MAKERERE  **UNIVERSITY**

MAKERERE UNIVERSITY BUSINESS SCHOOL

THE INFLUENCE OF GOVERNANCE AND ECONOMIC FACTORS ON ELECTRICITY ACCESS IN UGANDA.

BY

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A DISSERTATION SUBMITTED TO MAKERERE UNIVERSITY BUSINESS SCHOOL (FACULTY OF GRADUATE STUDIES AND RESEARCH) IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF MASTER OF ENERGY ECONOMICS AND GOVERNANCE OF MAKERERE UNIVERSITY

PLAN A

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DECLARATION

I, **Ayebazibwe Julius** hereby declare that this research report titled "THE INFLUENCE OF GOVERNANCE AND ECONOMIC FACTORS ON ELECTRICITY ACCESS INUGANDA" is my original work and has not been submitted to any other institution for any academic award.

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APPROVAL

This is to affirm that this research report titled "THE INFLUENCE OF GOVERNANCE AND ECONOMIC FACTORS ON ELECTRICITY ACCESS INUGANDA" has been entirely complied by Ayebazibwe Julius under my supervision and is ready for submission for the award of Master of Energy Economics and Governance.

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MAY GOD BLESS YOU ALL

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey Fuller
ANOVA	Analysis of Variance
ERA	Electricity Regulatory Authority
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GoU	Government of Uganda
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
MW	Mega Watts
NDPs	National Development Plans
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
PPP	Public Private Partnership
SDGs	Sustainable Development Goals
UK	United Kingdom
UN	United Nations
VAR	Vector Auto Regression
VECM	Vector Error Correction Model
VIF	Variable Inflation Factor

ABSTRACT

Over time, electricity access has proved to be engine to the socio-economic development through facilitation of mechanized production and service provision. This study examined the combined effect of the economic factors and governance factors on electricity access in Uganda. A longitudinal research design was employed which involve a quantitative approach using time series data obtained from the World Bank data bank from 1996 to 2019 to establish the correlation and strength and relationship between independent variables and the dependent variable. This study used the VAR models to examine the economic, governance and combined effects as per the objectives. The results established that the economic factors alone have no significant effect on electricity access while the governance factors have a significant effect on electricity access. However, the results show that when these factors are combined, investment in the energy sector and control of corruption have significant positive effects while regulatory quality has a positive implying that there is a significant combined effect or economic and governance factors on electricity access. Nonetheless, this study confirmed that all these factors are key in determining electricity access in the long run and thus they must be incorporated in the planning processes by government. However, this study did not establish any cointegration among the variables and there was no causality from the independent variables to the dependent variable. Furthermore, the study established the need for further research to examine the bloodline factors of electricity access in Uganda's context using a mix of approaches such as qualitative and quantitative methods in order to close the knowledge gap identified by the results of this study.

CHAPTER ONE

INTRODUCTION

1.0. Introduction

This chapter presents the background to the study, problem statement, study purpose, research objectives, questions, and hypotheses, significance of the study and scope of the study and the conceptual framework of study variables.

1.1 Background of the study

Electricity access is a driving factor to socio-economic development majorly in low and middle income countries (Falchetta et al., 2022) as it supports provision of social basic needs such as health, education, communication, and safer water services to people (Sarkodie & Adams, 2020a;Cabello Eras et al., 2022). Notably, as of 2020, the world's electricity access rate was 91% which is about 1.2 billion while over 733 million people had no access to electricity of which 80% of the population with no electricity live in rural areas and 3/4 of these live in Sub Saharan Africa (Ciller & Lumbreras, 2020). More so, a lot of international organizations have come in to save the day, for example, United Nations has set the 2030 goals known as the Sustainable Development Goals among which, SDG7 seeks to enhance electricity access through provision of affordable, reliable, sustainable and modern access to energy (United Nations, 2018). Furthermore, in many countries in Africa, electricity access rate is at 40% (AfDB, 2023) and has increased by only 20 percent during the 25-year-period between 1991 and 2016, and does not vary from the current rate, showing an average growth rate of 0.8 percent per year which is below average (Abajuo, 2020).

As a result, this has since triggered studies to address the electricity access problem, for example, in Latin America Countries. Sanchez-Loor & Zambrano-Monserrate, (2015), identified a

unidirectional long-run causality running from Electricity Consumption to GDP in Ecuador, and otherwise for the other countries such as Mexico where a unidirectional causality from Electricity Consumption to Foreign Direct Investment was obtained. Similarly, in West Africa it was found that income per capita, the efficiency of institutional framework, population density and urban population rate are key (Tehero, 2021). Previous studies have identified economic factors such as GDP per capita, Income level, income inequality, good governance like control of corruption, government effectiveness, regulation quality and Human Development Index as key factors for electricity access (Sarkodie & Adams, 2020; Mahmood et al., 2020).

In comparison, most of these studies have used the Behavioral Economics Theory to establish the relationship between prices, income levels and the quantity of electricity demanded with adjusted demand model to fit their studies including economic or governance perspectives, having the household as the unit of analysis because a household only demands for electricity only if they derive utility from using it as compared to not using it (Kemmler, 2007). Notably, this theory postulates that combining economic and governance factors in a study provides a clear explanation for electricity access from the development world context showing that electricity demand is greatly affected by GDP per capita, energy prices, climate, endowment in natural resources and geographical differences (Mitrova, 2022).

Similarly, Uganda's NDP III set the 2020/2025 targets that will see Uganda increase electricity consumption per capita from 100KWh to 578 KWh, reduce the cost of electricity to USD 5 cents, increase electricity access from 21% to 60% all in this space of 5 years and the same NDP III reported that Electricity generation capacity increased from 601MW in 2010 to 1839MW in 2020 (NPA, 2020). Additionally, Uganda set an 80% (3668 KWh per capita) electricity access target in her 2040 vision given a baseline of 11% (75 KWh per capita) in 2010 and to achieve this target,

the government plans to build a hydro potential of 4500MW (GoU, 2007). However, despite these efforts, only a quarter of the households in Uganda can access the electricity grid while others use solar systems prompting the government to take steps to address the electricity demand-supply gap through its National Development Plans and rural electrification programmes (Ministry of Energy and Mineral Development, 2018; Kakumba, 2021). For example, the year 2020/21, UMEME presented to ERA an investment plan worth 149,931,947 US dollars which was targeted to grow electricity access (HUL, 2020), as this strategy worked in countries like China through rural electrification projects to attain almost 100% electrification rate for her rural areas (Bhattacharyya & Ohiare, 2012). Additionally, Uganda experiences a low electrification rate whereby only about 49% of the people live in areas served by electricity grid but still some people are not connected (kakumba, 2021; Wabukala et al., 2022). However, Wabukala et al., (2022) was studying electricity security not access. Therefore, considering the current revised energy policy, about 30% of Ugandans have access to electricity, with grid and solar home systems at 20% and 10%, respectively (Uganda's Energy policy, 2023)

On the contrary, previous studies have focused more on economic factors than governance factors that influence electricity access in several regions and countries and have left out the combined effect of these two perspectives on electricity access which has therefore become the focal point of this study. Despite the good efforts to address electricity access issue, it is not clear what triggers this poor electricity access problem in Uganda especially on the perspective of the both economic and governance factors. Therefore, the study seeks to examine the combined effect economic factors (GDP per capita, Energy Investment) and governance factors (corruption control, government effectiveness and regulatory quality) on electricity access in Uganda.

1.2 Problem statement

Electricity access still remains a problem in many African Countries which greatly affects their socio-economic transformations and growth (Mawejje & Mawejje, 2016). The Uganda Energy policy 2023, talks about 30% of Ugandans having access to electricity, with grid and solar home systems at 20% and 10% respectively with 13% of the population has access to pre-electrification through multi-light systems (Uganda's Energy policy, 2023). In view of this, about 66% live in multidimensional energy poverty while about 33% are severely energy poor (Ssennono et al. 2021). Consequently, inability to access electricity hinders economic development and limited access to modern public services like education, Health, transport etc. (Zhang et al., 2019). Nonetheless, great strides have been taken to increase Uganda's electricity access such as the investment collaborations with World Bank and African Development Bank to have electricity extended to households, refugee and host communities, industrial parks, commercial enterprises and public institutions, as well laid in the NDPs I, II and III, Uganda's vision 2040 and programmes like the Rural electrification programme and many others (Ministry of Energy and Mineral Development, 2017). Despite the above efforts stretched out, Uganda is still considerably electricity insecure characterized by darkness cover in rural areas, constant power outages and small percentage of Ugandans accessing electricity. In Uganda, while examining electricity security and energy poverty, Wabukala et al., (2022); Ssennono et al., (2021) and Namujju et al., (2015) respectively, quality of governance (control of corruption, regulatory quality and government effectiveness), economic (income inequality, level of income) and financial factors are key to electricity access. More so, previous studies in Uganda, Rwanda, Tanzania, West Africa and Africa at large, have focused on economic factors that drive electricity access (Platchkov & Pollitt, 2012; Rugabera et al., 2013f) and less attention has been paid to governance factors yet

leadership and governance play a critical role in electricity access in both rural and urban areas. Therefore, the aim of this study was to examine the influence of governance and economic factors on electricity access in Uganda by examining the combined effect of economic and governance factors using the theoretical perspective to explain electricity access in Ugandan context.

1.3 Study/Research purpose

The purpose of the study was to examine the influence of governance and economic factors on electricity access in Uganda.

1.4 Study objectives

This study intended to examine

i) The effect of economic factors on electricity access in Uganda.

ii) The effect of governance factors on electricity access in Uganda.

iii) The combined effect of economic factors and governance factors on electricity access in Uganda.

1.5.1 Research study questions

i) What is the effect of economic factors on electricity access in Uganda?

ii) What is the effect of governance factors on electricity access in Uganda?

iii) What is the combined effect of economic factors and governance factors on electricity access in Uganda?

1.5.2. Research hypotheses

Hypothesis 1: **Ho1**: There is no significant effect of economic factors on electricity access

Ha1: There is a significant effect of economic factors on electricity access

Hypothesis 2: **Ho2**: There is no significant effect of governance factors on electricity access

Ha2: There is no significant effect of governance factors on electricity access

Hypothesis 3: **Ho3:** There is no significant combined effect of economic factors and governance factors on electricity access

Ha3: There is a significant combined effect of economic factors and governance factors on electricity access

1.6 Scope of the study

The scope of the study was established in three different forms such as; geographical scope, time scope and content/subject scope.

1.6.1 Geographical scope

The study was limited to Uganda and only data for the economic and governance study variables related to Uganda was used.

1.6.2 Time scope

The study utilized the time series data on the different identified variables between 1996 and 2019. Years 2020 and 2021 were left out because in this period, the country and the rest of the world were experiencing COVID19 pandemic which affected most sectors and definitely data generation was affected too whose inclusion could have distorted the results.

1.6.3 Content/subject scope

The study intended to examine the different governance and economic factors that influence electricity access in Uganda by studying the impact of GDP per capita, Energy Investment and Governance factors (control of corruption, government effectiveness and regulation quality) on electricity access in Uganda.

1.7 Significance of the study

i) The findings of the study are expected to provide information on energy sector regulation, energy investment levels which will play a big role in energy policy formulation.

