

MAKERERE UNIVERSITY

MAKERERE UNIVERSITY BUSINESS SCHOOL

DETERMINANTS OF ELECTRICITY SUPPLY 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 MASTER OF ENERGY ECONOMICS AND GOVERNANCE.

PLAN A

NOVEMBER 2023

DECLARATION

I declare that this proposal is my original work and it has never been presented to any academic institution of higher learning for the award of an academic qualification.

Signature .....Date...13/11/2023

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APPROVAL

This is to certify that this proposal has been submitted for examination with our approval as supervisors.

Signed ..... Date 13/11/23

Assoc.Prof. Sheila Namagembe

Signed ..... Date 13/11/2023

Dr. Olyanga Anthony Moni

DEDICATION

This research work is dedicated to my mother Mrs. Namukirima Mary Gorreti you are a miracle so perfect and complete.

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LIST OF ACRONYMS

ERA	ELECTRICITY REGULATORY AUTHORITY
NDP	NATIONAL DEVELOPMENT
REA	RURAL ELECTRIFICATION AGENCY
SDG	SUSTAINABLE DEVELOPMENT GOAL
UBOS	UGANDA BUREAU OF STATISTICS
USD	UNITED STATES DOLLAR
VECM	VECTOR ERROR CORRECTION MODEL
ARDL	AUTOREGRESSIVE DISTRIBUTED LAG

ABSTRACT

The study examined the determinants of electricity supply in Uganda particularly, Technology,cost of production,price of electricity and rainfall. The objective was to examine their effect on electricity supply. The study employed the Autoregressive distributed lag (ARDL) model with structural break in time series data using the Gregory Hansen cointegration test.Data used wasfrom the first quarter of 2009 to the fourth quarter of 2019.

Findings indicated that there was a structural break in 2016:Q1.Further, findings reveal thatTechnology,cost of production,price of electricity and rainfall have a positive effect on electricity supply in Uganda both in the long run and short run.

The study results will guide policy makers such as the government in designing policies on electricity supply. Also, the study findings will be used by scholars and academicians as a source of reference for further research on electricity supply in Uganda as no scholar has studied these factors in a similarin Uganda . Similarly findings from this study will help stakeholders to appreciate the effect of price of electricity,cost of production,technology and rainfall on ensuring sustainability of electricity supply in uganda. .

CHAPTER ONE

1.0.Introduction

This chapter is composed of the background to the study, problem statement, purpose of the study, research objectives, research hypotheses, significance of the study, scope of the study and the theoretical model.

1.1.Background of the study

Supply is the ability of a manufacturer to produce and offer certain products at certain price levels and in certain period (Sihol, 2017). Electricity is needed for the attainment of growth and development agenda for all countries as it serves as an input for production of other goods and services (Kwakwa, 2018).In simple terms, electricity supply is the flow of electrical power or charge (Ubi et al., (2012).

According to the SDG7 ,By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support.The NDP III emphasizes the importance of industrialization in job creation and economic growth where provision of affordable energy is a prerequisite for industrial growth. To this end, Government seeks to lower energy tariffs to about US cents 5/KWh.

Uganda has made significant strides in expanding its electricity generation capacity, resulting in an increase in supply of electricity in the country. According to Uganda electricity regulatory authority, installed electricity capacity in Uganda is 1,378.81 megawatts with peak demand at 800 MW.A comparison of this supply and demand imbalance translates into a popular belief that Uganda has excess production of electricity and, could lead to a loose conclusion that the country is “electricity secure” in terms of availability(Wabukala et al., 2022). This surplus exists because only 42% of the population has access to grid electricity and a large suppressed demand particularly among industrial consumers, due to Uganda’s unreliable transmission and distribution systems.However, peak electricity demand is forecasted to grow to 2,000 MW by 2025, more than

triple its 2018 level of 600 MW. A significant portion of growth could be attributed to households being electrified for the first time, in line with the government target of 98% electrification by 2030. Installed capacity is expected to quadruple from current levels to around 4,200 MW by 2030.

The government put in place National Development Plans I & II and the Rural Electrification Strategy and Plan between 2010 and 2015, aiming to expand the national electric grid (Ministry of Energy and Mineral Development, 2018). In 2018, the government launched the Electricity Connection Policy giving customers an electricity connection for just UGX 20,000 (about U.S. $5.50), aiming to ensure access for 60% of households by 2027 (Nile Post, 2021; Rural Electrification Agency, 2018).All these interventions will increase electricity demand in Uganda. On the otherside, the sustainability of electricity supply in Uganda is uncertain due to various factors that affect the long-term of electricity supply in the country.Forexample,Climate change has an impact on the electricity infrastructure in the country. This is created by weather extremes like floods that damage hydropower spillways and damage the electricitytransmission infrastructure(Katutsi et al., 2021). This was observed in May 2020, when the Nyamwamba small hydro project camp (in Uganda) was washed away by heavy flood, which was attributed to climate change, leaving the region in a total black out which left the sustainability of electricity supply in the country questionable. This study aims to investigate the effect of electricity prices, cost of production, rainfall, and technologyon electricity supply. These variables were identified by (Ubi et al., 2012) in Nigeria,Kwakwa, A. P., & Alhassan, H. (2017) in Ethiopia,(Wahid, 2016) in Pakistan,(Adom, 2016)in Ghana,(Sihol, 2017) and (Obi & Uzodigwe, 2016) in Nigeria but no study has been carried out in Uganda combining the above variables.

Uganda's energy mix is characterized by a mix of renewable and non-renewable energy sources, with hydroelectric power contributing the majority of the electricity generated in the country(Katutsi et al.,(2021).However, the availability of hydroelectric power is dependent on rainfall, which has been affected by climate change in recent years (Katutsi et al. 2021). Therefore, understanding the impact of changes in rainfall patterns on the availability of renewable energy sources is essential in ensuring sustainable and reliable electricity supply in the country (Ddamulira, 2016).

The development and adoption of new technologies, such as energy storage systems, smart grids, and renewable energy technologies, have the potential to alter the energy mix and the efficiency of electricity production (Atawi et al. 2022). Therefore, investigating the effect of technological advancements on electricity supply in Uganda is crucial in identifying opportunities for improving the sustainability of the electricity supply.

Therefore , this study aims to provide insights into the complex interplay between electricity prices, cost of production, rainfall, technology, and electricity supply in Uganda, Understanding the impact of these factors is essential in ensuring a sustainable and reliable energy future for the country.

1.2.Problem statement.

The electricity regulator authority (ERA) estimates that as of December 2022, installed electricity capacity in Uganda was 1,402 megawatts (MW) with demand at 843 MW, leaving a surplus of 559 MW. However, peak electricity demand is forecasted to grow to 2,000 MW by 2025, more than triple its 2018 level of 600 MW.

This surplus exists because only 42% of the population has access to grid electricity. (Wabukala et al.,2022). Bigger infrastructural projects such as the standard gauge railway, oil refinery and petrochemical industry are soon starting which are expected to increase electricity demand, therefore there is need for a significant amount of reliable electricity supply in Uganda.

Uganda experiences unreliable electricity supply which is blamed on a multitude of factors. Although factors such changes in the technology, natural hazards such increased rainfall and prolonged drought, an aging electricity infrastructure, increased cost of production, electricity thefts, and vandalism of transmission and distribution infrastructure and changes in price of electricity have been identified from the literature. The effect hasn't been empirically tested neither have these variables been examined all at once in a single study in Uganda. Therefore, the researcher bridged the literature gap by examining the effect of electricity prices, cost of production, rainfall, and technology on electricity supply in Uganda.

1.3. Purpose of the study

The purpose of this study was to examine the determinants of electricity supply in Uganda.

1.4.Research objective

i. To examine the effect of technology on electricity supply in Uganda.
ii. To examine the effect of cost of productionon electricity supply in Uganda.

iii. To examine the effect of price of electricity on electricity supply in Uganda.

iv. To examine the effect of Rainfall on electricity supply in Uganda

1.5.Research Hypotheses

This study sought to test the following research hypotheses

H1: There was no significant effect of Technology on electricity supply in Uganda

H2: There was no significant effect of cost of production on electricity supply in Uganda.

