ELECTRICITY COST AND FIRMS PRODUCTIVITY: EVIDENCE FROM MANUFACTURING FIRMS IN AFRICA

Research project submitted to the African Center of Excellence in Energy Studies for Sustainable Development (ACE-ESD) in partial fulfillment of the requirement for the Degree of MASTERS OF SCIENCE IN (ENERGY ECONOMICS)

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DECLARATION

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

Signed…….. Date……5/11/2021…….....

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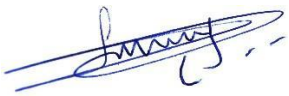
This Thesis has been submitted with the approval of my supervisor whose signature is appended against their respective names below:

Signed:  Date: November 5, 2021

Dr. Aimable NSABIMANA

DEDICATION

I dedicate this research project to my lovely son, Brighton for giving me a humble time to work on this project. My parents and siblings for always cheering me up and supporting me during my entire project period.

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May the Almighty God bless you all.

ABSTRACT

Electricity is an important component for any process of industrialization. This is because no industry, whether manufacturing or service, can grow without reliable electricity supply. Electricity deficit has a huge implication in firms output and also in the development of human capital. One concern in Sub-Saharan Africa is unreliable power supply, low access to electricity infrastructure and poor electricity networks leading to high electricity prices. All these constraints makes manufacturing sector vulnerable to unreliable electricity supply The primary objective of this study was to examine the impacts of electricity cost on manufacturing firms in selected countries in African economies. This study explored the relationship between electricity cost and firms productivity in manufacturing sectors in Africa countries from 2003 to 2016. In this paper we utilized data from WBES and apply econometric analysis to unbalanced panel of manufacturing firms consisting of approximately 7276 observations.

Using regression analysis, the results from this study indicate that high electricity cost has a negative and significant effects on firms' productivity. The analysis further explained that an increase in one unit of electricity cost reduces labour productivity and total factor productivity by 34.3% and 6.7% respectively when all the other variables are controlled. This is partially supported by descriptive statistics that 66.06% of the firms view electricity outages as a major obstacle in a firm while 33.94% view as a minor obstacle .Other control variables such as firms controls and individual characteristics used in my study have significant impacts on my outcome variable. The analysis showed that with power outages, many firms self-produce electricity using generators. Continuous power blackout leads to increased firms electricity cost due to generator use. Firms will reduce their productivity to cope up with high electricity costs. We used power outages to instrument for potential endogeneity concerns in our estimations .The results from the analysis present a strong and significant positive correlation of instrument (power outages) with electricity cost. The implication of these findings is to enhance creation of electricity infrastructure and suitable electricity price policies which will go a long way in eliminating power outages so as to promote performance of manufacturing firms' in Africa.

Key words: Electricity cost, firms' productivity, manufacturing firms

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ACCRONYMS AND ABBREVIATIONS

SSA - Sub Saharan Africa

IEA- International Energy Agency

ADB-African Development Bank

SDGs- Sustainable Development Goals

IRENA- International Renewable Energy Agency

ARDL- Auto Regressive distributed Lag

OLS- Ordinary Least Square

WBES- World Bank Enterprise Surveys

CHAPTER 1: INTRODUCTION

1.1 Background to the study

Energy has become a global strategy for any country in business today. Energy is the basic component of the social-economic development of any nation (Dinkelman T. , 2011). It is a major contributor that fuels industry, commerce, transportation, agriculture among other economic activities (Lipscomb, Mobarak, & Barham, 2013). Energy being an important component for the industrialization process. The low rate of electrification leads to the loss of some significant benefits- such as gains of in business, the employment creation (new jobs), working and studying at home opportunities and health and wellbeing improvements. Human capital development can be improved through success to electricity while its loss can be caused by electricity access deficit (Khander, Doughlas, & Hussain, 2009). For a country to industrialize, an adequate, accessible and affordable energy supply is a prerequisite.

Access to energy infrastructure and services is very low in many of African countries, especially in Sub-Saharan Africa (Avila, Carvallo, Shaw, & Kammen, 2017). Nearly, more than 700 million people in Africa live without access to modern and affordable electricity (IEA, 2015). By 2030, the International Energy Agency (IEA) estimates that—at current levels of growth in generating capacity—access to power will just keep pace with population growth (IEA 2010b). 40% of Sub-Saharan Africa countries will not reach the goal of universal access to electricity by 2050 Many African countries continue to import electricity to meet the demand subjecting them to price volatility (Guo, et al., 2020) & (Trotta , 2020). Countries that import energy bears an exponentially higher cost of electricity, high inflation, trade deficit and devaluation of the currency. One concern in Sub-Saharan Africa is poor electricity networks as a result of technical issues leading to high electricity prices.