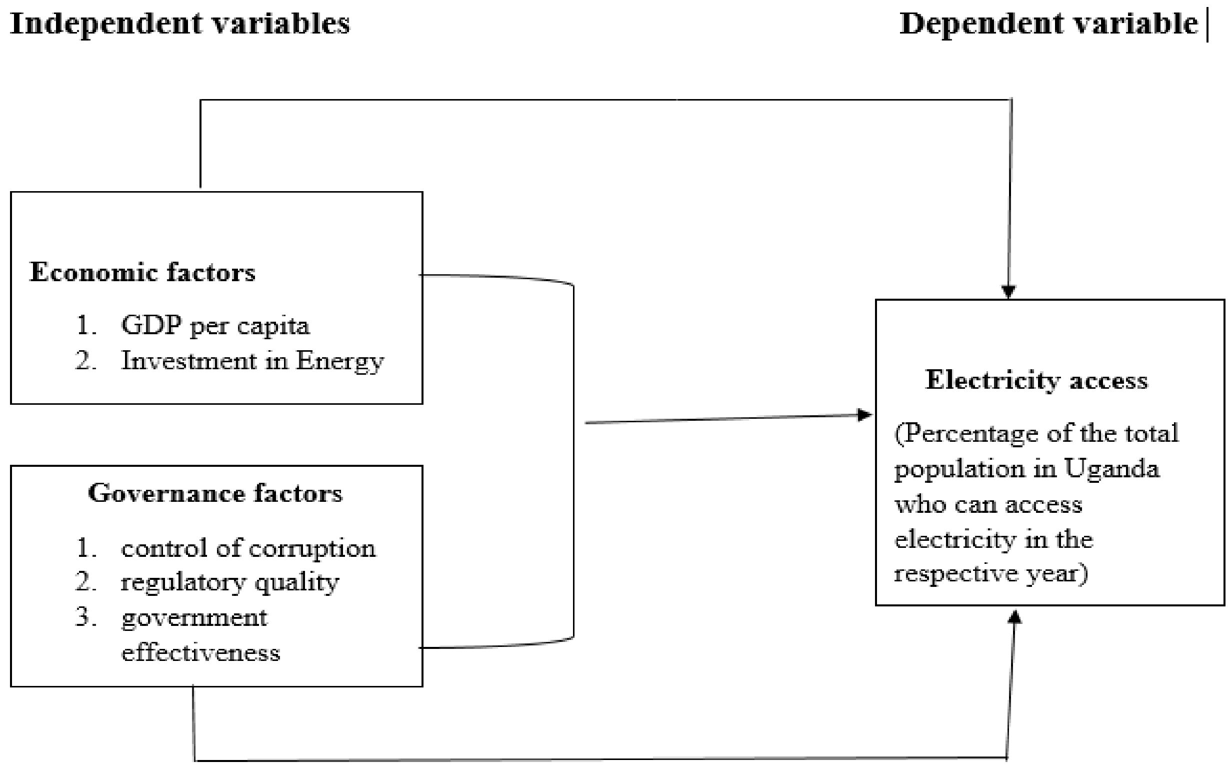
ii) The findings of the study are expected close the information gap on the different strategies used by government to increase electricity access and further provide new recommendations to improve the energy sector in Uganda.

iii) The study findings are expected to form a basis of comparison for the future researchers because the study results shall form part of the literature that can be reviewed by future researchers.

1.8 Conceptual framework of the study

This section diagrammatically shows the relationships between or among study variables, as shown in the Figure 1 that follows.

Figure 1. Conceptual frame work



Source: Adopted by the researcher according to literature review and the study objectives.

1.8.1 Model description

From the conceptual framework, the study utilized a three stage model as follows;

$$ea = f(gdp, ei) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$ea = f(cc, rq, gvte,) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$ea = f(gdp, ei, cc, rq, gvte) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where; ea, is electricity access, gdp, is the Gross Domestic Product per capita, ei, is the Investment in the energy sector, cc, is control of corruption, rq, is the regulation quality and $gvte$ is Government effectiveness. Equation (1) shows the influence of economic factors on electricity

access, equation (2) shows the influence of governance factors on electricity access and lastly, equation (3) shows the combined effect of economic ad governance factors on electricity access.

CHAPTER TWO

LITERATURE REVIEW

2.0. Introduction

This chapter contains definition of key words, the theoretical framework of the model, literature on the relationship between GDP per Capita, Investment (PPP) in the energy sector, governance factors (government effectiveness, control of corruption and regulation quality) and electricity access.

2.1. Definition of key words

Combined effect. This is the aggregate effect of both economic and governance factors on electricity access.

Economic effect. This is the effect of GDP and investment on electricity access.

Economic factors. These are variables that influence the country's economy at large. This study involved two macroeconomic factors of GDP per capita and investment.

Electricity access. Ability of a household to obtain and use electricity which should be stable and reliable. In this study, electricity access is measured by the percentage of the total population in Uganda who have access to electricity.

Electricity sector. This refers to the subset of the energy sector that involves parties that generate, transmit, distribute and consume electricity in Uganda.

Governance effect. Effect of the governance factors on electricity access.

Governance factors. The study used governance factors to mean the Worldwide Governance Indicators and specifically control of corruption, governance effectiveness and regulatory quality.

2.2. Theoretical framework of the model

This study utilized the Behavioral Economics theory to explain the relationship between the independent variables and the dependent variable in the econometric model.

Behavioral Economics Theory combines the psychological and economic explanations to the differences in consumer behavior in a market given different human limitations and complications (Puaschunder, 2022). The traditional economic consumer theory focuses on the commodity price and the consumer's budget to explain the consumer's choice. However, the Behavioral Economic Theory improves and includes the real life application of the psychological assumptions of the economic theory and goes ahead to combine psychology and economics which gives a better predication of the economic behavior and policy formulation (Camerer, 1999). This theory includes psychological knowledge about human behaviour helps improve and extend the economic models used for decision making by including the other factors or elements in the microeconomic models to explain and predict consumer behavior under certain and uncertain circumstances (Jabbar, 2011). Additionally, in order to study the determinants of energy consumption in households at a regional level, behavioral economics enhanced with psychological knowledge and empirical evidence shone light on the purpose of adding more factors on the determining microeconomic model (Borozan, 2018). Unlike the traditional economic theory, the Behavioral Economics theory considers other factors while making consumption choices such as the status quo bias, the endowment effect, mental accounting and the sunk cost effect, other heuristics and

biases related to availability, salience, the anchoring effect and simplicity rules, as well as the effects of other supposedly irrelevant factors while maximizing utility (REISCH & ZHAO, 2017).

Behavioral economics involves modifying the traditional economics theory assumptions through drawn insights from psychology and how the consumers deviate from these traditional assumptions (Mundaca, 2020). Mundaca (2020) further asserts that behavioral economics explores the cognitive, motivational and contextual factors that affect people's preferences, decision making processes and the end choices made.

In relation to energy and electricity access, the Behavioural Economics Theory "can provide new perspectives that can inform policy design on how individuals evaluate options, make decisions, and change behaviour and uses insights from psychology to increase the explanatory power of economics" (Pollitt & Shaorshadze, 2011). Additionally, behavioural economics can be used to inform decision making in energy policy which has attracted attention from policy makers and researchers (Alcot and Mullainathan 2010; DEFRA 2010; OFGEM 2011). Behavioral economics theory considers the significant influence of information provision. For example, electricity access as a consumption element is a behavioral aspect which is affected by information and feedback (Pollitt & Shaorshadze, 2011). Hence these economic and governance factors affect the kind of information that the consumers receive, how it is presented, how they perceive it and their feedback which is reflected in their choices made which policy makers must consider.

However, Diacon et al., (2013) found out that the behavioral economics theory faces challenges like any other theory for example, the determined variables are so many and no exact number of variables to be included in the model has been agreed so far. In response they went ahead to explain the key concepts and assumptions to be applied to this theory as follows;

i) Bounded rationality. As stated by Herbert Simion, it stipulates that rationality of people is a priori limited by given factors like the access to information, their finite amount of time, and the cognitive limitations of their minds.

ii) Complete preferences. This assumption requires the economists to adopt the model of the utility function by taking into account preferences of the consumers.

iii) Non-egoistic behaviour. For example, consumers are selflessly interested in the welfare of others and however, self-interest have limits and imperfections.

iv) Emotions, ethics, justice, well-being and social preference are also important variables that affect the decision-making process of a consumer.

v) Inter-temporal choice that describes how people act when they make decisions with future repercussions.

vi) Choice under risk and/or ambiguity. It was shown that the type and amount of information people capture can sometimes transfix the decision-making process

vii) Equilibrium. This concept implies that behavioral economics has to advance beyond individual choice, up to the analysis of the market in which the consumer participates.

Generally, Behavioral Economics Theory explains how consumers deviate from rational actions to how they actually act in reality which implies the irrationality in human choices and actions and it further asserts that factors that affect consumption have not been exhausted which allows room to test other factors such as the different economic and governance factors involved in this study.

2.3 Previous empirical studies on factors that influence electricity access

Several studies have been conducted to establish the factors that influence electricity access, a key driver to economic development in different parts of the world. For example, in Latin America

Countries, Sanchez-Loor & Zambrano-Monserrate, (2015) studied the influence of GDP and FDI on electricity access, in West Africa, Tehero (2021) studied the effect of GDP, Institutional frameworks on electricity access, in Rwanda Mwizerwa & amp; Bikorimana, (2018) studied the effect of macroeconomic determinants of electricity access, while in Tanzania, Rugabera et al., (2013) studied the effect of public and private investments on electrification rate and others studies in different areas. However, on the side of investment, most studies focused on FDIs (Mbianke et al 2022) while the PPPs have been given limited attention. In Uganda, similar studies have been done only on factors that have limited rural electrification by the Ministry of Energy and Mineral Development and its project funders such as the World Bank African Development Bank and other organizations in the same field, Namujju et al., (2015) for household charactieristixcs and electricity access, Wabukala et al., (2022) for electricity security, ssennono et al., (2021) for energy poverty, Mawejje et al., (2016) for electricity sectoral reforms and others regarding rural electrification.

Additionally, Tehero (2021) carried out a study in the West African Power Poor Countries to establish the determinants of electricity access and found that income per capita, institutional framework efficiency (regulation quality and government effectiveness), population density and urban population are key factors that affect electricity access.

Banerjee et al. (2015) established that in Africa, the literacy rate of the household head and the regularity of primary income had a positive influence on the rate of access to electricity while monthly expenditure had a negative influence. In Sub-Saharan Africa, the size of the rural population and the government effectiveness play important roles in the actualizing electricity access (Onyeji et al., 2012). Still in Sub-Sahara Africa which as well includes Uganda, income inequality was found to have a negative impact on electricity access while income level, human

development and enhancing the political climate had positive influence on access to electricity (Asumadu & Adams, 2020; Nanka-Bruce, 2008). Additionally, it was established that financial development, income, education, industrial structure, infrastructure development such as internet and tele, had a long-run relationship with electricity access while on the contrary, factors such as urbanization, natural landscape, and government fiscal conditions, are not influencing factors (Zhang et al., 2019).

2.4 The effect of economic factors on electricity access.

Previous scholars' studies have revealed that GDP per capita and investment in the energy sector are key economic drivers of electricity access. Therefore, this section includes the relationship between GDP per capita and Investment in the energy sector on electricity access.

2.4.1. GDP per capita and electricity access

There are mixed views about these two variable where some say that as the economy grows, this results into increased demand for energy/electricity while others say that the economy grows due to energy consumption while the rest agree that both variables cause each other (Tursoy & Resatoglu, 2016). Studies by Campo, (2013) and (Kahsai et al., 2012) show that there is a significant relationship between GDP and electricity access and the cointegration is said to exist in both directions despite varying results from various researchers. In his study, Tehero, (2021) found an effective linear relationship between GDP and electricity access. Kraft and Kraft (1978) and Acaravci (2015) found a unidirectional causality from electricity consumption to GDP in United States and Turkey respectively while Erol and Yu (1987) found a bidirectional causality between electricity consumption and GDP. Electricity can be from renewable and nonrenewable sources and it has been established that GDP promotes consumption of renewable energy (Tudor

& Sova, 2021) on assumption that economic growth stimulates development of the energy sector hence increased electricity access (Tursoy & Resatoglu, 2016). Furthermore, in his study in India and Pakistan, Ashgar (2008) found out that growth in GDP resulted into increase in energy consumption in Pakistan which was not the case with India which showed opposite results (Szustak, 2022). Studying the long run macroeconomic context of energy consumption, among the drivers of aggregate energy consumption, Platchkov & Pollitt (2012) found that there was a strong positive relationship between energy consumption and Income (GDP) for most countries under study while Murphy et al. (2014), a negative relationship between reduced power outages and increased GDP per capita, economic growth and development.