H3: There was no significant effect of price on electricity supply in Uganda.

H4: There was no significant effect of Rainfall on electricity supply in Uganda

1.6Scope of the study

1. 6.1 Subject Scope

The study was limited to the determinants of electricity supply in Uganda

1.6.2 Time scope

The research was based on time series data. The data for this study covered a period of 10 years (2009-2019) and it is secondary data.

1.6.3 Geographic scope

The study covered the whole of Uganda

1.7 Significance of the Study

i. The study findings will guide policy makers such as the government in designing policies on electricity supply.

ii. The study findings will be used by scholars and academicians as a source of reference for further research on electricity supply in Uganda as no scholar has studied these factors together in Uganda .

iii. The findings from this study will help stakeholders to appreciate the effect of price of electricity ,cost of production ,technology and rainfall on ensuring sustainability of electricity supply in uganda. .

1.8Theoretical model

Technology, Cost of production, Electricity prices, Rainfall, and Electricity supply in Uganda

$$\boldsymbol{ES = \alpha_0 - \alpha_1 TEC - \alpha_2 C.O.P + \alpha_3\ PX + \alpha_4 RF + \varepsilon_i \ldots\ldots}$$

α_0 Is the coefficient for the constant

α_1 Is the coefficient for Technology

α_2 Is the coefficient for the cost of production

α_3 Is the coefficient for the price of electricity

α_4Is the coefficient for rainfall

ES –is Electricity supply

TEC is Technology

C.O.P is cost of production

PX is price of electricity

RF rainfall

Source:(Sihol, 2017)**;**(Wahid, 2016) ,(Kwakwa, A. P., & Alhassan, H. 2017)**&**(Ubi et al., 2012)

CHAPTER TWO

LITERATURE REVIEW

2.0.Introduction

This chapter presents a review of literature related to the effect of technology ,cost of production ,price of electricity and rainf(Sihol, 2017)all on electricity supply in Uganda.

Different sources of data including but limited to journal articles, theses, policy papers and textbooks were reviewed.

2.1.1Theoritical Review

Theory of supply is the basic theoretical framework, which underlies this research. It should be noted that supply as used here does not necessarily mean the total stock of a product produced but it is just the amount that is actually offered for sale. It is a common knowledge that producers tend to offer more for sale at a higher price and less at a lower price, all things being equal. (Ubi et al., 2012).

In line with the theory of supply, there are factors that determine the quantity of a product that may be offered for sale at any given price. These factors are price of the commodity, cost of production,

state of technology, natural phenomenon like rainfall, government policy, etc. to mention but a few. (Kwakwa& Alhassan, 2017)

With the supply of electricity energy, it can be influenced by several factors such asnumber of generation units, installed capacity, power capacity, investment, energy produced, fuelconsumption, the unit price of fuel, the energy produced per type of fuel, shrinkage energy andcaptive power (Sihol, 2017).

In addition to these factors, the supply of electricity is also affected by the selling price of electricity itself, fuel price, and the level of technology used to produce electricity(Obi & Uzodigwe, 2016).

2..2Technology and the supply of electricity .

The effect of technology on electricity supply has been an increasing concernin recent studies, hence leading to plethora of studies in this area. Very many studies have included technology as one of the drivers of electricity supply and in many studies the effect has proven to be positive however, there is aproblem on how to measure technonlogy.

Ubi et al.(2012) carried out an econometric analysis of the determinants of electricity supply in Nigeria for the period 1970-2009, with electricity supply, electricity price, government funding, annual rainfall, level of technology and included also power loss as the variables of the study. The study used chronological time as aproxy to measure technology.Using cointegration technique and Parsimonious error correction mechanism, the results show that technology has apositive effect on electricity supply in Nigeria.

Obi & Uzodigwe(2016) assessed the optimal electricity supply in Nigeria for the period 1980 to 2014,with electricity supply,electricity price, volume of electricity generated or produced , government spending on electricity , technology and the quantity of electricity loss .The study used electricity use per capita kilowatt hour as aproxy for measuring technology.Using the estimate of

the partial adjustment equation, the results revealed that electricity technology is positively related to electricity supply.

Similary, (Wahid, 2016) studied the Determinants and Forecasting of Electricity Supply in Pakistan for the period 1972 to 2014 with Total Electricity Supply, Rain Fall,Petroleum Import Electricity Transmission and Distribution loss growth,Final Oil Price and technology as the research variables.The study used Average Sale of Electricity @ TREND as aproxy for technology.The study results showed that techonology has apositive effect on total electricity supply.

However, Adom(2016)studied Electricity Supply and System losses in Ghana where electricity supply was a function of own price, input cost, technology, market size, andweather variability.The study used total system losses as aproxy for technology . The study results showed that techonology has apositive effect on total electricity supply.Buidling from this, the study used generation losses as aproxy for technology because Uganda's electricity supply chain has majorly three segments i.e generation –transmission –distribution yet for other countries it's a combimation of transmission and distribution.

2.1.3Cost of production and supply of electricity

Cost of production is the total cost incurred by a business to either produce a product or offer their services. Production costs typically include supplies and raw materials that are consumed during production, along with labor expenses.

Operating costs for power plants include fuel, labor and maintenance costs. Unlike capital costs which are "fixed" (do not vary with the level of output), a plant's total operating cost depends on how much electricity the plant produces. The operating cost required to produce each Mwh of electric energy is referred to as the "marginal cost." (Wahid,2016).

Rosnes & Vennemo(2012) in their study on the cost of providing electricity to sub-Saharan Africa, found that a realistic estimate for the region over a 10-year period is approximately 100–120 GW in terms of generation capacity investments and that the investment cost would amount to

approximately160–215 billion USD. The estimate includes a significant amount of refurbishment, which is more economical than greenfield investments. The cost of generation comprised half of the total, while transmission and, in particular, distribution comprised the other half. The annual cost of system expansion and operation, a concept that includes variable cost (e.g., fuel cost) and the annualised cost of capital,amounts to 39–48 billion USD. Approximately 10–12 billion of this amount refered to a cost-efficient operation of the existing electricitysystem.

Kavuma et al.,(2021) in their study on analysis of power generating plants and substations for increased Uganda's electricity grid acces concluded that costs will be minimized if transmission lines are extended to unserved areas instead of increasing power generation substations as the net present worth of USD 63.6 million showed that extending the grid to the unserved areas was worthwhile. The extension could be done from the nearest substation or generation plant to the new served area for a proposed substation.

Adom, (2016) in his study on Electricity Supply and System losses in Ghana. What is the red line? Have we crossed over? Looked at system losses; climate change; electricity price; in put costs, investment as variables under observation, using the ARDL model, the study used price of crude oil as the cost of inputs. The result shows a significant shift in the effect of crude oil price. Fuel prices have adversely affected production incentives in the sector causing decline in electricity supply. This has been fuelled by the shift in production structure towards thermal generation. The current structure means production in the sector will continue to be subjected to the developments in oil market. Given the volatile nature of oil market, the security of electricity supply is likely to be very uncertain. This will not be good for the sustainable development of the country this is different from this study because it uses operation and maintance costs as a proxy for cost of production.

Sihol(2017) studied the Analysis Of Factors Affecting the Electricity Supply in Indonesia.the variables that were studied included , Supply of Electricity Energy or Total of Electricity Production (GWh),Selling Price of Electricity (Rp/KWh), Fuel Price (Input Price) (Rp/Liter) ,Length of Transmission Network (Kms), Electrical Energy Losses (%) ,Distribution Interruption using Fixed Effect Model Estimation. The most dominant variables affecting on electricity supply

(PEL) are variable of electricity price (HEL) and the fuel (input) price of electricity (HIEL).The paper has shown that there exist other costs that affect the decision of acompany.

2.1.4Effect of Electricity price on supply of electricity.

