption (model 2):

$$ELEC = f(GDP, GOV, GFCF, URB, INF, UNEM)\ (7)$$

Moreover, combining with the previous equations, the model for electricity consumption becomes:

$$lnELECit = \propto 0 + \propto 1lnGDP + \propto 2lnGov + \propto 3lnGFCF + \propto 4URB + \propto 5INF + \propto 6UNEM + \varepsilon 1, it\ (8)$$

A panel data regression is different from a simple cross-sectional regression or one using the time series, by having a double index of its variables [46]

$yit = c + \propto iyi, t - 1 + \beta i\ xit + \delta i + \gamma t + \epsilon it$ (9)

where Yi,t is the dependent variable, Xi,t is a k-dimensional vector regression and "it are innovations for the M cross units and observed to T period, terms δi and γt are specific effects (random or fixed) for the sectional variables for certain periods of time. For the robustness of the research, the dynamic panel data model will be applied, the advantage of which is to eliminate many of the cross-sectional and static panel data deficiencies:

$$gdpit = \propto 0gdpit - 1 + \propto 1kit + \propto lit + \propto 3eit + \propto 4(good\ governance) + \propto 5(controlvariables) + \varepsilon 1, it \qquad (10)$$

To avoid spurious regressions, the unit root test helped us to test the series staticity (Breitung–Das unit root test) to observe the stationary order, I (0) or I (1). If the series are I (1), we tested (Westlunf cointegration test) if there were long-term relations between the variables analyzed, taking into account the possible cross-sectional dependence. After these tests, we estimated long-run coefficients using
the two Dynamic OLS (DOLS) and Fully Modified OLS (FMOLS) methodologies.
This research will conclude with the estimation of short-term causality using the Granger test methodology.

For determining the cross-sectional dependence between the analyzed variables, will be applied for the transversal dependency test (Langrage Multiplier (LM)) that was developed by Breusch and Pagan (1980). According to it, the empirical equation for the Langrage Multiplier test is modeled as follows:

$$yit = \propto i + \beta ixit + \varepsilon it, for\ i = 1,2 \dots N; t = 1,2 \dots \quad (11)$$

Where i indicates the cross-sectional dimension, the time dimension is shown by t, and x is a vector k x1 of the independent variables. In the basic configuration of our model, the variable y represents GDP (energy consumption), and the variable x represents the energy consumption/government (GDP).

We used i a and i b for revealing the individual interceptions and slope ratios for the analyzed countries.

Without cross-section dependence, the null-hypothesis is presented as follows:

$$Ho: Cov(uit, ujt) for\ all\ t\ and\ i\ \neq j$$

The alternative hypothesis of cross-sectional dependence is guided by:

$$H1: cov(uit, ujt) for\ at\ least\ one\ pair\ of\ i \neq j$$

In this regard, the null hypothesis could be accepted by the cross-sectional dependence test if, for the loads factor, appears a zero environment in the cross-sectional dimension. In order to address the issues, the LM test was modified by Pesaran et al. (2008) [38], using the exact average and variance of LM statistics. If the null hypothesis first considers T→ ∞ and then N → ∞, then the LM test is asymptotically distributed as normal.

For the stationary of the tests using panel unit root test (Breitung), if the calculated probability is appropriated to 0, then the series is stationary; if it is close to 1, then the series contains a unit root.

Type unit root tests will be calculated after the model:

$$\Delta Yit = \propto i + \sum_{k=1}^{p+1} Bik\ Xi, t - k + \ \varepsilon it \ \ (12)$$

Where: $\propto i$ is constant, t is the trend, DYt-1 is the value of one time-delay difference.

The null and alternative hypothesis for the panel unit root test is:

$$Ho: \beta 1 = \beta 2 = \cdots = \beta n \ (13)$$

HA : at least one coefficient βi is different from zero.