2.4.2 Investment (PPP) in the energy sector and electricity access

The success of a PPP depends greatly on the development of capacity, sound legal policies, and binding contracts that explain the relationship between government agencies and private firms (Nsasira et al. 2013). In addition to political commitment and financial access, investment is another important factor to consider while ensuring access to energy services such as electricity (Halff et al., 2015). Therefore, PPP investments are urgently needed in Sub-Sahara Africa but these are however affected by the poor governance resulting into sector failures (Ahmed, 2023). It is therefore important to understand how private investment works and how it can be mobilized and promoted through public intervention in order to achieve great access to energy/electricity (Remco Fischer et al, 2012). This kind of investment promotes electricity generation by ensuring that the necessary infrastructure is put in place and this eventually makes electricity available to people for consumption (Song & Shahzad, 2022). Due to its climate and environment benefits, renewable energy is increasing attracting attention of most world players in the energy sector who have a committee to increase investment in renewable energy technology and innovation (Pina et al.,

2017). It has been highlighted that PPPs are among the most innovative approaches to increase electricity access in the Sub Sahara Africa through mobilization of local and foreign resources to boost development of the energy infrastructure (Enegy Poverty in Africa, 2008).

In a similar study in Tanzania about the policy for electricity access in African countries, it was established that limited public and private investments led to low electrification rate hindering socioeconomic development (Rugabera et al., 2013). The same results were obtained by Sovacool, (2013) in his study about expanding renewable energy access with pro poor private public partnerships in the developing world. Besides, other studies in Uganda to examine electricity access in relation to PPPs (Ssebabi, 2014) where PPPs greatly contribute to electricity access while Mawejje and Munyabonera, (2013) and Meyer et al., (2018) focused on the reform of electricity sector,

Hence **hypothesis 1** consisting of Ho1 and Ha1 were derived as follows;

i. **Ho1**: There is no significant effect of economic factors on electricity access
ii. **Ha1**: There is a significant effect of economic factors on electricity access

2.5. The effect of governance factors on electricity access

Some previous scholars have studied the effect of governance factors on electricity access, however, these studies have established that control of corruption, government effectiveness and regulatory quality, are key governance drivers of electricity access. Hence this section involves the effect between government effectiveness, control of corruption and regulatory quality on electricity access.

2.5.1 Government effectiveness and Electricity Access

Not many studies have been conducted to establish how government effectiveness influences electricity access which translates into limited literature. However, this study shall put together relevant literature on this subject matter to establish how the quality of public services, the quality of the civil service and degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies can influence electricity access. Electricity access promotes social and economic development of a country which makes it not independent from the political climate of that particular country (Brass et al., 2019). While studying the effect of government efficiency on the energy use efficiency among the OECD countries, Chang et al., (2018) found out that government efficiency leads to reduction in energy intensity. In order to close off the electricity access gaps, policies and programs must evolve specifically around these gaps so as to achieve the global targets of energy access (Delina & Sovacool, 2018).

In order to achieve greater electrification in developing countries, Best & Burke (2017) found out that government effectiveness is the most important governance attribute which encourages transition to electrification, leads to effective electricity provision and donors seeking to make impact on electrification prefer countries with more effective governments. Unlike other countries, those in the Sub-Saharan Africa experience variations in electrification which is greatly attributed to their respective government effectiveness (Onyeji et al., 2012). In addition to having a legal framework and organizational arrangement, the government must pledge strong commitment, financial support, lay down a strong and systematic plan to achieve successful electrification and this commitment has become a theme among most developing countries (Bhattacharyya, 2012) and definitely weak governance leads to poor electrification rates among

some countries in Sub Saharan Africa (Bhattacharyya, 2013). According to Ahlborg et al., (2015), a democracy government is believed to be effective and has a positive impact on household electricity consumption per capita and that there is a positive association between democracy and rural electrification in Sub-Saharan Africa (Trotter, 2016). According to Mahmood et al., (2021), government effectiveness has a positive effect on consumption of all energy resources which increases electricity access among the South Asian countries. Government's effectiveness facilitates the expansion and maintenance of electricity infrastructure which support electricity access interventions through creation and enforcement of consumer and supplier regulations as well as responding to challenges caused by economic and political instability (Moore et al., 2020) and similarly Asumadu & Adams (2020) confirm that government ineffectiveness hinders electricity access in Sub Saharan Africa. Also, Wabukala et al. (2022) examines government effectiveness studying electricity security rather than electricity access.

2.5.2 Regulatory quality and electricity access

The regulation environment per the electricity sector requires clear reforms and policies to contain the challenges regarding prices, electricity supply and the return on regulation (Steiner, 2001). The electricity sector cannot work in isolation but requires all government agencies to work in unison to achieve a common goal. Regulatory quality encompasses the perceptions about the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development which has a vital impact on the development of the electricity sector by supporting investment (Falchetta, 2021). Over the years, regulatory reforms have emerged important in both OECD and Non-OECD countries which requires transparency, coherency and comprehensiveness among the regulatory regimes to put in place functional regulatory frameworks to make and implement policies (OECD, 2002). An effective regulatory

framework promotes electricity access through attracting investors to supplement on public investment in the electricity sector since electricity markets are well regulated (Blimpo & Cosgrove-davies, 2019). African countries have taken great strides to develop their regulatory frameworks for their respective electricity sectors which has transformed their electricity markets (*electricity regulatory index for Africa*, 2018).

Promoting electricity access requires policy machining institutions to pick interest in the household electricity consumption per capita as a key measure of electricity access growth (Ahlborg et al., 2015). In Bolivia, Micheal & Antonio (2003) found out that establishment of quality regulation led to a faster growth in electricity users in urban areas. Moore et al. (2020) found out that regulatory issues prevent access to electricity and having effective regulatory interventions improve management of the electricity systems which in the long run improves electricity access. In Mozambique, in order to improve electricity regulation, Salite et al. (2021) recommended that the electricity sector should be unbundled to improve management of the sector and reduce government inefficiencies that hinder transparency and performance of the institutions which greatly affects electricity access. The energy access report on the progress of achievement of the SDG7, identified the need for a clear policy and regulatory framework to promote investment and innovation in the energy sector in order to achieve growth in electricity access (Bhattacharyya, 2019). Furthermore, Muchapondwa (2021) recommended that in order to address challenges of sustainable electrification in Africa, there is need to restructure the regulatory environments in the electricity sector in addition to matching the donor target interventions and bringing the private sector on board. Although, Twesigye (2023) examined governance in the electricity sector, his focus is on organizational governance and its effects on organizational performance.

2.5.3 Control of corruption and electricity access

Corruption in the electricity sector takes on many forms from petty corruption in meter reading and billing to grand corruption in the allocation of lucrative monopolies in distribution and transmission (Lovei et al., 2000). Most Sub Saharan African countries have introduced electricity sector reforms to reduce the influence of corruption in the sector, because corruption can significantly reduce technical efficiency of the sector and constrain efforts to increase electricity access (Imam et al., 2019) and control of corruption was found to have a positive potential net impact on the usage of renewable energy due to reduced costs in the sector (Mahmood et al., 2021; Opeyemi et al., 2019). On the contrary, Cummins & Gillanders (2019) found out that corruption in form of bribes could increase electricity access to households that pay bribes to access these services because corruption can incentivize these electricity firms to operate in the shadow economy. The Kenyan electricity sector is characterized by uneven distribution of grids, red tape in connection to the grids and unfair billing which have compelled the electricity users in the country to devise other means such as bribing in order to gain access to the grid which fosters corruption (Boamah et al., 2021). Generally, corruption leads to adjustments in quantity, quality and price of services provided by monopoly institutions like Umeme a distributor of electricity in Uganda which eventually impacts the electricity access (Estache et al., 2009). Corruption affects electricity generation as it increases the capital costs of power plants which costs have upfront effects like expensive tariffs which constrains electricity access (Debnath, 2021). It was also established that corruption in form of bribes to the officials of the electricity firm to attain connection to the grid, affects electricity reliability as well as access to electricity in the long run (Pless & Fell, 2017). In their study in South Africa about the determinants of electricity access,

Sarkodie & Adams, (2020) found out that there is a negative relationship between electricity access and corruption which exhibits that poor governance and institutional environment.

In this case therefore, **hypothesis 2** was derived as follows;

i. **Ho2**: There is no significant effect of governance factors on electricity access
ii. **Ha2**: There is no significant effect of governance factors on electricity access

However, no specific previous study has looked at the combined effect of economic and governance factors on electricity access, hence there is no literature about the combined effect of these factors on electricity access which shall be the major contribution of this study.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the research design, data type and source, data diagnostic tests, estimating model for study variables, description and measurement of variables, summary of a priori expectations, data analysis and presentation of results and ethical considerations.

3.1 Research design

Saunders, et al. (2012) define research design as the plan used to analyze the subject matter under a particular research study in order to provide solutions to the research questions and also test the research hypotheses. Also, a research design stipulates the procedures for collecting, analyzing, interpreting and reporting data in research studies (Creswell & Plano Clark 2007).This study employed longitudinal research design involving a quantitative approach to provide answers to the "what" questions rather than "why", "when". This design helps establish patterns of change in the data as well as testing of hypotheses using quantitative tests. This design helped to reach the conclusions based on available statistical facts rather than individual judgement (Burney 2008). The direction, strength and causal impact of the independent variables on the dependent was also obtained (cooper and schindler, 2008).

3.2 Data type and source

According to Cooper and Schindler (2008), there are three types of data sources such as; primary, secondary and tertiary data sources. This study utilized the secondary time series data for all

variables from 1996 to 2019 from World Bank using links such as; https://www.worldbank.org/en/publication/worldwide-governance-indicators for governance data & https://datatopics.worldbank.org/world-development-indicators/ for economic factors.. This data extract consists of variables such as; electricity access expressed as a percentage of the population with access to electricity, GDP per capita expressed in United States Dollars, governance factors (control of corruption, government effectiveness and regulatory quality) expressed as indices ranging from -2.5 (implying weak governance performance) to 2.5 (implying strong governance performance) and investment in the energy sector specifically Public Private Partnership expressed in United States Dollars. The governance factors were extracted from the Worldwide Governance Indicators, a research database from the large number of surveys conducted by experts, non-governmental organizations, international organizations and private sector firms. The World Bank is a reputable institution with professional researchers and expert who collect and compare data from several surveys by expert personnel and organizations free from ant state's influence, which makes it a globally acceptable source of data of all types and disciplines for further research studies.

3.3 Data Diagnostic tests

In order to use the econometric model, there are certain assumptions that must be fulfilled first before data analysis can take place so as to obtain reliable results. Therefore, while using secondary time series data, it is vital to use several statistical instruments to test the robustness of the estimated results and the assumptions in the regression or econometric model by performing diagnostic tests (Guajarati, 2003). This study considered the following diagnostic test; tests for Stationarity, Normality, Linearity, Heteroscedasticity, autocorrelation, perfect multicollinearity

and cointegration. These tests provide evidence for the validity of the study results such that conclusions can confidently be made (Tashakkori and Teddie, 1998; Johnson et. al., 2007).

3.3.1 Test for stationarity

The researcher used the Augmented Dickey Fuller test (ADF) to ascertain whether the data for all variables was stationary or non-stationary.

Table 3.3.1: Stationarity test results -Dickey-Fuller test for unit root

	Level variables		***After differencing to order one***	
Variable	***p-value***	***Comment***	***p-value***	***Comment***
Ea	0.9864	Not stationary	0.0000	Stationary
Cc	0.9924	Not stationary	0.0109	Stationary
Gvte	0.0846	Not stationary	0.0001	Stationary
Rq	0.9827	Not stationary	0.0001	Stationary
Ei	0.1092	Not stationary	0.0000	Stationary
Gdp	0.9209	Not stationary	0.0001	Stationary

Source: Data Analysis

The null hypothesis tested was, **Ho: There is a unit root in the series**, if the p-value is greater than 0.05 level of significance, it implies that the series has unit root a thus the series are non-stationary. Table 3.3.1 shows that the all level variables are non-stationary since their respective p-values are greater than 0.05 (i.e. 0.9864, 0.9924, 0.0846, 09827, 0.1092 and 0.9209 respectively). However, after differencing the original data to order 1, all the series become stationary because their respective p-values are less than 0.05 (p=0.000, 0.0109, 0.0001, 0.0001, 0.0000 and 0.0001 respectively) showing absence of the unit root in the series integrated of order 1 implying that series become stationary after differencing to order 1.