In terms of the general literature, while there is a plethora of studies focusing on Electricity's own price as one of the most factors affecting electricity supply, these studies differ on how they measure the price and the effect of price on electricity supply which could be attributed to the different segments of the electricity supply chain studied.

Sihol(2017) looked at an Analysis of factors affecting Electricity Supply in Indonesia. Using Chow Test and Hausman Test, the result of estimation shows that the factors affecting the supply of electricity in Indonesia are the price (tariff) of electricity, the price of fuel, the length of transmission lines, and the energy losses. The study results indicate that the price (tariff) of electricity has apositive and significant effect on supply of electriciy.

Similarly,(Adom, 2016) studied Electricity Supply and System losses in Ghana. What is the red line? Have we crossed over? with an aim to investigate the key drivers of electricity supply in Ghana. In this study, electricity supply was modelled as a function of own price, input cost, technology, market size, and weather variability. The study used average end-user tariff as ameasure of electricity own price .The results indicated apositive effect between electricity supply and its own price.

However ,(Obi & Uzodigwe,2016) in their study ,Assessing the Optimal Electricity Supply in Nigeria modelled electricity supply as a function which depends on electricity price, volume of electricity generated or produced ,government spending on electricity ,technology and the quantity of electricity loss for aperiod 1980 to 2014.Using average electricity tariff by residential ,commercial and industrial as ameasure of electricity price, the study found out that the effect of electricity price on electricity supply is negative. The study concludes that this may be due to the fact that payment rates for electricity bills are low .The study further recommends that government should formulate and implement appropriate pricing policies that can affect profitability and hence boost electricity supply .

This study also included price of electricity and used the average price transmission pays to generation companies because electricity supply was considered to be the amount of electricity that is actually offered for sale by generation companies to transmission .

2.1.5Rainfall and supply of electricity.

The weather and climate impacts are not limited to one power generation source type, but are common to almost all, including hydropower, wind power, biofuels, solar energy , oil and natural gas, and thermal power**(**Majodina *et al.*, 2018). However most of the studies that have studied the effect of rain fall on electricity supply or production have studied it in relation to hydroelectricity.Other studies have studied all the climatic or weather factors including rainfall.

Hydropower generation is solely dependent on water although evaporation dominates the water balance and governs the availability of water resources in arid and semi-arid areas. Small changes in land use, precipitation, and temperature can lead to large changes in surface water flows, which in one way or another can affect the production of hydropower.Perera & Rathnayake(2020) and Adegbehin *et al*.,(2016)in their study on Effect of Weather Parameters on Hydroelectric Power Generation in Kainji Dam Niger State, Nigeria, using the Pearson correlation coefficient by SPPS software to examine the strength of the relationship between the variables, Rainfall, temperature and evaporation on electricity generated, relationship between the variables the research indicated that rainfall with 0.83 correlation coefficients have strong relationships with the amount of power generated.

Kabo-Bah et al. (2016) in their study on Multiyear Rainfall and Temperature Trends in the Volta River Basin and their Potential Impact on Hydropower Generation in Ghana, showed that the annual temperature trend was positive while rainfall showed both negative and positive trends in different parts of the country.

Significant increase in rainfall amounts and intensity, and flooding as predicted could also seasonally increase water levels in lakes and rivers and become barriers to energy generation. Between 2019 and 2020, the Lake Victoria basin received increased rainfall and run-off, which

increased the water level of Lake Vitoria to unprecedented levels, by 13.42 meters at Entebbe, which exceeded the 13.41 meters level recorded in 1964. This rise in water level created some challenges to electricity generation, with moving islands/ floating vegetation blocking water flow to the hydro power stations on the Nile in Jinja.

Wahid,(2016) on the determinants and forecast of electricity supply in Pakistan show that, rain fall (RF) directly affects electricity supply. The implication of this result is 1 %, increase in RF will bring 0.059337 % increase in electricity supply. The sign of Rainfall confirms with theoretical expectation but statistically insignificant at 5 percent level. This means that the whole electricity is not generated from water reserve, only 33.6 percent electricity was generated from hydro and the rest of electricity was generated from other sources (Economic Survey of Pakistan 2011-12). Tanzania has had six major droughts in the last 30 years and the last major drought ended in 2006/07, all of which reduced electricity supply(Ddamulira, 2018) .

Boadi & Owusu, (2019) in their study on Impact of climate change and variability on hydropower in Ghana using Rainfall data for six Synoptic stations in the South Volta Basin were collected from the Ghana Meteorological Agency find that rainfall helps predict annual variation in power generation. The regression coefficients associated with monthly total basin rainfall is 2.964 which implies that if mean basin rainfall increases by a unit (1 mm), one will expect power generation to increase by 2.964 GWh.This study looked at the effect of rainfall on aggregate electricity supply irrespective of the source of production.

CHAPTER THREE
METHODOLOGY

3.0 Introduction

This chapter provides the research method that was utilized to carry out the study. It covers the research design, data sources, data collection methods, data processing and treatment of data. This is followed by an explanation of the methods of data analysis and the implied diagnostic tests.

3.1 Research Design

This study used quarterly time series data covering the period 2009Q1 to 2019 Q4.The period was considered because it covers the period when the government of Uganda constructed more dams such as Isimba 2019,Bugoye 2009,Achwa2 2019,Nyagak 2012,Bujagali 2012 and Kabalega 2013 which were aimed at reducing power supply shortages in the country. To enable this, the researcher usedpurely quantitative method.

3.2 Data type and data source

The study used quarterly secondary data. The data used were collected from two sources. Data on Electricity tariffs (PX), Technology (TEC), electricity supplied (ES) and Cost of production (C.O.P) were sourced from Electricity Regulatory Authority online data base while data on rainfall (RF) was sourced fromUganda meteorological authority website. The choice of the starting period was because of availability of data on electricity supply, the period 2009 to 2019 was considered because it showed a remarkable improvement in the generation of Electricity in Uganda which is because of a conducive regulatory environment created by ERA.

3.3. Specification of the empirical model

The estimation model was derived from the traditional theory of supply.Theoretically, supply of any commodity is determined by the price of the commodity (PE), the market size/number of buyers (MS), cost of inputs (IC), technological (TEC), and weather (W) (Adom, 2016).In the case of electricity supply, these factors are very crucial. Mathematically, the theoretical relations for electricity supply can be written as$ES = F(P_{E,}I_C, M_S, T_{EC,W})$…….. (1)

The empirical framework in this study is strongly motivated by equation 1. In this study, Electricity supply is a function of technology, cost of production, electricity tariffs/Price and rainfall.This is depicted by ES =F (TEC, C.O.P, PX, RF)…… (2)

Where ES is electricity supply, all electricity generated by power plants in Uganda and is supplied to Uganda Electricity Transmission Company limited measured in Megawatts per hour. TEC isTechnology and in this research, system losses were used as a proxy of technology,system losses that is the difference between electricity generated and electricity sold to transmission was used as a proxy of technology.This is because there is strong correlation with technological investment (Adom, 2016).

C.O.P is the cost of production, where Operation and maintenance costs incurred by generation companies were used as a proxy for cost of production.PX is the electricity tariffs /prices, which is the average price at which generation companies sell to the transmission company in US Cents. In addition, RF is rainfall which is refers to the amount of rain received per quarter in Uganda.

All the variables were transformed into logarithms. Logarithmic transformation is a convenient means of transforming a highly skewed variable into a more normalized dataset. It helps to disregard the units of measurement that may differ per variable. Hence, the model was specified as,

$$\boldsymbol{logES_t = \alpha_0 + \alpha_1\, logTEC_t - \alpha_2 LogC.O.P_t + \alpha_3 logPX_t + \alpha_4 logRF_t + \varepsilon_t \ldots\ldots} \textbf{ (3)}$$

Where: ***log ES*** is the logarithm of electricity supply; $LogTEC$ is the logarithm of Technology $LogC.O.P$ is the logarithm of cost of production; $LogPX$ is the logarithm of Electricity tariffs and $LogRF$ is the logarithm of Rainfall and ε_i is a stochastic term.