In Equation (3), the Breitung test statistic (2000) tests the following null hypothesis that the process is a stationary difference:

$$H0 = \sum_{k=1}^{p+1} Bik - 1 = 0$$

The alternative hypothesis assumes that the series is stationary; this is, H1

$$H1 = \sum_{k=1}^{p+1} Bik - 1 < 0$$

The specialized literature has established that the Breitung panel unit root test has the maximum power and the smallest distortion in size compared to the other panel unit root tests, and is therefore used in this work.

In order to explain the relationship between analyzed variables and according to the data series analyzed I (1), it is necessary to investigate the long-term equilibrium. The results of the analysis could be altered by cross-sectional dependence, so, we will use the cointegration analysis (Westerlund and Edgerton [39]), which can, at the same time, consider cross-sectional dependence and structural breaks.

The model used is:

$$yit = aihit + niDit + XitBi + (DitXit)yi + zit \ (14)$$

where i = 1, … , N and t = 1, …, T represents the cross-section and the time series, respectively, and Dit is a dummy time, taking into account structural pauses. ai and bi represent intercept and slope before pause, respectively, and di and gi intercept and slope after pause, respectively.

Using the estimation methods by different techniques (FMOLS estimator developed by Phillips and Hansen (1990) [40] and by Saikkonen's (1991) [41] and DOLS estimator created by Stock and

Watson (1993) [42], we could perform tests on cointegrated vectors. These techniques help normally distributed estimates if panel data are used (Kao and Chiang (2001) [43].

The FMOLS panel estimator for the coefficient β is defined as:

$$B = N^{-1} X \sum_{t=1}^{N} (\sum_{t=1}^{T} (Yit - Y)^{2-1} (\sum_{t=1}^{T} (Yit - Y))^{zit - Tnt} \quad (15)$$

Where $(Zit - Z) - \frac{L21i}{L22i} \Delta Yit\ X\ nt$

The panel DOLS estimator for the coefficient β is defined as:

$$B' = \frac{1}{N} \sum_{t=1}^{T} i = 1^{n} X \left[\sum_{t=1}^{T} (Zit\ Zi,t)^{-1}\ X \left[\sum_{T=1}^{T} (Zitwi,t) \right] \right] \quad (16)$$

Where $Zit = [Xit - Xi, \Delta Xit, t - k, \ldots \Delta Xi, t + K]$ is the vector of regressors.

Then, we examined the causality direction between the variables in a panel context. Engle and Granger (1987) [72]. Going from the assumption that we found a long-term balance of real GDP, energy consumption, and governance, using the Granger causality, we developed a model with a dynamic error correction representation.

The cointegrated model based on OLS and reveal that the traditional VAR model is increased by a time delay error correction term gave data from Table 1.

3 .4: DESCRIPTIVE STATISTICS OF THE VARIABLES

Table 1: Summary descriptive statistics of the variables used..

Source: Authors' computations.

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	126	4.153237	.1490901	2.631889	4.293195
ELEC	126	6.254154	.734831	4.983607	7.604895
GFCF	126	27.40476	24.64506	3	126
GOV	126	29.02857	14.72191	9	68
INF	126	64.07405	38.65769	47.19	430
UNEMP	126	4.194683	3.702807	1.06	14.03
URB	125	19.50328	6.047128	8.25	35.23

Where: GDP is the natural logarithm of real gross domestic product; ELEC is the natural logarithm of final electricity consumption; GFCF is the Gross fixed capital; GOV is the Good governance; INF is the inflation rate; UNEM is the Unemployment rate; URB is the urban population.

An important indicator of physical capital, the gross fixed capital formation, shows an average of 24.89; a maximum of 41.53 belongs to Kenya in 2018 and a minimum of 8.86 belongs to Burundi in 2015 (Figure A2a, Appendix B).

Another important indicator, of human capital, the urban population, shows an average of 45; a maximum of 63 belongs to TANZANIA in 2017 and a minimum of 50.62 to south Soudan (Figure A2b, Appendix B). Good governance indicators have similar

values for the analyzed countries: average of 15, maximum 20.56 in Tanzania in 2016, minimum of 5.6 belongs to south Soudan (Figure A3a, Appendix B).