3.3.2 Test for Normality

The researcher used the Skewness/Kurtosis test for normality for the residuals after running the regression for level variables used stating the null hypothesis as, **Ho: The distribution of the data is normal**

Table 3.3. 2: Normality test results for the regression residuals.

				joint	
variable	***obs***	***pr(Skewness)***	***pr(Kurtosis)***	***adj chi2(2)***	***prob>chi2***
Myresiduals	96	0.0003	0.0195	14.86	0.0006

Source: Data analysis in STATA

The p-value of the chi square in table 3.3.2 is less than 0.05 thus the null hypothesis cannot be rejected and therefore, the regression residuals of level variables are normally distributed.

3.3.3 Tests for Linearity

The researcher used the ANOVA table which contains tests for the linear relationship between the independent and dependent variables.

Table 3.3. 3: The ANOVA results

Source	SS	df	MS	Number of obs =	96
				F(5, 90)=	41.7
Model	7649.47577	5	1529.89515	Prob > F =	0.0000
Residual	3302.12642	90	36.6902935	R-squared =	0.6985
				Adj R-squared =	0.6817
Total	10951.6022	95	115.280023	Root MSE =	6.0573

Source: Data Analysis in STATA

The null hypothesis tested was, **Ho: There is no linear relationship between the dependent variable and the independent variables**. This means that the coefficients of the independent variables are equal to zero. The ANOVA results in table 3.3.3, show that the p-value associated with the F-value of the regression model (p=0.000) is less than 0.05. Therefore, the null hypothesis, **Ho: No linear relationship between dependent variable and Independent variables,** is rejected, implying that there is a statistically significant linear relationship between the dependent variable and the independent variables, thus the independent variables reliably predict the dependent variable in the short run.

3.3.4 Test for Multicollinearity

The researcher used Variable Inflation Factor (VIF) test for multicollinearity whereby small inter-correlations among the independent variables are expressed with VIF ≈ 1. The null hypothesis tested was, **Ho: there is multicollinearity among the independent variables.** Using the VIF technique, the value 1 indicates that there is no multicollinearity, a value between 1 and 5 indicates moderate multicollinearity while a value greater than 5 indicates severe multicollinearity which is a problem in time series analysis.

Table 3.3. 4: Multicollinearity test results

Variable	*VIF*	*1/VIF*
gdp	4.04	0.247772
cc	3.07	0.325545
rq	2.93	0.341582
gvte	2	0.499754
ei	1.41	0.708951
Mean VIF	2.69	

Source: Data Analysis in STATA

Results in table 3.3.4 show that the mean VIF is 2.69 which is greater than 1 but far much less than 5 indicating that our independent variables are moderately correlated which cannot be a major problem in analysis.

3.3.5 Test for autocorrelation

The researcher used the Breusch-Godfret LM test to test for autocorrelation in the independent variables. The test statistic can vary between 0 and 4 with a value of 2 indicating that the residuals are uncorrelated. A value greater than 2 indicates a negative correlation and a value less than 2 depict a positive correlation.

Table 3.3. 5: Autocorrelation test results

lags(p)	*chi2*	*df*	*Prob > chi2*
1	82.798	1	0.0000

Source: Data Analysis in STATA

The Breusch-Godfret LM test gives a p-value of 0.000 which is less than 0.05 thus the null hypothesis that, **Ho: there is no serial correlation** is rejected implying that there is serial correlation in the error terms over time.

Correction for autocorrelation

Durbin-Watson statistic (original)	*0.15767*
Durbin-Watson statistic (transformed)	*1.09533*

Source: Data Analysis in STATA

The results shows that serial correlation persists even after correcting for autocorrelation in the regression indicating that convergence is not achieved because the D-Watson statistics are far from 0. This implies that the ordinary least squares regression produces spurious results hence cannot be used to estimate the long run effect of independent variables on the dependent variable showing the need to estimate the autoregressive models.

3.3.6. Test for heteroscedasticity

The researcher used the Cameron & Trivedi's decomposition of IM-test and White's test which are available in STATA. The null hypothesis being tested was, **Ho: Presence of homoscedasticity in the series**, which implies that there is constant variance of the error term across the series. The null hypothesis is rejected if the p-value is less than 0.05 which implies that there is unrestricted heteroscedasticity in the series.

Table 3.3. 6.1: Heteroscedasticity test results

Cameron & Trivedi's decomposition of IM-test results				**White's test results**	
Source	Chi square	Df	p-value	Chi square (20)	60.56
Heteroscedasticity	60.56	20	0.0000	p-value	0.0000
Skewness	15.64	5	0.0079		
Kurtosis	5.67	1	0.0173		
Total	81.87	26	0.0000		

Source: Data Analysis in STATA

Results from table 3.3.6.1 shows that the p-value of the Chi-square (p=0.0000) from the White's test is less than 0.05, which implies that the null hypothesis is rejected and conclude that there is

heteroscedasticity in the series hence the need for correction for heteroscedasticity and these results agree with the Cameron & Trivedi's decomposition of IM-test results.

Table 3.3.6. 2: Regression results after correcting for heteroscedasticity

					Number of obs	96
					F(5, 90)	82.45
					Prob > F	0.0000
					R-squared	0.6985
					Root MSE	6.0573
ea	*Coef.*	*Robust Std. Err.*	*t*	*P>t*	*95% Confidence Interval*	
cc	-71.2914	9.485327	-7.52	0.0000	-90.1357	-52.4471
gvte	-17.2249	9.747872	-1.77	0.0810	-36.5908	2.140922
rq	-23.4166	4.771844	-4.91	0.0000	-32.8967	-13.9365
ei	6.24E-09	2.08E-09	3.00	0.0040	2.10E-09	1.04E-08
gdp	-0.00962	0.003708	-2.59	0.0110	-0.01698	-0.00225
_cons	-57.5023	11.50509	-5.00	0.0000	-80.3591	-34.6454

Source: Data Analysis in STATA

Results from table 3.3.6.2 show that the coefficients in the new regression have robust standard errors instead of the normal standard errors which indicates that heteroscedasticity is not present anymore in the model. The percentage of explained variations remains as 69.85% as before. However, since heteroscedasticity was found among the original series, the VAR model which produces better results is preferred to the ordinary regression.

3.3.7. Cointegration test.

The researcher used the Johansen Test to establish whether cointegration exists or not.

Table 3.3.7. 1: **Results from determining the number of lags for the cointegration test**

lag	*LL*	*LR*	*df*	*p*	*FPE*	*AIC*	*HQIC*	*SBIC*
0	-2465.7				8.70E+15	53.733	53.7994	53.8975
1	-1624.4	1682.7	36	0.000	2.20E+08	36.225	36.6896	37.3762
2	-1499.8	249.08*	36	0.000	3.2e+07*	34.3001*	35.1631*	36.4382*
3	-1482.3	34.942	36	0.519	4.90E+07	34.703	35.9642	37.8278
4	-1469.7	25.213	36	0.911	8.60E+07	35.2115	36.871	39.3231

Source: STATA data analysis Output.

The values with an asterisk (*) show the optimum number of lags to use in the cointegration test. The results from the table 3.3.7.1 show that all tests used i.e. Akaike information criterion, Hannan-Quinn information criterion, and Schwarz's Bayesian Information Criterion agree on the optimum number of lags being 2, at 34.3001, 35.1631 and 36.4382 respectively and that is what was used in the cointegration test. The results in table 3.3.7.2 were obtained using lag length of 2.

Cointegration test results

The null hypothesis that, **Ho: There is cointegration,** is rejected when the trace statistic is greater than the critical value. The results in table 3.3.7.2 show that at maximum rank 0, the trace statistic is greater than the critical value hence the null hypothesis is rejected and conclude that there is no cointegrating equation combining the variables. The trace statistic also agrees with the max statistic criterion that there is no cointegration in the variables.

Table 3.3.7. 2: Cointegration test results

maximum rank	parms	LL	eigen value	trace statistic	5% critical value
0	42	-1572.331		65.1811*	94.15
1	53	-1557.896	0.26444	36.3115	68.52
2	62	-1547.475	0.19887	15.4693	47.21
3	69	-1542.311	0.10405	5.1414	29.68
4	74	-1539.999	0.04800	0.5178	15.41
5	77	-1539.74	0.00549	0.0000	3.76
6	78	-1539.74	0.00000		

maximum rank	parms	LL	eigen value	max statistic	5% critical value
0	42	-1572.331		28.8696	39.37
1	53	-1557.896	0.26444	20.8423	33.46
2	62	-1547.475	0.19887	10.3279	27.07
3	69	-1542.311	0.10405	4.6236	20.97
4	74	-1539.999	0.04800	0.5178	14.07

Source: STATA data analysis Output.

3.3.8. Granger causality test results

The null hypothesis tested was; **Ho: no granger causality** while the alternate hypothesis is, **Ha: there is granger causality**. This test was only performed for the target variable electricity access as the dependent variable.

Table 3.3.8. 1: Granger causality Wald test results

Equation	Excluded	chi2	df	prob>chi2
Ea	*Ei*	3.6896	2	0.158
Ea	*Gdp*	0.61308	2	0.736
Ea	*Cc*	5.9941	2	0.050
Ea	*gvte*	2.6867	2	0.261
Ea	*Rq*	1.5067	2	0.471
Ea	*ALL*	11.27	10	0.337

Source: Data Analysis in STATA

The results in table 3.3.8.1 show that the p-values of the independent variables are greater than 0.05 (i.e. 0.158 for investment in electricity sector, 0.736 for GDP per capita, 0.261 for government effectiveness and 0.71 for regulatory quality) and conclude that there is no granger causality except for control of corruption whose p value is 0.050, implying the null hypothesis that there is no granger causality from control of corruption to electricity access is rejected. Additionally, considering all variables at once, the p-value is 0.337 which is greater than 0.05, and therefore it implies that there is no granger causality from the independent variables to the dependent variable. However, comparing with the coefficients of the VAR model, causality exists between electricity access and its lags 1 & 2, and the lags 1 & 2 of control of corruption only.

3.3.9. VAR model characteristics

Table 3.3.9. 1: Autocorrelation results

lag	chi2	df	prob>chi2
1	28.2819	36	0.8170
2	3.9317	36	1.0000

Source: Data Analysis

Autocorrelation was the first characteristic to be tested using the Lagrange-multiplier test. The results in table 3.3.9.1 show that the p-values of both lags are greater than 0.05, thus the null hypothesis that **there is no autocorrelation in the series** cannot be rejected. Therefore, the error terms of the VAR model not auto correlated.

Table 3.3.9 2: **Normality test results**

Equation	chi2	df	prob > chi2
ea	197.534	2	0.00000
ei	2393.02	2	0.00000
gdp	850.77	2	0.00000
cc	21.282	2	0.00002
gvte	49.687	2	0.00000
rq	148.845	2	0.00000
ALL	3661.13	12	0.00000

Source: Data Analysis

Normality was the second characteristic to be tested using the Jarque-Bera test. The results in table 3.3.9.2 show that the p-values of all variables are less than 0.05, thus the null hypotheses that, **Ho: The series are normally distributed** are rejected. Therefore the errors in the series of the VAR model are not normally distributed.

Table 3.3.9. 3: Model stability test results

Eigen value			Modulus
1.000259			1.00026
0.946994	+	0.0891614i	0.95118
0.946994	-	0.0891614i	0.95118
0.872833	+	0.2221384i	0.90066
0.872833	-	0.2221384i	0.90066
0.739714	+	0.2268669i	0.77372
0.739714	-	0.2268669i	0.77372
0.67305	+	0.347853i	0.75763
0.67305	-	0.347853i	0.75763
0.515306	+	0.2267675i	0.563
0.515306	-	0.2267675i	0.563
0.314838			0.31484

Source: STATA data analysis output.

Model stability was the third and last characteristic to be tested using the Eigen value test. The eigenvalue stability condition requires that, at least one eigenvalue should give modulus 1.0 or all

less than one or lie within a unit circle. The results in table 3.3.9.3 show that all the eigenvalues are either less than 1.0, or very close to 1.0 or around the modulus 1.0. Therefore, the VAR model shows some level of stability and thus stationary.