Variables in the equations, expected signs and sources.

Variables	Measurement of Variables	Definition	Expected sign	Data source

Electricity Supply	Megawatt-hours (MWh)	Electricity supply is the flow of electrical power or charge,Ubi et al.(2012) In this study its amount that is actually offered for sale by generation companies to transmission .		ERA (2020)
Technology	Megawatt-hours (MWh)	Technology was measured using system losses that is the difference between electricity generated and electricity sold to transmission. The lower the system losses the more advanced the technology and vice versa.	Positive	ERA (2020)
Cost of production	Million shillings	Operation and maintenance costs incurred by generation companies	Negative	ERA (2020)
Electricity Prices	US Cents	The price of electricity is the average price transmission pays to generation companies.	Positive	ERA (2020)
Rainfall	Millimeters	Amount of rain received per quarter in Uganda	Positive	Uganda meteorological authority.(2020)

3.4.0Data Analysis

The data was processed and analyzed using STATA version 15. The data patterns and economic model were estimated.

3.4.1.0 Data Analysis Procedures

3.4.1.1 Descriptive statistics

Descriptive statistics were estimated to provide a general description of the data characteristics. This helped to ensure that the data had a normal distribution otherwise it would produce misleading

results. In particular, frequency tables, time series line graphs, a summary of the mean, minimum, maximum variance, and standard deviation values were computed and presented.

3.4.1.2Normality Test

A normality test was conducted to examine whether the error term was normally distributed in the model.

For the purpose of this study, the Jarque-Bera (JB) normality test was used to test whether the variables are normally distributed. The JB test of normality is an asymptotic or large sample test based on the OLS residuals. It integrates the skewness (S) and kurtosis measures (K) of the OLS residuals for a sample of size (n) to form a test statistic written as,

$$\boldsymbol{JB} = \boldsymbol{n}[\frac{\boldsymbol{S}^2}{\boldsymbol{6}} + \frac{(\boldsymbol{K}-\boldsymbol{3})^2}{\boldsymbol{24}}] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (\,)$$

Because S=0 and K=3 for normally distributed variable, the JB normality test tests simultaneously the joint hypothesis that S and K are 0 and 3, respectively. In which case the value of the JB statistic is expected to be zero. The researcher was to reject the null hypothesis if $p<0.05$ and could fail to reject the normality of error term iff $p>0.05$.

3.4.1.3 Unit root test

Unit root tests are tests for stationarity in a time series. A time series has stationarity if a shift in time does not cause a change in the shape of the distribution; This is an important step to carry out to avoid cases of spurious regressions in case non-stationary variables are regressed on other non-stationary variables with no cointegration relationships. Non-stationarity of variables implies that the means and variances of the variables always change with time. In this study, Augmented Dickey-Fuller unit root test was used to test for stationary variables. The ADF Equation

$$\Delta Yt = \alpha + \beta_t\,(p-1)Y_{t-1} + \Sigma_{j=1}^{p}\lambda_j \Delta Y_{t-j} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Ho: Time series is non-stationary

The researcher shall reject Ho iff p>0.05 or if Z (t) computed is less than the critical value of z (t) at a 5% level of significance.

3.4.1.4 Linearity Assumption Test

Linearity refers to the presence of a straight-line relationship between two variables. Graphically, linear data is obtained when the scores are seen to be in the form of straight line, not a curve.
A normal probability plot (normal Q-Q plot) was used in this study to plot the residual against the predicted scores and if it produced a fair straight diagonal line, then the data would be linear and if it didn't then the data wouldn't be linear and this would call for further testing of outliers and removing them in the data.

3.4.1.5 Heteroscedasticity

Heteroscedasticity problem occurs when the error term variance is different or not constant across the observation or independent variables. If there is a detection of heteroscedasticity problem, the model should be re-estimated by using the weighted or generalized least square method. After the re-estimate process, the model would be more efficient to be estimated compared to the OLS method (Holgersson & Shukur, 2004). To test for heteroscedasticity problem in the model, the Autoregressive Conditional Heteroscedasticity (ARCH) Test was carried out.

Hypothesis Statement:

H_o: There is no heteroscedasticity problem in the model.

H_1: There is heteroscedasticity problem in the model.

Decision Rule: Reject H_o if p-value is less than the 0.05 level of significance. Otherwise, do not reject $H_o$and conclude that there is no heteroscedasticity problem in the model. In case there is heteroscedasticity, the ARCH model is estimated

3.4.1.6 Multicollinearity

Multicollinearity exists if the regressors correlate highly when regressed against each other. A collinearity diagnostic test under regression analysis was utilized. Under this procedure, two values are given, the tolerance and the variance inflation factor (VIF). The tolerance value is an indicator of how much of the variability of the specified independent variable is not explained by the other independent variables in the model. The VIF is the inverse of the tolerance value. Basing on the tolerance figures, various scholars indicate different cut off points for the accept/reject standard.

According to Menard (1995), if the tolerance values are below 2, that shows the existence of multicollinearity.

3.4.1.7 Autocorrelation

Autocorrelation/Serial correlation is the relationship between a given variable and a lagged version of itself over various time intervals. Serial correlations are often found in repeating patterns, when the level of a variable affects its future level (Zovko, 2008). Autocorrelation tests was conducted to determine the effect of a variable with its own past and present values. In order to test the autocorrelation problem, the test of the null hypothesis H_0 of no serial correlation ($\rho = 0$) was conducted based on the Durbin- Watson statistic.

Otherwise, we shall fail to reject the null hypothesis H_0 if $1.7 \leq d \leq 2.3$ and conclude that there is no serial correlation in the error term. However, for higher order serial correlation, the Lagrange Multiplier (LM) is employed and in this case, we failed to reject H_0 if $\rho > 5\%$ level of significance and concluded that there was no serial correlation in the error term.

3.4. 1.8 Cointegration Analysis

Two sets of variables are co integrated if a linear combination of those variables has a lower order of integration. Co-integration defines two variables that are not moving in the same direction but they are co-integrated. It indicates the existence of a long-term equilibrium relationship between the variables. In this study, Gregory-Hansen Cointegration Test was applied to determine the co integrating relationship among variables.

As noted by Perron (1989), ignoring the issue of potential structural breaks can render invalid the statistical results not only of unit root tests but also of cointegration tests. Kunitomo (1996) argues that in the presence of a structural change, traditional cointegration tests, which do not allow for this, may produce spurious cointegration.

Therefore, one has to be aware of the potential effects of structural breaks on the results of a cointegration test, as they usually occur because of major policy changes or external shocks in the economy. In this study considering the effects of potential structural breaks is, therefore, very

important, especially given that Uganda's electricity sector has faced numerous structural breaks including those majorly caused by changes in policy and politics.

The Gregory-Hansen approach (1996) (hereafter, GH) addressed the problem of estimating cointegration relationships in the presence of a potential structural break by introducing a residual-based technique so as to test the null hypothesis (no cointegration) against the alternative of cointegration in the presence of a break (such as a regime shift).

G-H introduced three alternative models. The first model includes an intercept (or constant) (C) and a level shift dummy. This model is illustrated as follows:

$X_{1t}=\mu_1+\mu_2 DU_t+\alpha_1 X_{2t}+e_1$

In this case, the intercept dummy variable DU_t takes the value of one after the break date and zero otherwise.

The second alternative model (C/T), contains an intercept and trend with a level shift dummy, and is shown as follows:

$$x_{1t} = \mu_1 + \mu_2 DU_t + \mu_3 t + \alpha_1' x_{2t} + e_t$$

The third model is the full break model (C/S), which includes two dummy variables, one for the intercept and one for the slope, without including a trend in the model. This model allows for change in both the intercept and slope as illustrated below:

$$x_{1t} = \mu_1 + \mu_2 DU_t + \alpha_1' x_{2t} + \alpha_2' x_{2t} DU_t + e_t \qquad t=1,\ldots,n$$

In the above equations DUt =0, if t n ≤ [nτ] and DUt =1 if t > [nτ], where the unknown parameter τ ∈ (0, 1) is defined as the relative timing of the change point. The cointegration slope coefficient before the regime shift is denoted by α_1 and change in the slope coefficient at the time of regime shift is denoted by α_2. Finally, μ_1 represents the intercept before the level shift, and the change in the intercept at the time of the shift is represented by μ_2. This study only considers and applies the C/S model to electricity supply data, thereby allowing for both changes in the intercept as well as change in the slope.