Table 2: Correlational statistics.

Source: Authors' computations.

	GDP	ELEC	GCF	URB	INF	UNEMP	GOV
GDP	1.0000						
ELEC	0.0482	1.0000					
GCF	0.2269	0.1262	1.0000				
URB	0.1258	0.7027	0.3218	1.0000			
INF	-0.2077	0.0105	-0.1494	-0.0185	1.0000		
UNEMP	-0.3861	-0.1470	-0.3089	-0.0131	0.3614	1.0000	
GOV	0.2191	0.2951	0.0440	0.6719	-0.1111	-0.3797	1.0000

The results of the CD—cross-section dependence test [44] are presented in Table 1. The null hypothesis of non-dependence is rejected for all variables at a significance level of 1% and 5%; for all variables, there is a transversal dependence and the variables in each country are correlated with those in another country. Under these circumstances, in the presence of cross-dependence, it is extremely important to use a root-based test that generates consistent, second-generation results.

Further, to get the correct results, we perform the root unit test on all the regression variables to determine the existence of unit roots for those series. In this work, we use the Breitung panel root test to determine whether the variables are stationary at levels or at first difference, starting from the null hypothesis that all panel series contain root units (Table 4); if the statistical value is lower than the standard value of the test, then a co-integration relationship is applied to establish first differential equilibrium.

CHAP 4: ECONOMETRIC METHODOLOGY AND EMPIRICAL FINDINGS

In the following sections, we describe appropriate econometric methodology and apply these for our sample countries.

4 .1: ISSUES RELATED TO HETEROGENEITY AND CROSS-SECTIONAL DEPENDENCE

According to Pesaran, violation frequently results in the IPS test's undesired finite sample features. In order to determine whether cross-sectional dependency existed within our panel variables, we employed the usual diagnostic test for cross-section dependence in panels. The correlation coefficients between the time-series for each panel country are used in this test. In this test, the alternative hypothesis of cross-sectional dependence is contrasted with the null hypothesis, which implies cross-sectional independence. The existence of cross-sectional dependence between the countries was confirmed by the rejection of the null hypothesis.

The results of the Pesaran CD test for the factors under consideration are shown in Table 3; for each of the variables, the cross-sectional independent null hypothesis was categorically rejected. We draw the conclusion that cross-sectional dependence is present as anticipated.

Table 3: Pesaran test for cross-sectional dependence

Source: Authors' computations.

variables	Statistic	p-value	1%	5%	10%
GDP	-4.5696	0.0000	-2.320	-2.080	-1.950
ELEC	3.1319	0.0000	-2.320	-2.080	-1.950
GFCF	-0.3655	0.0000	-2.320	-2.080	-1.950
GOV	2.2820	0.0000	-2.320	-2.080	-1.950
URB	8.5226	0.0000	-2.320	-2.080	-1.950
INF	-3.2934	0.0000	-2.320	-2.080	-1.950
UNEM	3.1523	0.0000	-2.320	-2.080	-1.950

4. 2: ESTIMATION STEPS AND EMPIRICAL FINDINGS

The main descriptive statistics are presented in Table 2. The GDP evolution shows an average of 70 billion dollars for the East African Community countries, with minimum values of 2.90 billion dollars (for Tanzania) and a maximum of 467,167 billion dollars (south Soudan 2017).

GDP per capita has been steadily increasing since 2000 and, to date, with the panel average of 8326.58 dollars; the maximum value being 20,800 dollars (, 2017)

(Figure A1a, Appendix

Table 2; shows the values of the correlation statistics between the analyzed series and the associated probabilities. All variables are associated with GDP: electricity consumption, urbanization, and governance have a positive influence on this variable, while inflation and unemployment have negative influences; for electricity consumption, urbanization and governance have a positive influence on it, inflation and unemployment show negative influences.

Table 4: Results of panel unit root tests Breitung t-stat.