3.4 Model specification and estimation.

Electricity access similar to electrification, is where an end user person is able to consume electricity for desired services (United Nations, 2020) making it a demand and consumption problem. Therefore, in order to study the factors that influence electricity access, the researcher used the Behavioral Economics theory and improvement to the basic consumer theory to study the demand for electricity which significantly impacts electricity access (Blimpo & Cosgrove-davies, 2019), and which was in agreement with (Kemmler, 2007) and (Onyeji et al., 2012) who conducted similar studies in India and Sub Sahara Africa respectively. The Behavioral Economics theory, with help of the psychological knowledge and empirical evidence, allows for adjustment of the microeconomic model to add more factors that determine the microeconomic model (Borozan, 2018). A household can choose to use/demand for electricity, if the Utility of using it (U_1) is greater than Utility of not using it (U_0) (Kemmler, 2007). The utility model was given as;

$y^* = U_{i1} - U_{i0}$; Where $y^* > 0\ if\ 1\ (using)\ is\ chosen\ and\ y^* \leq 0\ if\ 0\ (not\ using)\ is\ chosen.$

Therefore, if more other factors are introduced in the microeconomic model for electricity demand, the extended demand function for electricity becomes;

$Q = X_i\beta + u_i$; Q is electricity demand, X is the vector of explanatory variables (other factors influencing electricity demand), β is the vector for coefficients while u_i is the stochastic component. Therefore the study utilized the OLS regression to estimate the econometric model in

order to establish the impact of GDP per capita, Energy Investment and Governance factors on electricity access in Uganda which is the same approach used by (Nanka-Bruce, 2008; Onyeji et al., 2012). The model estimation was performed in three stages as illustrated in the conceptual frame work in chapter one. Generally;

Electricity demand $(Q) = ea = f(economic\ factors, governance\ factors)$. Implying that;

Model 1. $ea = f(gdp, ei)$ ……(4)

Model 2. $ea = f(cc, rq, gvte,)$ …… (5)

Model 3. $ea = f(gdp, ei, cc, rq, gvte,)$……(6)

Where;$ea = Electricity\ Access,\ \ gdp = Gross\ Domestic\ Product\ per\ capita,$ while $Quality\ of\ Governance\ measured\ \ by\ control\ of\ corruption\ (cc), regulaton\ quality(rq),$ $and\ governemnt\ effectiveness\ (gvte);\quad and\ ei = Investment\ in\ Energy\ Sector$

Model 1 represents the economic influence on electricity access, Model 2 represents the governance influence on electricity access while Model 3 represents the combined effect of economic and governance factors on electricity access. In order to establish the magnitude of influence plus the direction of the relationship, the study adopted more specific VAR econometric models for the target variable (electricity access) since the results did not establish any cointegration.

Following the diagnostics results such as non-stationarity of level variables but stationary when differenced to order one, absence of long run relationship between independent and dependent variables, presence of autocorrelation and heteroscedasticity make it appropriate to use the Vector Autoregressive model. Additionally, the VAR model was preferred because unlike the linear regression that may produce spurious results, the VAR model gives better results and further explains probability of the causality relationship between the series deemed nonstationary at level

but stationary when integrated of order 1. Additionally, the VAR model can trace out the shocks in the series and the respective effects which leads to better forecasting results and the diagnostics results did not find the long run relationships hence opting for short run VAR model relationships.

Model 1: Economic effect

$$ea = \alpha + \sum_{i=1}^{k} \beta_i \, ea_{t-i} + \sum_{j=1}^{k} \gamma_j \, ei_{j-i} + \sum_{m=1}^{k} \varphi_m \, gdp_{m-i} + \varepsilon_t \quad \text{..... (7)}$$

Model 2: Governance effect

$$ea = \alpha + \sum_{l=1}^{k} \omega_l \, cc_{l-i} + \sum_{n=1}^{k} \theta_n \, rq_{n-i} + \sum_{p=1}^{k} \rho_p \, gvte_{p-i} + \varepsilon_t \quad \text{..... (8)}$$

Model 3: Combined effect

$$ea = \alpha + \sum_{i=1}^{k} \beta_i \, ea_{t-i} + \sum_{j=1}^{k} \gamma_j \, ei_{j-i} + \sum_{m=1}^{k} \varphi_m \, gdp_{m-i} + \sum_{l=1}^{k} \omega_l \, cc_{l-i} + \sum_{n=1}^{k} \theta_n \, rq_{n-i} + \sum_{p=1}^{k} \rho_p \, gvte_{p-i} + \varepsilon_t \quad \text{..... (9)}$$

3.5 Variable description and units of measurement

Electricity Access is the dependent variable as shown in the model. This variable is measured in terms of the percentage of the total population in Uganda who can access electricity in the respective year. The values of this variable were population proportions established by the World Bank as a representation of the citizens who are able to access electricity in Uganda for different purposes. This variable is affected by many factors called independent variables, a few of which have been identified and include in the model as explained below.

GDP per capita is the first independent variable that affects electricity access in a country like Uganda. GDP has many definitions, but in this study, GDP will be defined in terms of the National Income from different activities which tells about national economic growth and the study focuses on electricity access as one characteristic (Markets, 2022), because national income can influence people's connection to the grid and other off grid power connections looking at affordability.

Quality of governance is another independent variable which has been subdivide into three independent dimensions to be studied as individual variables as shown in the function equation (2) and (5) under model estimation. Quality of governance is further subdivided into three variables that are studied specifically as;

i) **Governance effectiveness -** Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

ii) **Control of corruption-** Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

iii) **Regulatory quality**- Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development,

Quality of governance is vital in boosting electricity access by encouraging the transition to increased electrification in developing countries like Uganda. (Best & Burke, 2017) and this applies to other factors of governance such as regulatory quality, control of corruption etc. The three governance dimensions above have annual values (indices) ranging from -2.5 to 2.5 reflecting weak and strong governance performance respectively as analyzed by the World Bank.

Investment in the energy sector is the last independent variable for this study measured in the "000,000"US Dollars and particularly focusing on the Public Private Partnerships as the appropriate form of investment in the energy sector. The United Nations theme report on energy

access shows that priotization of public and private investment in energy(electricity) access to realise Sustainable Development Goal number seven (SDG7) is important (Bhattacharyya, 2019).

Table 3.5. 1. Summary of variable description with the a-priori expectations

Variable	*Description*	*Unit of measurement*	*Expected sign*
EA	Electricity Access	%age of population	Dependent variable
GDP	Gross Domestic Product per capita	US dollars	+
$GvtE$	Government effectiveness	Estimate of governance (ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance)	+
CC	Control of corruption	Estimate of governance (ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance)	+
RQ	Regulatory quality .	Estimate of governance (ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance)	+
EI	Investment in energy (public private partnerships)	"000,000"US dollars	+

3.6 Data analysis

STATA was used in this study for analysis to extract meaningful information from the data obtained. Descriptive statistics, graphical, correlation and regression analyses were performed.

Additionally, vector auto regression was performed to establish the long run effects of the lags of variables. More so granger causality test was run to establish any causation effects. The chi square, F-test plus the ANOVA analysis table were used to ascertain the goodness of the model and significance of the model estimates and make inferences.

3.7 Presentation of results

This study used graphs, tables, diagrams and texts to present the analysis results.

3.8. Ethical considerations

Given that secondary data was used, the study did not raise any major ethical issues. The data source used was an open source with limited editing rights to only the administrators of the World Bank website who update it accordingly. However, the source of the data was acknowledged. Several publications have used the same data source for related studies whose published results are internationally recognized, henceforth, it was appropriate for the researcher to use the same data for a similar study in Uganda since the study variables are the same and have the required data.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.0 Introduction

This chapter involves description of the data variables, the relationship between or among the study variables and the specified models to exaplin the relation between the dependent variable and independent variables.

4.1 Description of the characteristics of the varibles under study.

This section involves the descriptives of the variables and the graphs showing the pattern of behavior of the varibles over time between 1996 and 2019.

4.1.1 Descriptives of the variables

The results were obtaoined from a total of 96 observations per variable under study that were used in the analysis. The findings show that Uganda is not performing well according to the governance factors strudied. This is because the averages of corruption control, government effcetivemess and regulation quality are all negatives showing very weak governance performance with values -0.918, -0.513 and -0.131 respectively with standard deviations 0.11, 0.08 and 0.15 respectively. The averages of electricity access, gross domestic product and investment in energy were also obtained but do not carry any significant weight of meaningful information but the results show that Uganda's average quarterly GDP is 534.6085 million US dollars while about 8.1 million US dollars is invested quarterly into the electricty sector.

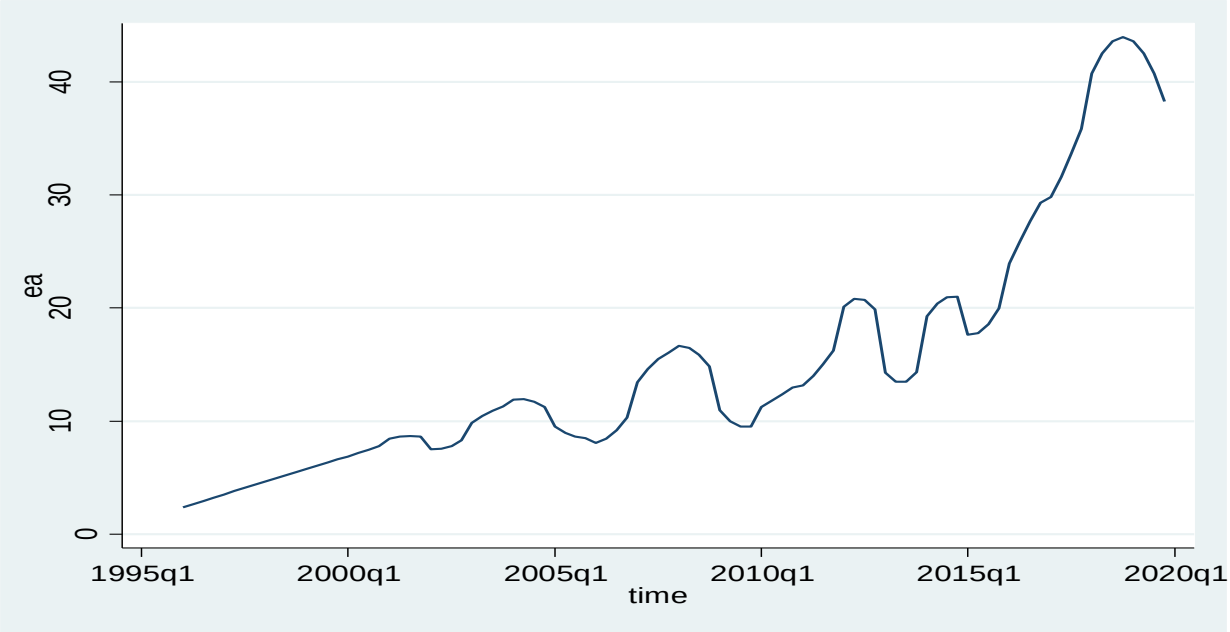
Table 4.1. 1: **Summary of the descriptive statistics of the variables under study.**

Variable	Obs	Mean	Std. Dev.	Min	Max
ea	96	15.25678	10.73685	2.385021	43.95241
cc	96	-.9184857	.1144219	-1.242417	-.6926067
gvte	96	-.513414	.0873941	-.7420148	-.3630407
rq	96	-.131114	.1473931	-.4409795	.2052512
ei	96	8.10e+07	1.73e+08	-6.39e+07	9.26e+08
gdp	96	534.6085	255.504	237.2921	889.2805

Source: Data analysis in STATA

4.1.2 Graphs showing the growth pattern of the study variables.

Graph 4.1.2.1: Line graph showing the trend of electericty access between 1996 and 2019