3.4.1.9 Autocorrelation

The study controlled for autocorrelation in the residuals of the regression because the popular ordinary least squares (OLS) estimator is inconsistent if the model's residuals are auto correlated. It is therefore important to be able to test for autocorrelation in the residuals of the dynamic linear regression model. The study used the Durbin-Watson (DW) test to check for autocorrelation. The DW test was used to determine whether the residuals in a linear regression model followed an AR (1) process.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION OF FINDINGS

4.0 Introduction

This chapter outlines the different data findings through logical data presentation, analysis and interpretation. In this chapter, the descriptive statistics tables, graphs are displayed and models are estimated and interpreted based on the corresponding hypothesis.

4.1 Descriptive Statistics of the Study Variables

Under this sub chapter, the characteristics of the different study variables are described using summary statistics and trend lines.

Table 4.1.0 Descriptive Summary for the Study Variables in Levels.

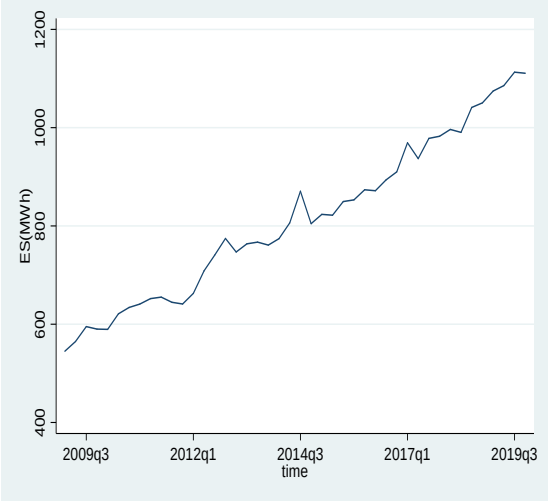
Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Electricity supply (MWh)	44	813.204	164.349	544.997	1112.959
Technology (Mwh)	44	22.904	2.0264	20.038	25.769
Cost of production (millions)	44	16818.730	6484.457	4094.270	25421.600
Price of electricity (Us. Cents)	44	8.744	0.515	7.683	9.949
Rainfall (mm)	44	343.547	128.978	80.711	743.242

Source: *Authors' computation using secondary data*

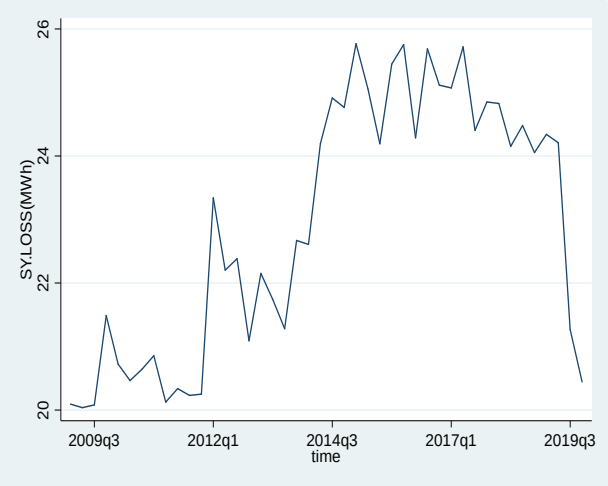
The above table summarizes data using the measures of central tendency and measures of dispersion for each study variable. The descriptive results revealed the average quarterly electricity supply of813.204 Mwh with a quarterly standard deviation of 164.349 Mwh, which implies that data on electricity supply is widely distributed.

Time series plots of the study variables from 2009-2019

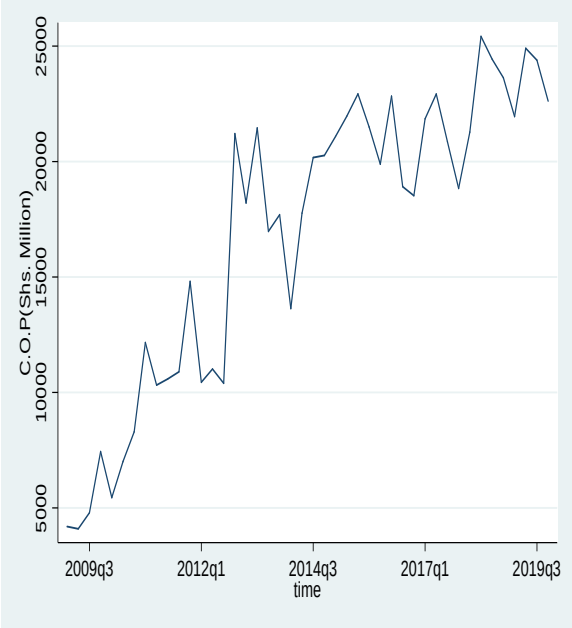
Electricity supply



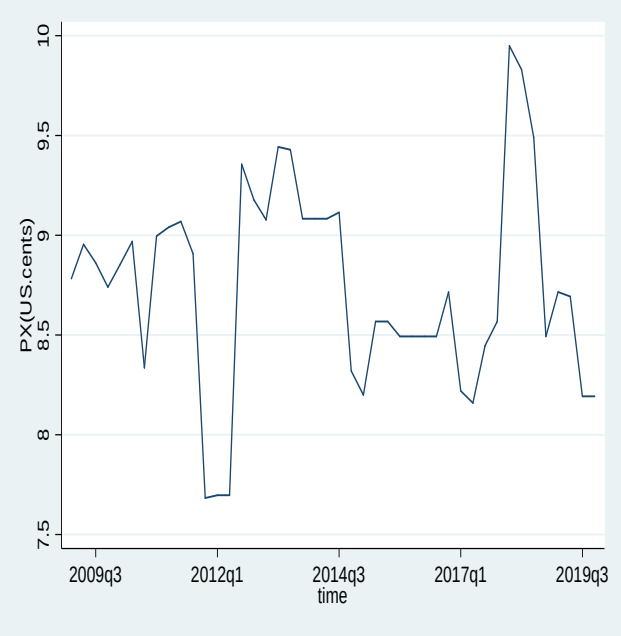
Technology



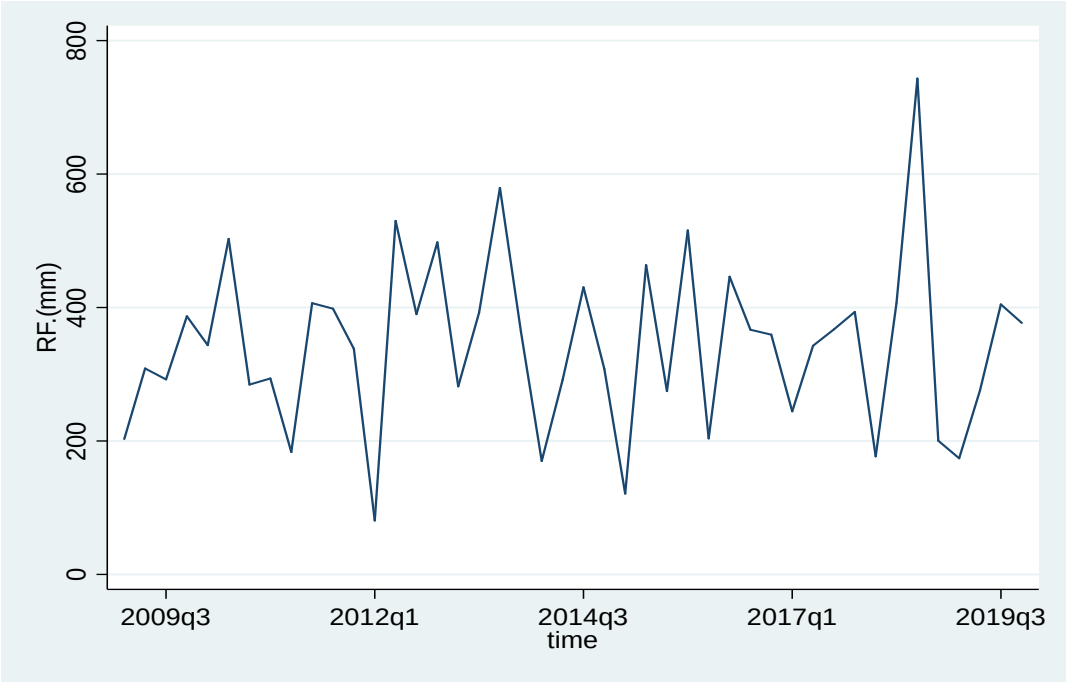
Cost of production.