Source: Authors' computations

Level			First Difference	
	Statistic	p-value	Statistic	p-value
GDP	0.0144	0.5057	-4.3604	0.0000
Electricity consumption	0.6094	0.7289	-4.7274	0.0000
Good governance	-0.2738	0.3921	-4.9286	0.0000
Gross fixed capital formation	-1.2637	0.1032	-4.0920	0.0000
Urbanization	-6.6533	0.21	-7.1290	0.0000
Inflation	-2.8281	0.0023	6.5717	0.0000
Unemployment	5.0738	1.0000	2.5299	0.0000

In addition, denotes statistical significance at 1%, 5%, and 10% level, respectively.
Source: Authors' computations

The first category of panel cointegration test, as well as the first generation of unit root tests, can give errors because it does not consider structural breaks. For the second category of tests, taking into accounts both cross-section dependence and structural breaks, and based on previous results, we use the Westerlund and Edgerton (2008) [67] panel cointegration test.

Table 5 shows the results obtained in the Westerlund panel cointegration test. The null hypothesis is rejected for 3 of 4 tests, thus confirming the presence of cointegration between the variables analyzed.

Based on cointegration tests, we can state that for East African Community (EAC), GDP, electricity consumption, and government cointegrate each other in the long term.

Table 5 : Results of panel unit root tests Breitung t-stat.

Source: Authors' computations.

	Statistic	p-value
Gt	-2.0139	0.0220
Ga	-2.5354	0.0056
Pt	-2.7478	0.0030
Pa	-1.8228	0.0342

Once the cointegration relationship has been established, long-running coefficients are estimated in the next step using FMOLS and DOLS estimators. The results of the four estimates are shown in Table 6.

Table 6 :Results of panel unit root tests Breitung t-stat.

Source: Authors' computations

Model 1 (GDP)		
	FMOLS	DOLS
GDP		
ELEC	2.327 *** (0.000)	1.460 ** (0.000)
GOV	0.064 ** (0.000)	0.056 *** (0.000)
GFCF	- 0.316 *** (0.000)	- 0.037*** (0.000)
URB	0.322 *** (0.000)	1.976*** (0.000)
INFL	- 2.479** (0.000)	4.102 * (0.000)
UNEM	-0.228** (0.000)	- 0.237 ** (0.000)
constant	1.893* (0.000)	2.308 ** (0.000)
R2	0.8677	0.6975

* *denote statistical significance at 1%,* ** *denote statistical significance 5%, and* *** *denote statistical significance 10% level respectively.*

The impact of total energy consumption and good governance on economic growth is revealed in model 1. The FOLS estimation results are presented below. The value of the coefficient is positive (2.327), which means that the economic development is sustained every year by 2.327 percent for the EAC. Good governance has a positive

effect on economic development, the coefficient being positive of 0.064, also the urbanization is 0.322; in contrast, inflation and unemployment have negative coefficients, respectively - 2.427 and - 0.228 (Figure A3a,b, Appendix B).

Similar studies [45], [46], show that for the states from East African Community, the relationship between economic growth and good governance (corruption) is in the defragmentation of the development theory. For all that, the coefficients from panel DOLS estimator are 1.460 and 0.056 for energy consumption and governance, respectively. At 1% level, the effect of energy consumption on GDP is positive and statistically significant and the significance of 1.460 shows that a 1% increase in energy Consumption increases GDP by around 1.460%. In addition, it was revealed that the effect of governance on GDP is positive and statistically significant at 1% level. The significance of 0.056 reflects that a 1% increase in governance increases GDP by 0.056%.

Model 2; looks at the impact of economic growth and good governance on energy consumption. The results of the GDP coefficient (0.239) assume that they have a positive and statistically significant effect on economic development in some observed countries. The 1% increase in energy consumption by the population increases economic growth by 0.239, the results being similar to those obtained by [82]. It is also confirmed in this case the previous hypotheses: the growth energy-led hypothesis and the hypothesis of the positive effect of good government on economic development. Good governance has a positive effect (0.011), lower than that achieved by GDP. Variables inflation and unemployment have a negative and significant effect on economic growth (- 0.095 and - 0.007); in turn, urbanization has important positive effects (0.007).