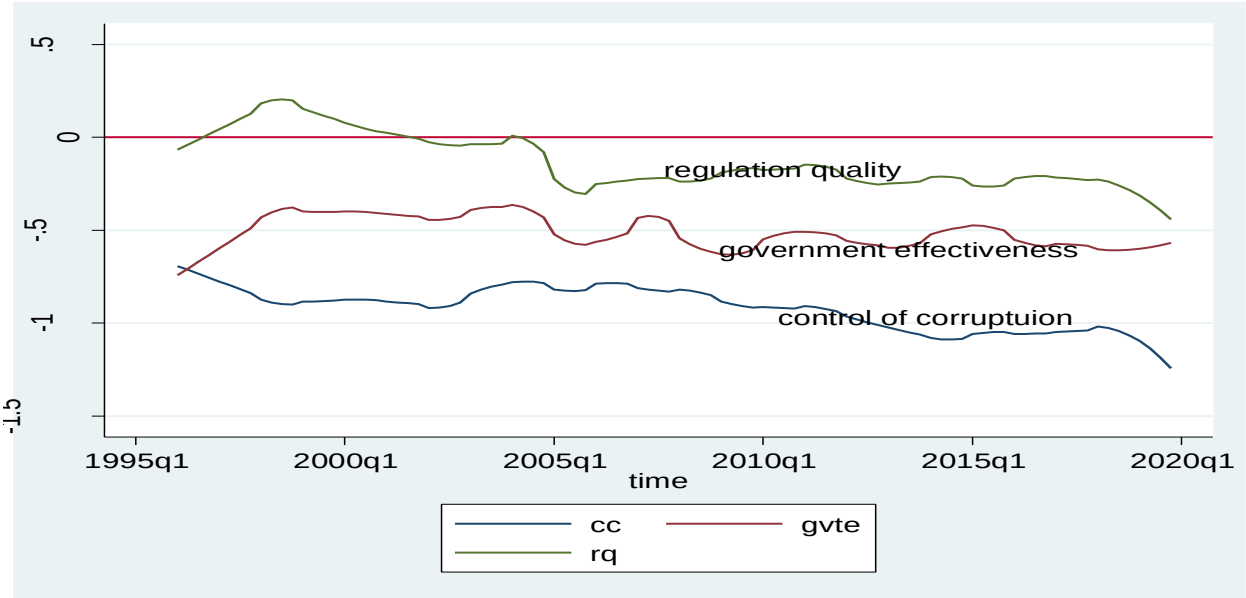
Source: Data analysis in STATA

The graph 4.1.2.1 shows a generally increasing growth pattern of electricity access since 1996 with variations in the growth between 2005 and 2015. The variations can be attributed to the factors of the economic cycle. However, special attention should be paid to the period between 2015 and 2019, where the electricity access rate has a significant high rate of growth which could be characterized by strong government efforts to increase electricity access among the citizens.

Governance factors

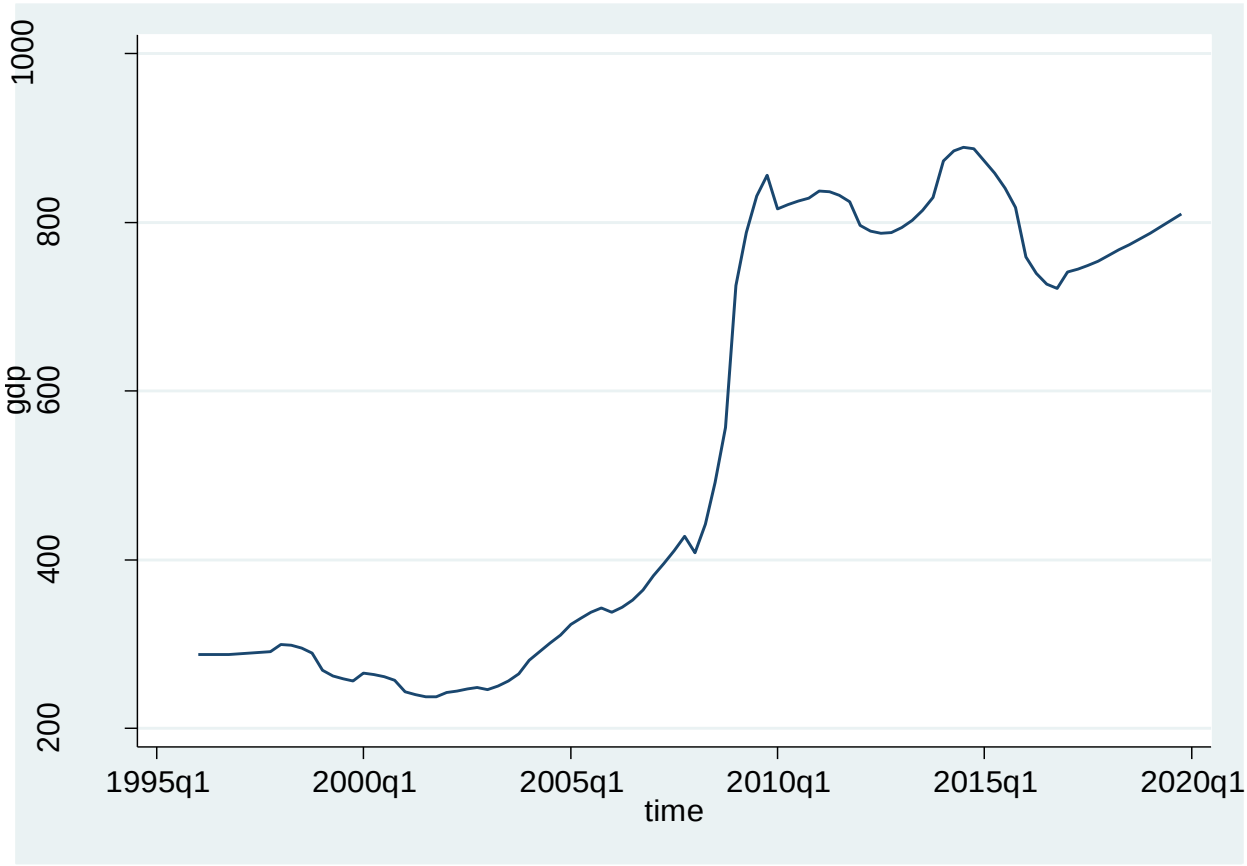
Graph 4.1.2.2 shows that all the three governance factors studied fall below the scale zero (0) and thus have negative values implying that governance performance is weak. However, among the three factors, the graph 4.1.2.2 shows that regulatory quality is stronger than the rest of the governance factors because it has a higher index compared to any other while control of corruption has the least index showing significant weak performance in this area.

Graph 4.1.2.2: Line graph showing the pattern of the governance factors



Source: Data analysis in STATA

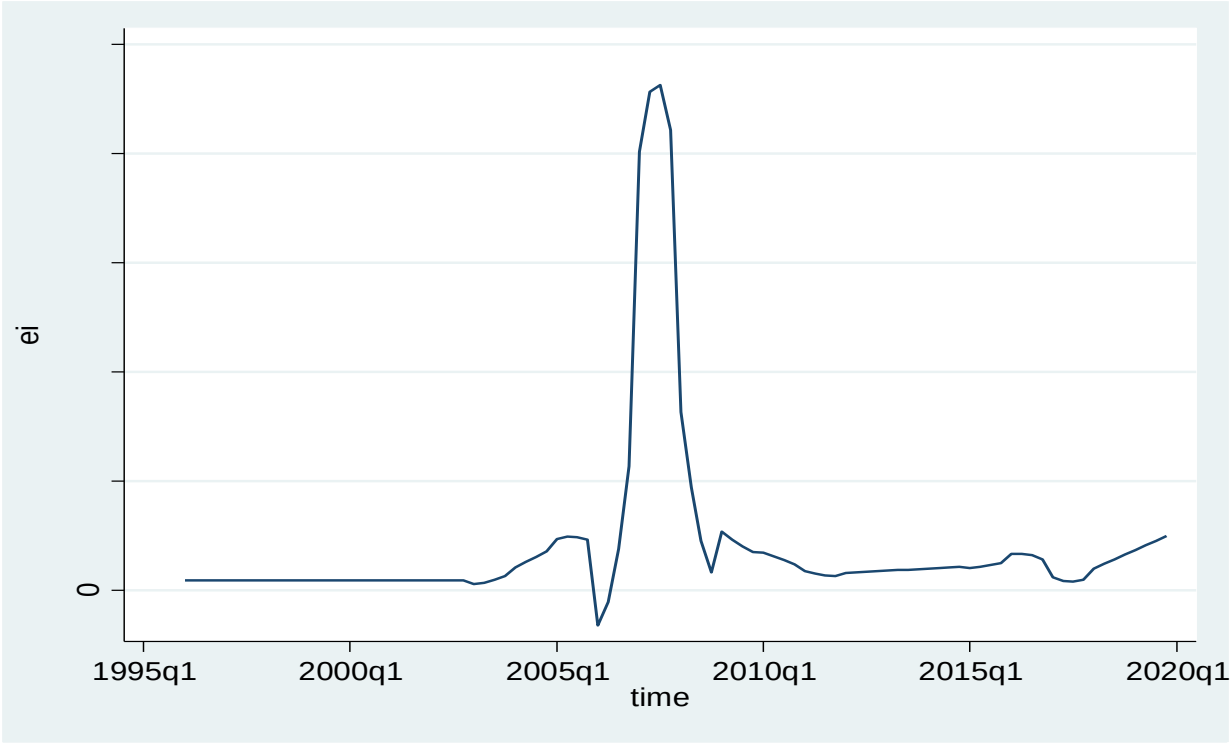
Graph 4.1.2.3: Line graph showing the growth pattern of GDP



Source: Data analysis in STATA

Graph 4.1.2.3 shows a stagnant growth between 2001 and 2004 which however grows significantly there after until 2009 where the country experienced fluctuations in growth between 2010 and around 2015. Furthermore, the graph 4.1.2.3 shows a decline in growth between 2015 and around 2017 where there after the economy started to recover.

Graph 4.1.2.4: Line graph showing the pattern of investment in electricity in Uganda since 1996 to 2019



Source: Data analysis in STATA

Graph 4.1.2.4 shows that investment in the energy sector follows a kurtosis distribution nature where a lot of funding was experienced between 2005 and 2010 to about 10 million US dollars around 2007 and 2008. For the rest of the periods before 2005 and after 2010, the funding is constantly stagnant but a slight increase is observed from around 2017.

4.2. The relationship between and among the variables under study.

This section presents results from correlation and regression analyses of the level variables.

4.2.1. Correlation

Table 4.2. 1 The correlation matrix showing the relationship between and among the study variables.

	ea	ei	gdp	cc	gvte	rq
ea	1.0000					
ei	0.0494	1.0000				
gdp	0.6469	-0.0582	1.0000			
cc	-0.7626	0.1615	-0.7734	1.0000		
gvte	-0.3603	0.1232	-0.5055	0.2154	1.0000	
rq	-0.6585	-0.2355	-0.6941	0.5157	0.5737	1.0000

Source: Data Analysis in STATA

Table 4.2.1 shows that there is a very weak positive correlation between electricity access and investment in the energy sector with correlation coefficient, r = 0.04 which is significantly less than 0.5. Additionally, there is a strong positive correlation between electricity access and GDP per capita with correlation coefficient, r = 0.6469 which is above 0.5. However, the table 4.2.1 shows a strong negative correlation between electricity access with control of corruption and regulation quality and weak negative correlation with government effectiveness with correlation coefficients of -0.7626, -0.3603 and -0.6585 respectively. The table 4.2.1 shows that investment in the energy sector has a weak negative correlation with GDP per capita and regulation quality but rather a weak positive correlation with control of corruption and government effectiveness. GDP per capita has a strong negative correlation with three factors of governance because the respective correlation coefficients are above 0.5. However, the negative signs imply a negative correlation implying that they move in opposite directions. Control of corruption has a weak positive correlation with government effectiveness (r=0.2154) and regulation quality (r=0.5157)

while government effectiveness has a strong positive correlation with regulation quality (r=0.5737).

4.2.2. Regression and ANOVA results

The table 4.2.2 shows that R-squared is 0.6985 which is closer to 1 implying a good model fit whereby the independent variables explain 69.85% of the total variations in the dependent variable. Additionally, the table 4.2.2 shows that the adjusted R-squared is 0.6817 which is still high and good implying that adding more independent variables would still improve the model. Furthermore, the p-value of the F-statistic (p=0.000) is less than 0.05, which implies that generally the model is well fit to represent a linear relationship between the dependent variable and the independent variables.

Table 4.2. 2: The ANOVA results and regression output.