Price of electricity



Rainfall



Source: Authors' computation using secondary data

There is a positive trend in all the variables. Electricity supply generally increased from 2009 to 2019 with random variations.

Technology and cost of production show random low and high points with the highest peak around 2014 and2018 respectively. Price of electricity increased at the start of 2009 and declined slightly in 2010.There is a bouncing back and forth in electricity prices towards the end of 2010. Further, price of electricity shows avery big decline in 2012 and a big increase in 2018.This can be attributed to low or high inflation and exchange rates at the time. Rainfall shows seasonal variations,it implies rainfall increases every second and fourth quarter. It shows Uganda has two rainy seasons.

4.2 Estimation Techniques

Under this section, estimation tests, which include tests for normality, unit roots and cointegration, were carried out to ensure that all time series econometric principles are sufficiently observed

4.2.1 Normality test

Using JarqueBera normality test, the null hypothesis was assessed so as to find outwhether the study variables are normally distributed as shown in Table 4.2.1

Table 4.2.1: JarqueBera normality test

Variable	*Chi2*	*P-value*	*Skewness*	*Kurtosis*
Electricity supply (Mwh)	2.292	0.318	0.194	1.951
Technology (Mwh)	4.530	0.104	-0.009	1.440
Cost of production (Millions)	4.439	0.109	-0.602	2.014
Price of electricity (Us. Cents)	0.006	0.997	0.025	2.974
Rainfall (MM)	2.718	0.257	0.462	3.793

Source: *Authors' computation using secondary data*

Ho: Normality; given results in Table 4.2.1, the null hypothesis is not rejected and its therefore concluded that data on electricity supply, technology , cost of production , cost of production ,price of electricity and rainfall is normally distributed at 5% significance level**.** This is because their P-values are greater than the critical value 0.05.

4.2.2 Lag Length Determination

In time series econometric studies, distributed lag models are used to predict the values of the dependent variables using the current and past values of the explanatory variables. The lag length criteria was used in order to decide about the number of lags used in the data variables. The autoregressive (AR) was used in order to determine the autoregressive lag length. The lag length autoregressive process *p* states that a time series in the present value of the variables is derived by its first lagged value AR (*p*). To determine the optimal lags length (past values), Akaike Information Criterion (AIC) was used and results are shown in the Table 4.2.2

Table 4.2.2: ***Lag length selection criteria***

Variable	*Lags*	*FPE*	*AIC*	*HQIC*	*SBIC*
logESMWh	4	0.00087*	-4.20398*	-4.12764*	-3.99287*
logSYLOSSMWh	1	0.002061*	-3.3469*	-3.31644*	-3.2625*
logCOPShsMillion	4	0.025932*	-0.8157*	-0.739384*	-0.604605*
logPXUScents	2	0.002849*	-3.02331*	-2.97751*	-2.89664*
logRFmm	4	0.163671*	1.02667*	1.103*	1.23778*
ALL	2	3.9e-11*	-9.84866*	-9.00902	-7.52645

Source: *Authors' computation using secondary data*

From the Table 4.2.2, logarithms of electricity supply,cost of production and rainfall had four as the optimal lag based on the Akaike information criterion, logarithm of price had 2(two) as the optimal lag based on the Akaike information criterion.However, logarithm of technology had one as the optimal lag based on the Akaike information criterion. The maximum lag using AIC for entire time series regression model with all variables considered for this research was 2(two). This implies that the present values of the variables are derived by their first lagged values in the second lag.

4.2.3 Stationarity Test

The null hypothesis is that the series have a unit root or are non-stationary. This means that the time series have a stochastic variance, mean and auto correlating across lags. The requirement for time series analysis is stationarity of the data series. Table 4.2.3 displays the inferential results for stationarity test using the Augmented Dickey Fuller (ADF). The ADF test was performed on log transformed, original variables and differenced variables as shown in Table 4.2.3.

Table 4.2.3: ***Unit root test for Stationarity results using Augmented Dickey Fuller***

Logs	**Non Differences**		**First difference**	
Variable	***Z_t-value***	***P-Value***	***Z_t –value***	***P-value***
logESMWh	-2.961	0.8571	-2.961	0.0009
Log TEC MWh	-2.952	0.5198	-2.952	0.0000

logCOPShsMillion	-2.961	0.0050
logPXUScents	-2.955	0.0031
logRFmm	-2.961	0.0392

Source: *Authors' computation using secondary data*

From the analysis, we reject the null hypothesis for unit root in the Log of cost of production, price of electricity and rainfall at 5% level of significance since its p-value is less than the critical value 0.05 and conclude that they are stationary at level.

The null hypothesis for unit root in logarithmic variables of Electricity supply and technology at 5% level of significance couldn't be rejected since the corresponding P-values are greater than the critical value 0.05.

The variables therefore were differenced and the ADF for the first difference of Electricity supply and technology indicated that they are stationary because their corresponding P-values were less than the critical value of 0.05.

This implied that the series were integrated of different order and in performing the cointegration test to establish a long run relationship among the variables, the ARDL model was chosen.

4.2. 4 Cointegration

Co integration was used to assess the possibility of long run effect in the time series analysis of the determinants of electricity supply in Uganda .If variables are integrated of different orders, the bounds test is used. However, if there were structural breaks, the bounds test would yield inconsistent results. Hence, the study used the Gregory Hansen cointegration test within the ARDL model to control for structural breaks.

The Gregory Hansen cointegration test

H0: no-cointegration at the break point
H1: there is cointegration at the break point

Decision rule: reject the null hypothesis if the absolute value of the Z_t statistic is higher than the 5% critical value, otherwise do not reject.

Table 4.2.4: ***Cointegration results using Gregory Hansen Cointegration test***

Equation		***Break***		***Break***		***Break***	***Critical***
	ADF	***date***	Z_t	***date***	Z_α	***date***	***value 5%***
Intercept Shift	4.29	2017q3	4.24	2017q3	28.42	2017q3	5.56
Intercept Shift with trend	5.58	2015q3	5.79	2014q3	38.20	2014q3	5.83
Intercept shift with slope	7.43	2016q1	7.51	2016q1	49.88	2016q1	6.41

Source: *Authors' computation using secondary data*

The reasearcher rejected the null hypothesis and concluded that there was cointegration at the breakpoint.It showed that cointegration was established under the assumption of intercept shift with regime shift with the shift occurring in 2016:Q1. Having established a structural break in 2016:Q1, the indicator function = 0 for periods 2009:Q1 to 2015:Q4 and = 1 for periods after 2016:Q1

4.3 Post Estimation Diagnostic Tests

The diagnostics were carried out to assess the validity of the model. These included test for autocorrelation, normality of the residual terms and the model stability.

4.3. 1 Autocorrelation Test.

The widely used test for checking autocorrelation, the Durbin-Watson d-statistic, was carried out. Based on the DW d-statistic of 2.0 The null hypothesis of no first-order autocorrelation couldn't be rejected since the d-statistic is equal to two and it can be concluded that the residuals were not correlated at 5% level of significance.