As far as the EAC countries are concerned, it can be seen that the relationship between economic growth and corruption is part of the second theory, namely, of defraying development, similar to the studies [44].

Using the DOLS estimator, we found that the coefficients are 0.150 and 0.003 for GDP and governance, respectively, and that, at 1% level, the GDP has a positive impact and statistically significant effect on energy consumption. The significance of 0.150 shows that a 1% increase in GDP activity determines the increase in the energy consumption, by around 0.150%. Accordingly, it was revealed the positive effect of governance on energy consumption and statistically significant at 1% level. The significance of 0.003 implies that a 1% increase in human development increases economic growth by around 0.003%.

Chap 5: CONCLUSION AND RECOMMENDATION

5 .1: CONCLUSION

Impact of good governance on the energy consumption and economic growth; evidence from the East African Community has led to contradictory results, which implies the need to open new research perspectives. Faced with previous studies, we introduced a new component, good governance, to analyze the impact of this on the initial variables. In this thesis, we used panel data for 6 countries from the East African Community for the period 2000 –20202, to analyze the relationship between three variables: electricity consumption, economic growth, and good governance.

The methodology used for the analysis performed in this study consisted of panel regression; four equations were made for each analytical component: total electricity consumption, electricity consumption industry, electricity consumption population, electricity consumption in transport, for each of them was made the analysis, separately on the variables discussed: electricity–economic - growth–good governance.

The results obtained for the variables analyzed present two important components. The first result refers to the influence of electricity consumption on economic growth, for East African Community countries, there is a causal and direct link between the two components, thus validating the hypothesis of the energy-led growth theory. Slightly different results, in terms of coefficients, were also obtained for the analysis of the structure of electricity consumption by sectors: industry, population, and transport. The second important outcome of the analysis is the full effect of good governance on electricity consumption and economic growth, the effect

revealed by the fact that it directly affects these indicators. Yet at the same time, good governance also has an indirect effect on electricity consumption through economic growth: good governance affects economic growth, which in turn affects energy consumption.

Good governance directly affects economic growth and indirectly through energy consumption. However, the analysis also implies an encouraging result: improving good governance could lead to increased energy efficiency and stricter energy policies. The results also show a number of important policy implications: policy makers can influence economic growth through energy consumption, as a reverse approach may be true. Authorities can achieve economic growth by raising the level of human capital, and, in particular, through education. In addition, encouraging results can also be achieved by improving the rule of law and government effectiveness.

Like any research, this study has its limitations. According to previous studies, the current levels of good governance are the effects of the previous measures, which lead to the idea that it is important to study the timing (the gap) where good governance affects the other indicators. Another important limitation of the study that might be considered is signaled by the effect of EAC accession in this period of the analyzed countries.

5 .2: RECOMMENDATIONS

Recommendations for future research can be formulated taking into account the results of the study. Firstly, it is important to control this energy–economic growth analysis and the effect of institutional quality by introducing other analysis factors: Regulatory Quality and Political Stability.

Secondly, future studies could use, as a method of analysis, time series analysis instead of panel-based methodology.

Thirdly, considering that we developed four separate, unique equations, we could use a system of equations that incorporate them all.