Source	SS	df	MS		Number of obs =	96
					F(5, 90)=	41.7
Model	7649.4758	5	1529.8952		Prob > F =	0.0000
Residual	3302.1264	90	36.690294		R-squared =	0.6985
					Adj R-squared =	0.6817
Total	10951.602	95	115.28002		Root MSE =	6.0573
Ea	coef.	Std. Err.	t	P>t	[95% conf. Interval]	
Cc	-71.2914	9.519167	-7.49	0.000	-90.20289	-52.37991
gvte	-17.2249	10.05897	-1.71	0.090	-37.20883	2.758974
Rq	-23.4166	7.214209	-3.25	0.002	-37.74889	-9.084318
Ei	6.24E-09	4.28E-09	1.46	0.148	-2.25E-09	1.47E-08
gdp	-0.00962	0.0048864	-1.97	0.052	-0.0193227	0.000927
_cons	-57.5023	10.03192	-5.73	0.000	-77.43241	-37.57209

Source: Data Analysis in STATA

Parameter estimates.

The coefficients of the model explain the magnitude by which a dependent variable increases or reduces due to unit change in the explanatory variable respectively taking its sign into consideration. The p-value of the coefficients, indicate whether the effect of the independent variable on the dependent variable is statistically significant or not at a certain level of significance of which for this study, it is 0.05. The table 4.2.2 shows that control of corruption, government effectiveness, regulation quality and GDP per capita reduce the rate of electricity access by -71.29, -17.22, -23.4 and -0.10 respectively while investment in energy sector increases the access by 6.2. However, the respective p-values of these coefficients are 0.000, 0.090, 0.002, 0.148 and 0.052 implying that the effects are significant except that from investment in the energy sector whose p-value of 0.148 is greater than 0.01 but the others are less than 0.01 implying that they are significant at 10% level of significance. However, since autocorrelation and heteroscedasticity were detected in the level variables, it implies that these regression results are spurious thus it was better to explain these effects and relationships using the VAR models.

4.2.3. Vector Auto regression

Since there was no cointegration in the series as shown by results presented in table 3.3.7.2, the VAR model was estimated obtained using the lag length of 2 as established in table 3.3.7.1.

Table 4.2.3. 1: Vector Auto Regression output

equation	parms	RMSE	R-sq	chi2	p>chi2
ea	13	1.28238	0.9875	7400.795	0.0000
ei	13	7.50E+07	0.838	486.2258	0.0000
gdp	13	18.9728	0.9952	19497.38	0.0000
cc	13	0.011049	0.9914	10457.07	0.0000
gvte	13	0.017996	0.95860	2085.319	0.0000
rq	13	0.019613	0.9849	5726.5820	0.0000

Source: Data Analysis in STATA

The results in table 4.2.3.1 show that all VAR equations estimated are significant because their respective chi-square p-values (0.0000) are lower than 0.05 hence the hypotheses that **the respective coefficients are equal to zero** are rejected. Additionally, the R-squared values are very close to 1 (one) showing that the variations in the dependent variables are explained fully by the respective independent variables for each model.

4.6.1. Objective 1: Examining the effect of economic factors on electricity access.

From equation (7), we obtain the VAR model as follows;

$$ea = 0.025 + 1.482ea_{t-1} - 0.508ea_{t-2} + 1.01ei_{t-1} - 1.08ei_{t-2} - 0.003gdp_{t-1} + 0.004gdp_{t-2} + u_t \quad (10)$$

However, since the series are stationary when integrated of order 1 (one), the first lags shall be considered and maintained in the new economic effect model;

$$ea = 0.025 + 1.482ea_{t-1} + 1.01ei_{t-1} - 0.003gdp_{t-1} + u_t \quad (11)$$

Table 4.6. 1: Economic effect model results

Var		***Ea***	***Ei***	***Gdp***
Ea	*lag1 (coefficient, P-value)*	*1.482, (0.000)*	*1.010, (0.64)*	*-0.003, (0.568)*
	Lag2 (coefficient, P-value)	*-0.508, (0.000)*	*-1.080, (0.482)*	*0.004, (0.453)*

Source: Data Analysis in STATA

The results of the model presented in equation (10) show the effect of economic factors on electricity access across a series of time periods and it is summarized in table 4.6.1. The results show that the first lag of electricity access has a statistically significant positive effect (1.482) on

electricity access while its second lag has a statistically significant negative effect (-0.508) because the respective p-values 0.000 and 0.000 are less than 0.05.

Also, the first lag of investment in energy has a positive effect (1.010) on electricity access while its second lag has a negative effect (-1.080) on electricity access but the effects from both lags are not statistically significant at 5% or 10% significance level because their respective p-values 0.64 and 0.482 are greater than 0.05 and 0.1. Additionally, the first lag of GDP per capita has a negative effect (-0.003) on electricity access while its second lag has a positive effect (0.004) on electricity access but the effect from both lags is not statistically significant at 5% or 10% level of significance because their respective p-values 0.568 and 0.453 are greater than 0.05 0r 0.1. Using equation (11) containing the first lags, the results show that both GDP per capita and investment in the energy sector are not statistically significant. Therefore, the null hypothesis **Ho1** in **hypothesis 1** cannot be rejected implying that economic factors have no significant effect on electricity access.

4.6.2: Objective 2: Examining the effect of governance factors on electricity access.

From equation (8), the VAR model showing the effect of governance factors on electricity access across a series of time periods can be obtained as shown in the equation (12) and this effect is summarized in table 4.6.2.

$$ea = -2.685 + 1.484ea_{t-1} - 0.516ea_{t-2} + 16.28cc_{t-1} - 18.94cc_{t-2} - 1.227gvte_{t-1} - 0.710gvte_{t-2} + 1.66rq_{t-1} - 1.792rq_{t-2} + v_t \quad (12)$$

Therefore the VAR model for the governance effect using the first lags is expressed as;

$$ea = -2.685 + 1.484ea_{t-1} + 16.28cc_{t-1} - 1.227gvte_{t-1} + 1.66rq_{t-1} + v_t \quad (13)$$

The results show that first lag of control of corruption has a positive effect (16.28) on electricity access while its second lag has a negative effect (-18.94) on electricity access but the effect on electricity access from either lag is not significant at 5% level of significance but the effect is statistically significant at 10% level of significance since their respective p-values 0.095 and 0.051 are greater than 0.05 but less than 0.1.

Table 4.6.2: **Governance effect model results**

Var		***Ea***	***Cc***	***Gvte***	***Rq***
Ea	*lag1 (coefficient, P-value)*	*1.484, (0.000)*	*16.28, (0.095)*	*-1.227, (0.850)*	*1.660, (0.802)*
	Lag2 (coefficient, P-value)	*-0.516, (0.000)*	*-18.94, (0.051)*	*-0.710, (0.909)*	*-1.792, (0.789)*

Source: Data Analysis in STATA

Also, the results show that both the first and second lags of government effectiveness have negative effects (-1.2227 & -0.710 respectively) on electricity access but the effect from both lags is not significant at 5% or 10% level of significance with respective p-values 0.850 and 0.909 greater than 0.05 and 0.1. Furthermore, the results indicate that the first lag of regulation quality has no statistically significant positive effect (1.660) on electricity access while its second lag has no statistically significant negative effect (-1.792) on electricity access at 5% or 10% level of significance. From equation (13) of the first lags of the governance factors, at least one indicator, that is control of corruption, is statistically significant at 10% level of significance. Therefore, the null hypothesis **Ho2** in **hypothesis 2** is rejected implying that governance indictors have a significant effect on electricity access at 10% significance level.

4.6.3. Objective 3: Examining the combined effect of economic factors and governance factors on electricity access.

From equation (9), the VAR model showing the combined effect of economic factors and governance factors on electricity access is expressed as shown in equation (14) and it is summarized in table 4.6.3.

$$ea = -3.605 + 1.413ea_{t-1} - 0.443ea_{t-2} + 4.13ei_{t-1} - 3.380ei_{t-2} - 0.003gdp_{t-1} + 0.004gdp_{t-2} + 24.46cc_{t-1} - 26.85cc_{t-2} - 11.523gvte_{t-1} + 7.500gvte_{t-2} + 6.022rq_{t-1} - 4.228rq_{t-2} + \varepsilon_t \quad (14)$$

However, taking the first lags variables of the model, we obtain the combined effect model as follows;

$$ea = -3.605 + 1.413ea_{t-1} + 4.13ei_{t-1} - 0.003gdp_{t-1} + 24.46cc_{t-1} - 11.523gvte_{t-1} + +6.022rq_{t-1} + \varepsilon_t \quad (15)$$

Table 4.6. 2: combined effect

Var		***Ea***	***Ei***	***Gdp***	***Cc***	***Gvte***	***Rq***
Ea	*lag1 (coefficient, P-value)*	*1.413, (0.000)*	*4.130, (0.055)*	*-0.003, (0.624)*	*24.46, (0.023)*	*-11.523, (0.174)*	*6.022, (0.399)*
	Lag2 (coefficient, P-value)	*-0.443, 0.000*	*-3.380, (0.087)*	*0.004, (0.558)*	*-26.85, (0.015)*	*7.500, (0.327)*	*-4.228, (0.559)*

Source: Data Analysis in STATA

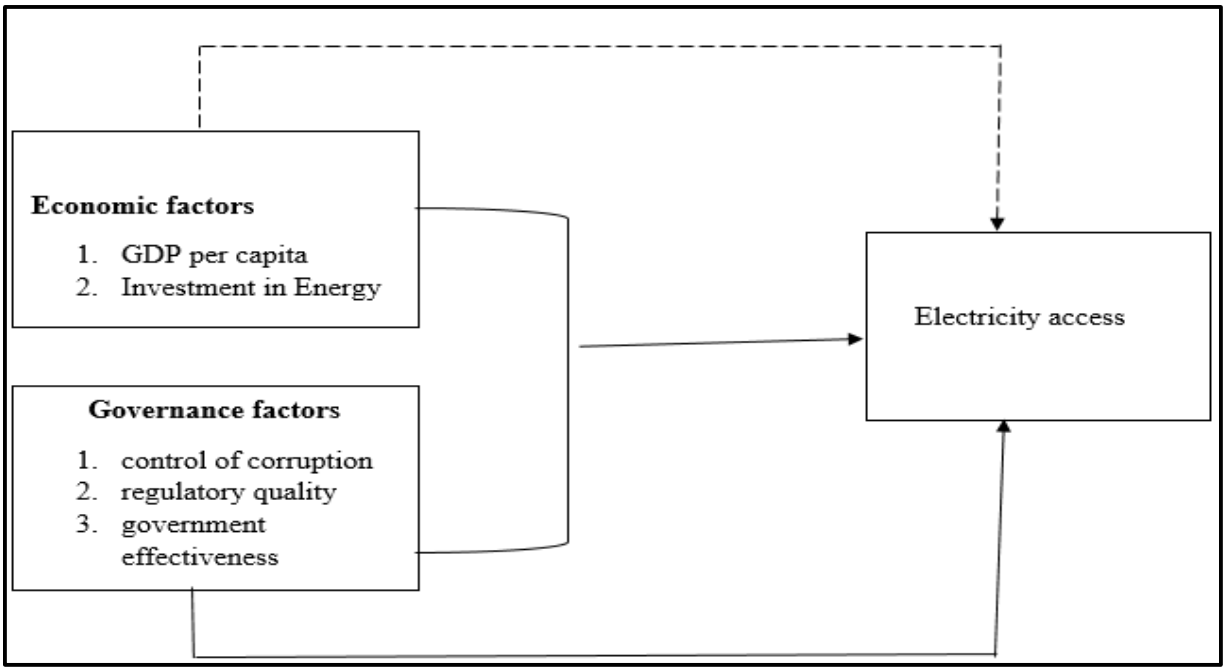
The results show that the first lag of investment in energy has a statistically significant positive effect (4.130)) on electricity access at 10% significance level while its second lag has a statistically significant negative effect (-3.380) on electricity access at 10% level of significance with the p-

values 0.055 and 0.087 respectively which are greater than 0.05 but less than 0.1. Additionally, the first lag of GDP per capita has a negative effect (-0.003) on electricity access while its second lag has a positive effect (0.004) on electricity access but the effect from both lags is not statistically significant at both 5% and 10% levels of significance because their p-values (0.624 and 0.558 respectively) are greater than 0.05 and 0.1. More so, the first lag of control of corruption has a positive effect (24.46) on electricity access while its second lag has a negative effect (-26.85) on electricity access and both lags are statistically significant at 5% and 10% level of significance because their respective p-values 0.023 and 0.015 are less than 0.05 and 0.1. Also, the first lag of government effectiveness has a negative effect (-11.523) while the second lag has a positive effect (7.50) on electricity access but the effect from both lags is not statistically significant at both 5% and 10% levels of significance because their respective p-values 0.174 and 0.327 are greater than 0.05 and 0.10. Lastly, the first lag of regulatory quality has a positive effect (6.022) on electricity access while its second lag has a negative effect (-4.228) and both effects from first and second lags are not statistically significant at 5% and 10% levels of significance because their p-values are greater than 0.05 and 0.1. From the combined effect equation (15) with only the first lags of all factors combined, at least two factors that is, control of corruption and investment in the energy sector have statistically significant effects on electricity access at 10% level of significance. Therefore, the null hypothesis **Ho3** in **hypothesis 3** which states that there is no significant combined effect of the combination of economic factors and governance, is rejected implying that there is a significant combined effect of the economic factors and governance factors on electricity access.