4.3 .2 Heteroscedasticity Test

As the widely used tests for checking heteroscedasticity, the White and Breusch-Pagan tests for heteroscedasticity were carried out. The results are shown in the table 4.3.2

Table 4.3.2: ***Heteroscedasticity results using White and Breusch-Pagan tests***

Test	***chi2***	***Df***	***Prob> chi2***
White	**42.00**	**41**	**0.4274**
Breusch-Pagan	-14.62	1	0.1397

Source: *Authors' computation using secondary data*

Based on results from Table 4.3.2,The null hypothesis of a constant variance couldn't be rejected since the p-values for White and Breush-Pagan tests weregreater than the critical value of 0.05 and it can be concluded that the model was homoscedastic at 95% confidence interval.

4.3.3 Normality Test for Residuals

The study used the Jarque-Bera (JB) test for checking normality of the residuals against the null hypothesis that the residuals are normally distributed. The JB test results are shown in Table.

Table 4.3.3: ***Jarque-Bera test results for Residuals***

Test	***chi2***	***Prob> chi2***
Jarque-Bera	**4.275**	**0.118**
No of Obs = 42; F =154.49; Prob>F = 0.0000; R-squared = 0.9918; Adj R-squared = 0.9854		

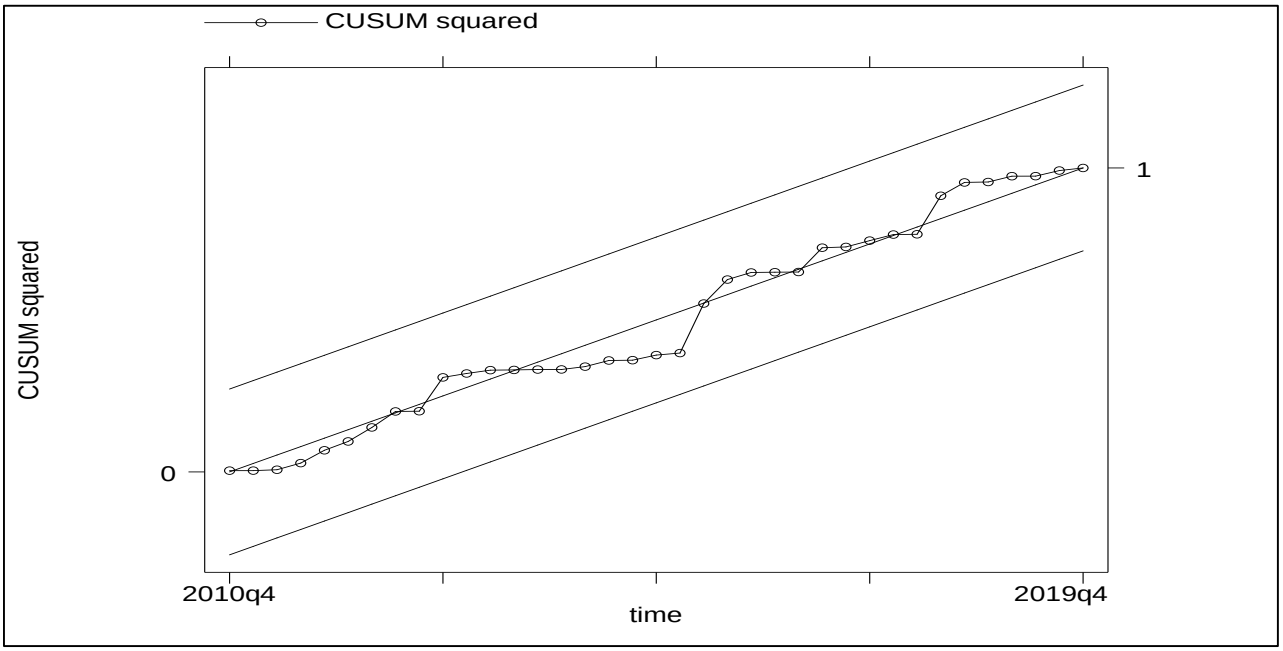
Source: *Authors' computation using secondary data*

Based on results from Table, the null hypothesis couldn't be rejected since the p-value of **0.118** was greater than the critical value of 0.05 and it can therefore be concluded that the residuals in the model were normally distributed at 5% level of significance.

4.3.4 Model Stability

The study tested to confirm whether the estimated model was stable. The Cumulative Sum (CUSUM) square test was used. This test was based on recursive regression residuals plotted against possible break points in the model within critical bounds of 5% significance. The model is stable if the CUSUM square of residuals falls within the 5% critical bounds. The test results are represented in form of a graph in the figure below.

Figure 4.3. 4: The CUSUM squared graph



The CUSUM square graph indicates that the dotted line (the cumulative sum square of residuals) entirely falls within the upper and lower critical bounds over the study period. The study thus concluded that the estimated model is stable.

4. 4 Model Estimation

4.4.1 ARDL Model estimation

Given the mixed nature of stationarity of the model variables, the ARDL model was identified as the best estimation technique. According to Enkoro (2016), the major advantage of the ARDL method is that, if properly augmented, it avoids problems of serial correlation and endogeneity.

Therefore, under the ARDL model, electricity supply was regressed against technology , cost of production, price of electricity and rainfall.

Table 4.4.1:*short run ARDL Model results*

LogESMWh	**Coefficient.**	**Std. Error**	**P>|t|**
logTEC.MWh	0.6095245	0.1591185	0.001
logCOP.ShsMillion	0.0478633	0.288428	0.043
logPX.UScents	0.2881186	0.995273	0.008
logRF.mm	-0.0068507	0.0134601	0.041
Cons	1.720793	0.4702226	0.001

Source: *Authors' computation using secondary data*

The results in table 4.4.1 indicate that, technology is observed to positively affect electricity supply in the short run. A percentage increase in technology leads to a 0.61 percentage increase in electricity supply at 95% level of confidence, and vice versa, holding other factors constant. This observation is consistent with a priori expectations; an increase in technology is expected to increase electricity supply.

Cost of production has a positive effect on electricity supply in the short- run. It means that a percentage increase in cost of production leads to a 0.05percentage increase in electricity supply at 95% of confidence in the short run, and vice versa, holding other factors constant. This observation is inconsistent with a priori expectations; an increase in the cost of production is expected to decrease electricity supply.

Price of electricity is observed to have a positive effect on electricity supply in the short-run. An increase in the price of electricity leads to a 0.29 percentage increase in electricity supply and vice versa, holding other factors constant. This observation is consistent with a priori expectations since increase in price from economic theory of supply is expected to increase supply.

Rainfall has a negative effect on electricity supply in the short-run. In precise terms, a percentage increase in rainfall leads to a 0.01 percentage results in a reduction in electricity supply at 95% confidence level in the short-run, and vice versa, holding other factors constant.

This kind of relationship is against the a priori expectations because it is expected that when rainfall increases electricity supply increases because of an increase in hydroelectricity produced.
The constant is positive in the short run. It means that when all the variables are zero, electricity supply is 1.72Mwh.

Table 4.4.2:Long run ARDL *Model results*

LogESMWh	**Coefficient.**	**Std. Error**	**Pr>|t|**
ADJ	-0.7307282	0.135394	0.000
LogTEC MWh	0.8341331	0.0361926	0.000
logCOP.ShsMillion	0.1363067	0.1238145	0.000
logPX.UScents	0.1892643	0.1367718	0.042
logRF.mm	0.0093751	0.1199043	0.041

Source: *Authors' computation using secondary data*

The results in table 4.5.1 indicate that, technology is observed to positively affect electricity supply in the long run. A percentage increase in technology leads to a 0.83 percentage increase in electricity supply at 95% level of confidence, and vice versa, holding other factors constant. This observation isconsistent with a priori expectations; an increase in technology is expected to increase electricity supply.