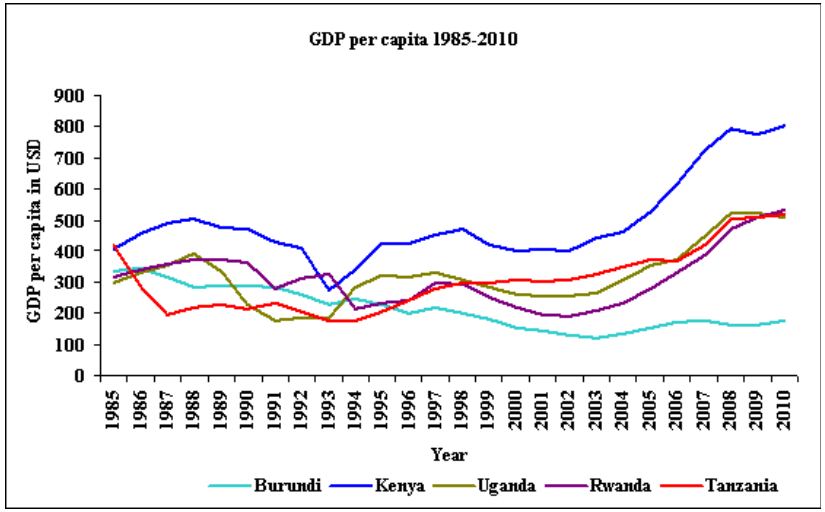
Last, but not least, our analysis has been carried out globally, by country, and future studies based on energy intensity and efficiency can be carried out at the level of energy consumption per unit of production.

Appendix A

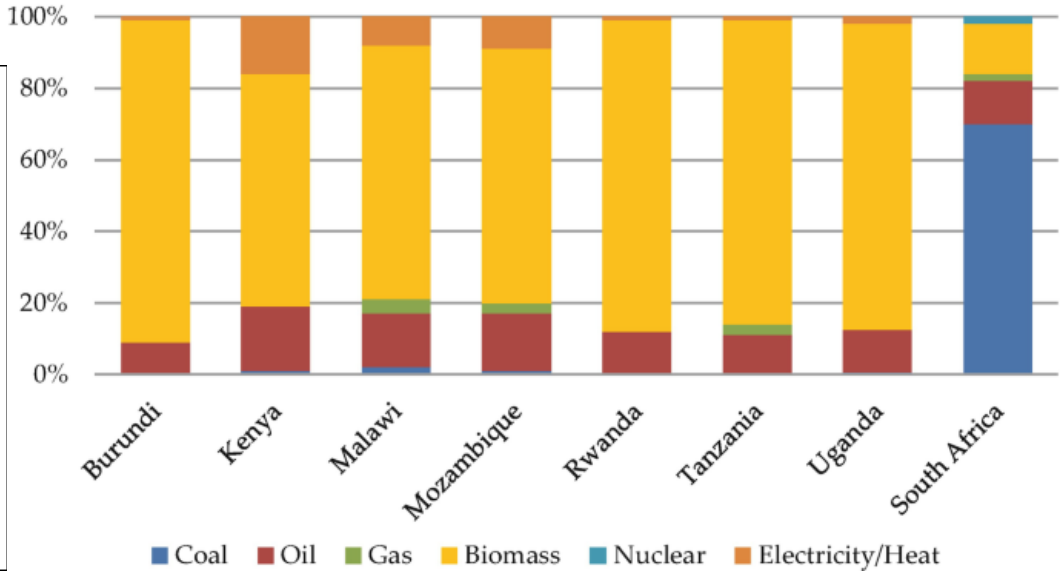
Table A1. The used indicators according with their source.

Indicator	Definition	Source	Observations	Expected Sign
GDP	GDP The final result of the production activity of resident producer units	World Bank	natural logarithm of GDP, period 1995–2017	
ELEC	This consumption stands for final energy consumption	Internal national energy outlook	natural logarithm of final energy consumption (transport) in thousands tons of oil equivalent (TOE)	+/-
GOV	Good governance measured by averaging the Six indices of governance (Kaufmann et al. 2010) [57]: control of corruption, rule of law, political instability, governmental efficiency, voice and accountability, and regulatory quality	World Bank	natural logarithm of good governance, period 2000–2020	+/-
GFCF	Gross fixed capital formation (% of GDP)	World Bank	natural logarithm of gross fixed capital formation, period 1995–2017	+/-
URB	The urban population (% of total)	World Bank	natural logarithm of urban population, period 1995–2017	+/-
INF	Inflation (year to year %) used as control variable	WWW.EAC.COM, World Bank	natural logarithm of good governance, period 1995–2017 UNEM	+/-
UNEM	Unemployment (year to year %) used as control variable	WWW.EAC.COM, World Bank	natural logarithm of good governance, period 1995–2017	+/-