Conclusion

The study results revealed that the economic effect model collapsed while the governance and combined effect models remained. This has been represented in figure 2.

Figure 2. Derived model based on the results



Source: Drawn by the researcher based on the results

The dotted arrow shows the collapsed economic effect model because all the factors in this model came out not statistically significant while the other two permanent arrows show the governance effect model and the combined effect model.

CHAPTER FIVE

DISCUSSION OF RESULTS, CONCLUSIONS AND RECOMMENDATIONS

5.0. Introduction

This chapter includes the discussion of the results in comparison with findings of previous studies by other researchers as per review of literature using empirical and theoretical perspectives. Additionally, this chapter presents the conclusions and recommendations drawn from the discussion of results, area for further research and the study limitations.

5.1. Discussion of results per the objectives

5.1.1. The relationship or association between and among variables.

The correlation results show that there is a positive relationship between economic factors (investment in the electricity sector and GDP per capita) and electricity access. These results match with arguments from previous studies by Ssebabi (2014) and who established that investment in the energy sector positively impacts electricity access and Murphy et al. (2014) and Sarkodie & Adams (2020b) who established that there is a positive relationship between GDP and electricity access. Additionally, these results agree with the theory that investment and economic growth improve the electricity sector which eventually promotes electricity access by facilitating demand and supply of electricity services.

However, the results indicate that there is a negative relationship between governance factors (control of corruption, government effectiveness and regulatory quality) and electricity access. No theory can explain this negative relationship however this kind of relationship could have resulted

from the decreasing values of governance factors yet electricity access is increasing time by time. This could be an implication that Uganda's governance performance deteriorates over time much as electricity access increases. Therefore, these results leave room for an unanswered question as to whether electricity access is affected by the general nation's governance system or rather the governance framework of the electricity sector.

5.2.1. The effect of economic factors on electricity access.

As per objective 1 and hypothesis 1, the results of this study indicate that GDP per capita has a non-statistically significant negative effect on electricity access in the long run. These results disagree with results of a study by Sarkodie & Adams (2020b) and Murphy et al. (2014) whose study in Uganda established that there is a positive relationship between GDP and electricity access. However their study focused on analyzing grid connected solar, diesel and hybrid distributed electricity. Additionally, these results do not match with arguments from Platchkov & Pollitt (2012) who found out that there is a strong positive relationship between energy consumption and income (GDP per capita). However, their study combined several countries of Uganda, Rwanda, Tanzania and some West African countries. Notably, the results of this show that GDP has a non-statistically significant effect on electricity access which agree with results of Ashgar (2008) in the study carried out in India where it was established that there is no relationship between GDP per capita and electricity access.

Still on objective 1 and hypothesis 1, the results indicate that investment in the energy sector has a non-statistically significant positive effect on electricity access in the long run. These results do not match the arguments from Song & Shahzad (2022) who argue that investment has a significant effect on electricity access because investment in the energy sector boosts electricity generation

and distribution making electricty available for consumpton . Other previous studies however not in Uganda, such as Rugabera et al. (2013) in Tanzania and Halff et al. (2015) have argued that investment in the energy sector greatly impacts electricity access and they argued that limited investment hinders the elctrification rate, thus their results do not match with the results of this study.

Since the null hypotheseis Ho1 was not rejected, the results establish that the effect from the economic factors is not statistically significant which deviate from results from Zhang et al. (2019) who argue that economic factors have a significant effect on electricty access. Theoretically, it implies that the economic factors alone may not the influence the decisions and choices of consumers but rather other factors must be considred.

5.2.3. The effect of governance factors on electricity access.

As per objective 2 and hypothesis 2, the results of the study show that government effectiveness has a negative effect on electricity access which is however not statistically significant. No specific study has looked at this effect in Uganda, however, in South Asian countries, Mahmood et al. (2021) found out that government effectiveness has a significant positive effect on electricity access. This is because government effectiveness encourages transition to electrification which improves electricity access as agreed by Best & Burke (2017) because government effectiveness facilitates development of infrastructure which in the end enhances electricity access.

Still on objective 2 and hypothesis 2, the results of the study show that regulatory quality has a positive effect on electricity access which effect is however not statistically significant. A similar study in Uganda was conducted by Wabukala et al. (2022) which however emphasized that regulatory quality promotes electricity security and did not explain how it affects electricity access.

The results of this study don't match the results from a study conducted in Bolivia by Micheal & Antonio (2003) who established that quality regulation led to faster growth in electricity users implying that regulatory quality has a significant effect on electricity access. The positive effect could be due to the fact that when sound policies and regulations are implemented, this leads to development of the private sector companies like UMEME for the case of Uganda which has a mandate to increase distribution of electricity and this eventually improves electricity access as agreed by Blimpo & Cosgrove-davies (2019) because an effective regulatory framework attracts investors into the electricity sector. However non-significant effect may not be explained by any theory but rather a random behaviour from the data. Nonetheless, in order to attain high rates of electricity access, the regulatory environment must have sound policies and frameworks to govern the electricity sector.

Lastly on objective 2 and hypothesis 2, the results of the study show that control of corruption has a statistically significant positive effect on electricity access. In Uganda, no specific study has looked at the effect of control of corruption on electricity access but similar studies have been conducted elsewhere. These results of this study match with findings by Sarkodie & Adams (2020) who estbalished negative relationship between elctricity access and high corruption rates implying that control of corruption has a significant positive effect on electricity access, and also, Mahmood et al. (2021) and Opeyemi et al. (2019) established that control of corruption has a potentially positive impact on electricity access by controlling the costs and prices. It is believed that control of corruption reduces the technical inefficiencies in the electricity sector hence improving electricity access which is supported by Imam et al. (2019). All in all, the results of this study established that there is significant effect of governance factors on electricity access.

Since the null hypothesis Ho2 was rejected, it means that the results showed that governance factors have a significant effect on electricity access as supported by Anteneh et al. (2020) who argue that governance challenges are a key hindrance in the electricity sector and they advocate for proper policy frameworks to improve electricity access. Theoretically, it implies that these contextual governance factors act as a motivation for consumers to accept connection to the electricity grids and other sources and that clear governance frameworks improve the cognitive ability for consumers to make preferred choices.

5.2.6. Combined effect of economic factors and governance factors on electricity access.

As per objective 3 and hypothesis 3, the results indicate when the economic factors and governance factors are combined, investment in the energy sector and control of corruption have positive and statistically significant effects on electricity access at 10% and 5% level of significances respectively. The significant effect from control of corruption matches the arguments from Mahmood et al. (2021) and Opeyemi et al. (2019). The significant effect from investment in the electricity sector match with arguments from and Halff et al. (2015). Similarly, regulatory quality still has a positive but not statistically significant effect on electricity access. However, GDP per capita and government effectiveness still have negative effects on electricity access respectively as already seen while discussing individual effects.

On the other hand, the results from the combined model effect show that the p-values of all explanatory show convergence towards 0.05 and 0.1 as compared to their respective p-values in their individual effect models, which implies the combined effect of economic factors and governance factors is significant. This is because as the p-values reduces in size, the randomness of the relationship reduces implying that the cause of the effect is due to other factors other than chance alone.

The results reveal that hypothesis Ho3 was rejected which implied that when the economic and governance factors are combined, they produce significant effects on electricity access as supported by Mahmood et al. (2021), recommended that countries should improve their governance frameworks and ensure economic growth to maintain their energy sectors which eventually improves electricity access. Theoretically, it implies that when these factors are all combined, this well informs their consumption decisions and their cognitive ability which gives them confidence in making choices of their preferences. However, there was no specific study that examined this combined effect which make this as the key contribution of this study to the literature.

5.7 Conclusion

The electricity access situation in Uganda is not quite an interesting one as about 60% of the people in Uganda lack access to electricity and the few that have access. This study was intended to examine the combined effect of the economic factors and governance factors on electricity access in Uganda by examining the influence of economic and governance factors on electricity access in Uganda. Using the longitudinal and quantitative approach, the VAR models were used to represent the effects from economic factors, governance factors and the combined effect from these factors on electricity access.

The literature and empirical results of this study revealed that investment in the energy sector, GDP per capita and generally economic growth, and governance quality characterized by control of corruption, government effectiveness and regulatory quality are vital in the improvement of electricity access and the electricity sector at large. The results established that investing in the energy sector and control of corruption produce very significant results as far as improving

electricity access is concerned. The findings further indicated that studying these factors individually as shown in objective 1 and 2 respectively, the effect from the economic factors alone not statistically significant, while the effect from the governance factors is statistically significant. This implies that when economic factors are modelled alone, they don't cause improvement in electricity access because they don't motivate the people to demand for electricity while the governance factors create a facilitating environment and prevent inefficiencies in service delivery in the electricity sector which eventually improves electricity access. Most importantly, when these economic and governance factors are combined, they produce a significant effect on electricity access. Therefore, the results further suggest that in order to attain significant results, these economic factors and governance factors should be combined to get aggregative results to address the electricity access problem.

5.8. Recommendations

In addition to the already existing investments like dam construction and rural electrification, budgetary commitments and incentives in the electricity sector such as reduction in the electricity cost and cheap cooking electricity tariffs, the government should increase investments tied to electricity access programmes. For example further reduction of connection fees to free connection or something manageable by rural poor people so that they are left with paying the usage cost only. This will have many people get connected and economies of large scale shall be realized after some time.

The government should increase and improve the efforts driven to control corruption in the private entities running government projects and government authorities. The researcher recognizes the current efforts such as the State House Anti-corruption Unit, the anti-corruption committee from

the Inspector General of Government, police and others. However, these drives are seasonal yet fighting corruption requires continuous engagements, which should be a major concern. Furthermore, more and strict laws and policies are needed to fight illegal connections to electricity grid, strong punishments to the government and utility employees who are bribed and also mishandle resources meant for electricity distribution.

Formulation of electrification strategies factoring in both the economic and aspect of governance. The government should focus on improving the economic growth, infrastructure and governance framework to create a facilitating environment in the electricity sector that stimulates demand for electricity. For example economic growth and investment without a functional and supporting governance framework cannot do much because formulation and implementation of policies is constrained by technical inefficiencies and weak governance frameworks. However, the researcher, acknowledges efforts by government such as drives to improve productive use of energy, but still this is not all hence more efforts and better strategies are needed accompanied by strong policies to facilitate implementation of these strategies.

5.9. Area for further research

Future studies about determinants of electricity access in Uganda should adopt a mix of qualitative and quantitative approaches to bridge off knowledge gaps raised by this study.

5.10. Limitations of the study.

i. Loss of confidentiality due to data pooling. Pooling data from multiple sources poses a big risk of losing confidentiality in the data used. However, the researcher overcame this risk by using only one source which is the World Bank data bank as acknowledged in the

methodology which provides data on all variables of the study and considers several surveys conducted by individual and organizational experts.

ii. Data relevancy gap. Much as it is true that the data used in this study was collected to answer by other researchers to answer research questions different from the questions in this study, the researcher evaluated the data source to ensure that all variables of the study have data, piloted the data for any errors and assessed the reputation of the source. It should be noted that the World Bank data bank is globally recognized as a reputable source of data because it considers multiple surveys on areas of interest.

iii. Longitudinal data time effects. This study used data that has been collected and recorded over a range of several years where shocks and structural breaks in this data series pose a great risk to the precision of the results. However, the researcher employed time series model that is the VAR model that overcome and trace out the effects of these shocks and structural breaks.

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