Cost of production has a positive effect on electricity supply in the long run. It means that a percentage increase in cost of production leads to a 0.14 percentage increase in electricity supply at 95% of confidence in the short run, and vice versa, holding other factors constant. This observation is inconsistent with a priori expectations; an increase in the cost of production is expected to decrease electricity supply.

Price of electricity is observed to have a positive effect on electricity supply in the long run. An increase in the price of electricity leads to a 0.19percentage increase in electricity supply and vice versa, holding other factors constant. This observation is consistent with a priori expectations since increase in price from economic theory of supply is expected to increase supply.

Rainfall has a positive effect on electricity supply in the long run. In precise terms, a percentage increase in rainfall leads to a 0.01 percentage increase in electricity supply at 95% confidence level in the short-run, and vice versa, holding other factors constant.

This kind of relationship is consistent with the a priori expectations because it is expected that when rainfall increases electricity supply increases because of an increase in hydroelectricity produced.

CHAPTER FIVE
DISCUSSIONS, CONCLUSION, AND RECOMMENDATIONS

5.0 Introduction

Based on the research objectives and hypotheses, this chapter presents the discussions about the findings of the research, concludes on the research study, and offers recommendations. The objectives of the study were toexamine the effect of technology on electricity supply in Uganda, to examine the effect of cost of production on electricity supply in Uganda, to examine the effect of price of electricity (electricity tariffs) on electricity supply in Uganda and to examine the effect of rainfall on electricity supply in Uganda.

5.1 DISCUSSION OF FINDINGS

5.1.1Effect of technology on electricity supply in Uganda.

This study was to examine the effect of technology on electricity supply in Uganda and the corresponding hypothesis was that there is no significant effect of technology on electricitysupply in Uganda.

From the ARDL model, it was established that technology positively affects electricitysupply in the long run at 95% level of confidence. In this case, the null hypothesis was rejected. The implication of this result is that a 1 per cent increase in the level of technology increases the level of electricity supply in Uganda by0.83 percent.

This implies that technology is a critical factor in electricity supply in Uganda and therefore deserves policy attention. . For example in Uganda technological advancements have enabled the expansion of renewable energy sources such as solar and hydroelectric power. These sources of energy have become more cost effective overtime and making them more attractive for electricity generation hence increasing electricity supply.This result agrees with Iwayemi,(2008)and Ubi et al., (2012)who identified technology as a critical determinant of electricity supply.However ,Ogundipe et al. (2018) in their study in Nigeria , they found out that power losses and technological level exerted a significant negative impact on energy production.

5.1.2. Effect of cost of production on electricity supply in Uganda.

This study was to examine the effect of cost of production on electricity supply in Uganda and the corresponding hypothesis was that there is no significant effect of cost of production on electricity supply in Uganda.

From the ARDL model, it was established that cost of production positively affects electricity supply in the long run at 95% level of confidence. In this case, the null hypothesis was rejected. The implication of this result is that a 1 per cent increase in the cost of production increases the level of electricity supply in Uganda by 0.14 percent.

It implies that the cost of production changes with a change in the electricity produced. This is true for example for operation and maintenance costs because a power plant may deteriorate more quickly when generating electricity than when the plant is idle.Thus, requiring increased repair or replacement of parts.However, the findings of this study contradict with the findings of Nababan (2016),Sihombing (2010) and Kwakwa& Alhassan (2017).

In these studies, a negative relationshipwas established between cost of production and electricity generation implying that a 1% increase in the cost of producing electricity reduces electricity supply. A higher cost of production leads to lower supply since the resources allocated for production are fixed.

5.1.3 Effect of price of electricity on electricity supply in Uganda.

This study was to examine the effect of price of electricity on electricity supply in Uganda and the corresponding hypothesis was that there is no significant effect of price of electricity on electricity supply in Uganda.

From the ARDL model, it was established that the price of electricity positively affects electricity supply in the long run at 95% level of confidence. In this case, the null hypothesis was rejected. The implication of this result is that a 1 per cent increase in the level in the price of electricity increases the level of electricity supply in Uganda by 0.19percent.When the price of electricity increases,it becomes more profitable for electricity producers to produce and supply more.So an increase in the price acts as an incentive to invest and operate their existing plants more frequently which increases supply. This is in line with economic theory of supply by Adam smith (1776)

which says that the higher the price the higher the quantity supplied. However, the effect is minimal because generation tarrifs are negotiated and fixed for a certain period.

The finding in this study confirms findings in previous studies including those of Ubi et al.(2012) ,Adom(2016) and Sihol(2017).This is because in most of these countries for example Nigeria,electricity is supplied by a public company owned by government in which profit making is not its cardinal goal, thus price is not a critical factor in determining electricity supply.

5.1.4. Effect of rainfall on electricity supply in Uganda.

The study also examined the effect of rainfall on electricity supply in Uganda and the corresponding hypothesis was that there is no significant effect of rainfall on electricity supply in Uganda.

From the ARDL model, it was established that rainfall positively affects electricity supply in the long run at 95% level of confidence. In this case, the null hypothesis was rejected. The implication of this result is that a 1 per cent increase in the amount of rainfall increases the level of electricity supply in Uganda by0.01 percent. The results are confirmed by Wahid, (2016)and Azman et al., (2020). Their results indicated that rainfall has apositive effect on total electricity supply.

5.2 CONCLUSION

This study aimed at examining the effect of technology, cost of production, price of electricity and Rainfall on electricity supply in Uganda.

Uganda's Quarterly data was used andwas starting from the first quarter of 2009 to the fourth quarter of 2019. Gregory Hansen test was used to test for cointegration and the autoregressive distributed lag (ARDL) model was used to estimate the empirical model.

The findings indicated that technology affects electricity supply positively and this conformed to the a priori expectation. The findings also showed that cost of production has a positive effect on electricity supply and this violated the a priori expectation. Further, the findings indicated that price of electricity positively affects electricity supply. The coefficient of rainfall was found to be positive, which was expected.

This study contributes to the scanty literature on the subject of electricity supply in Uganda. Very few studies or none has attempted to model the determinants of electricity supply in Uganda possibly for the reason that, the supply-side is considered more an engineering problem.

This research study tried to fill the gap in the current literature on the subject by using aggregate electricity generation, which makes the study unique from those carried out in other countries because most studies used hydropower generation only.Although the concentration of hydropower is still significant in Uganda, the country is exploiting solar power as well on its path to energy transition.

5.3 Recommendations and Policy implications.

The government should invest in advanced technology to ensure full utilization of all forms of energy .The government can train the personnel in advanced technologies to help them to confront technical problems and adequate maintenance of power stations to help increase on supply.

The study also recommends thatintensified and sustained afforestation and reforestation implementation programmes be promoted by the government, institutions, households and individuals, the private sector, civil society and multilateral organizations in order to have sustainable amounts of rainfall hence increasing electricity supply in Uganda.

The study further recommends that electricity tariffs should be set by the forces of demand and supply to achieve equilibrium in the market, this means that cross subsidization in the electricity sector especially at distribution will not yield much.

5.4 Limitations of the Study

Lack of previous research studies on the determinants of electricity supply in Uganda . Very few studies or none has attempted to model the determinants of electricity supply in Uganda possibly for the reason that, the supply-side is considered more an engineering problem.However the research study reviewed literature from other countries such as Nigeria , Indonesia, Ghana and Pakistan to draw better conclusions on the findings.

The study focused on electricity supply at the generation and transmission segments. Uganda's Electricity Supply Industry is divided into Three (3) independent segments:Generation Transmission and Distribution.The study focused on electricity supply at the generation and transmission segments because whatever affects supply at that stage would automatically affect supply at the distribution stage.

5.5Areas recommended for further research

Future studies should focus on electricity supply by studying other varibales such as government funding and climate change on electricity supply in Uganda such that more is known about electricity supply in Uganda.

Studies should also look the drivers of aggregate electricity supply in all the East African countries to ascertain which drivers work for each of the countries.

Future studies should also look at electricity supply at the distribution segment .That is they should study the drivers of electricity supplied by Umeme to all the domestic end user

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