Appendix B Graphs by Country and Variable



(a)



(b)

Figure A1. (a) GDP for CEE Countries 1995-2020; (b) Final Consumption Energy for CEE Countries 1995–2020

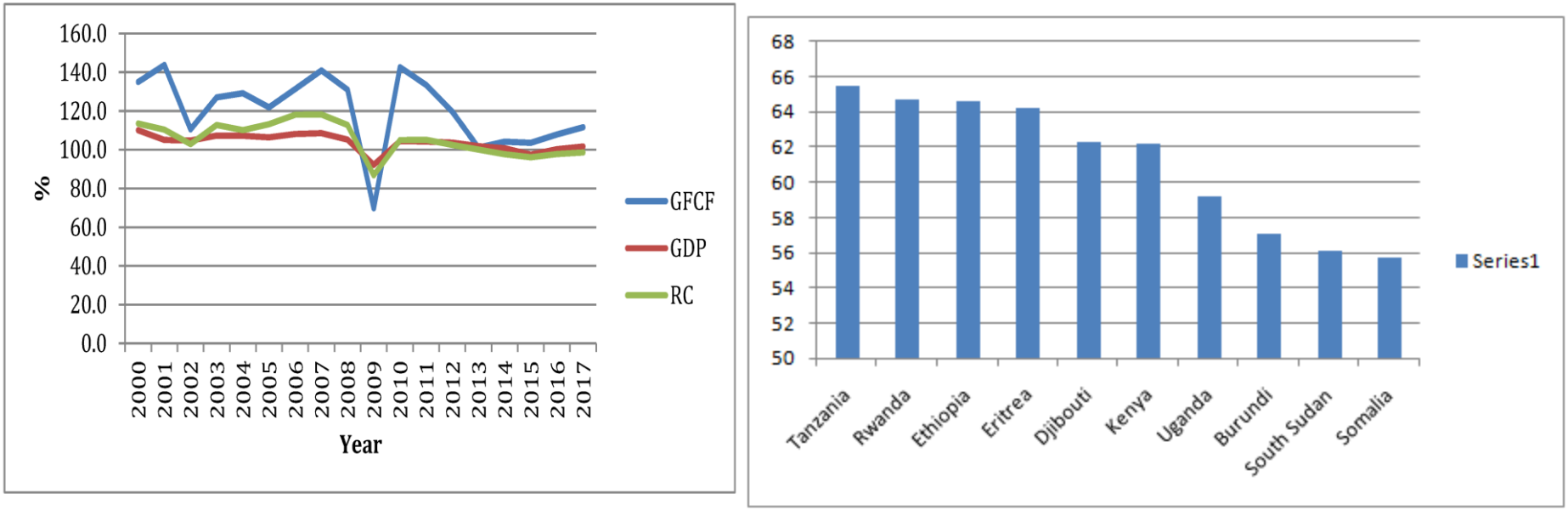


Figure A2. Figure A2. (a) Gross fixed capital formation for EAC Countries 2000–2020; (b) Urban Population for CEE Countries 2000-2020

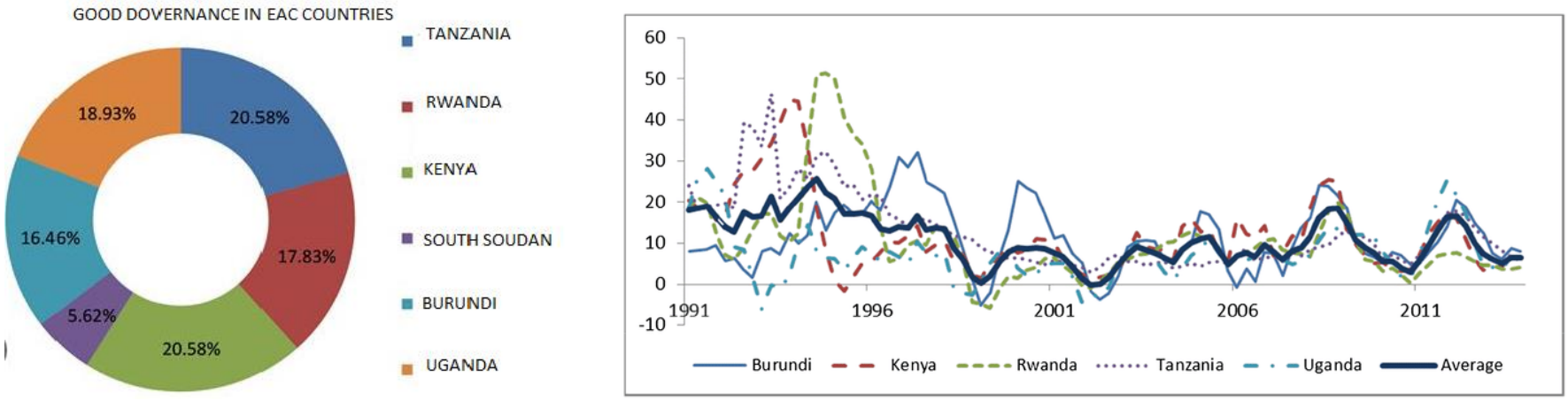


Figure A3. (a) Good Governance for CEE Countries 2000–2020; (b) Inflation for CEE Countries 2000–2020

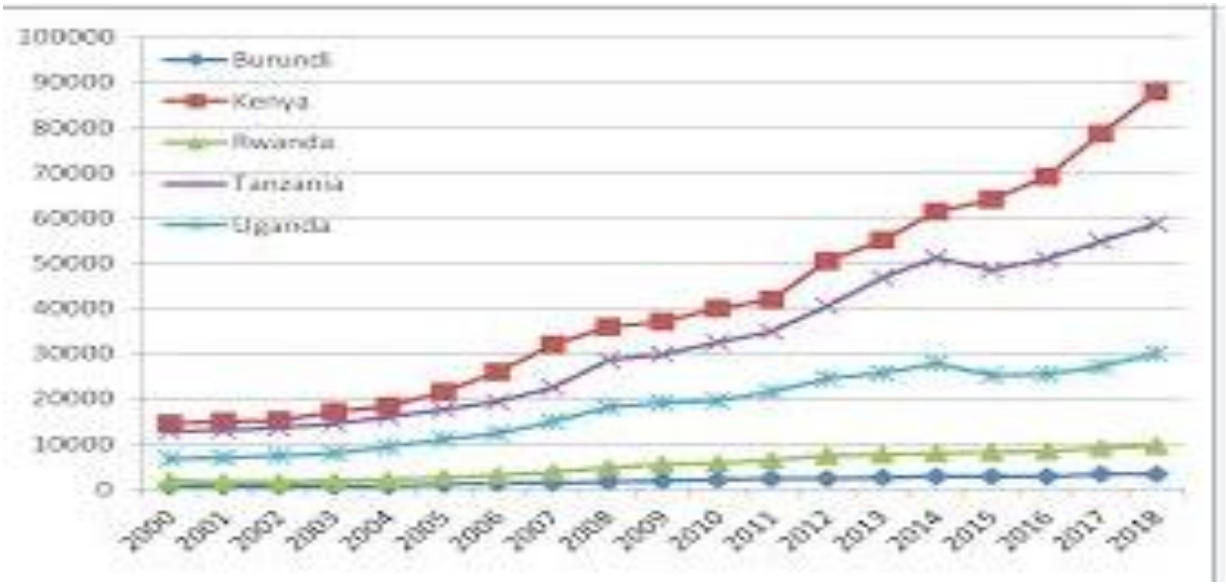


Figure A4. Unemployment for EAC Countries 2000-2020

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