At present, Africa's population is growing at a high rate with also the growth rate of urbanization being at a fast pace. It is projected that by the year 2050, the population will increase by about 2.1 billion people (African Development Bank, 2016).The urbanization growth rate has also increased from 14% in 1950 to 40% in 2016, and this is projected to reach 50% by 2030 and a level of 56% by 2050 (African Development Bank, 2016). The economic growth rate is expected to grow in future. However, in future, there will be challenges in the energy system due to constraints brought up by energy supply. To help stabilize the energy system in Africa through improvement of energy security, which is a prerequisite to achievement of the Sustainable Development Goals (SDGs), the adoption of renewable energy technologies is very important. African continent has huge potentials for renewable energy although the technology is least deployed and developed. However, there are concerns that the current high population growth increases the fluctuations in

energy pricing; possibly by affecting effective business investment decisions, and even water away the financial gains of various manufacturing companies.

The extent of power interruptions in SSA region is one of the highest in relation to other developing regions in the world. Normally, this is often characterized by lack of inadequate power and electricity infrastructure. Electricity supply in developing economies has been associated with inefficiency and unreliability, affecting the economic performance of firms due to disruption in power cost. Insufficient supply of electricity in Sub-Saharan countries is caused by factors such as increasing fuel cost, rapid urbanization, political instability, inefficient energy policies, poor infrastructure, corruption, and lack of private and public investment causing power outages (Moyo, 2012), (Cissokho & Seck, 2013). In most developing economies, power supply is mostly allocated to the Public sector. There is limited representation of private sector due to restrictive regulations making investors prefer to take alternative lower-risk or other investments with higher-returns (Adenikinju, 2003); (Eberhard, Rosnes, Shkaratan, & Vennemo, 2011). Lack of subsidization policies in energy sector has resulted into under-investments in the sector due to distorted prices increasing power outages (Um, Straub, & Vellutin, 2009)

The causal relationship between electricity shortages and firms' productivity has gained considerable attention in recent years (Allcott,, Collard-Wexler, & O'Connell, 2016). There is a compelling need to recognize energy cost as an important energy resource that can meet future energy needs. Many existing have indicated that there exists an inverse relationship between electricity shortage and firms' productivity (Fisher-Vanden, Mansur, & Wang, 2015) but did not identify the impact of electricity cost on profitability, labor productivity and total factor productivity especially in Sub Saharan Africa.

Energy is one of the essential component that affects the economic growth in any country since firms production is a function of capital, labour and energy. Electricity being one of the major source of energy in the manufacturing sector in SSA. In terms of primary energy consumption statistics in manufacturing sectors, electricity comprises more than 40% while coal is approximately 25%. This makes manufacturing sector vulnerable to unreliable electricity supply. Resource availability, reliability and affordability are important factors for firms' performance especially in developing economies like SSA. Most resources, such as water, minerals can be stored using storage resources (Baisa, et al., 2010). However, electricity cannot be stored. Unreliable electricity supply requires that firms respond differently to unpredictable supply since electricity is highly costly to store.

This study will contribute to the existing literature in two ways: first, is the role of electricity infrastructure in firms' performance. Little is known on the impacts of electricity access on firms (Reinikka, Ritva, Jakob, & Svensson, 2002) found that the electricity shortage reduces investment (Rud, 2012a) argues that electricity

network expansion increases firms output (Fisher-Vanden, Mansur, & Wang, 2015) shows that Firms outsource in response to shortage of electricity and (Allcott,, Collard-Wexler, & O'Connell, 2016) finds that firms revenues reduce due to electricity shortage. The missing outcome in this literature is the potential effects of electricity cost on firms' productivity and firms' response to electricity cost. Electricity cost is a vital engine of growth in the economy and identification of firms' response to electricity infrastructure is important to understand productivity in Sub-Saharan Africa. This study tries to bridge the gap of firms' growth in developing economies.

Secondly, the available literature focuses on power shortages (Rud, 2012a) and (Galadanci, 2010) found that power interruptions have negative impacts on firms' productivity. (Fisher-Vanden, Mansur, & Wang, 2015) Examined the effects of electricity shortage in china firms' performance. Estimates from (Allcott,, Collard-Wexler, & O'Connell, 2016)show that a 1% point increase in power shortages in India reduces manufacturing firms productivity by about 1.1%. Little has been mentioned about electricity cost constraints that might affect output. This paper focuses on addressing electricity cost in addition to addressing power outages when determining firms' productivity and will contribute significantly in filling the gap.

Recent studies examine the impacts of electricity shortages on various firm- and household-level outcomes (Allcott,, Collard-Wexler, & O'Connell, 2016) estimate the impacts of productivity on large manufacturing firms in India (Grainger & Zhang, 2017) used the same strategy on micro-, small, and medium Indian enterprises, (Fisher-Vanden, Mansur, & Wang, 2015) examine effects of productivity and environmental impacts on electricity shortages in China. (Foster & Steinbuks, 2008), (Alby, Dethier, & Straub, 2011) and (Andersen & Dalgaard, 2013)examine the impact of outages on firm size and technological adoption. (Samad & F, 2016) examine the impacts of power interruptions on household welfare in India and Bangladesh.

1.1.1 Electricity Situation in manufacturing firms in SSA

Table 1.1 show statistics of electricity infrastructure problem for different geo-economic regions derived from World Bank's Investment Climate Surveys Data. The statistics indicates that manufacturing firms in SSA regions experience power outages on average 10.30 making it the second highest region with number of power outages in the world and the second in terms of average duration of power outages at 6.7h. The findings from the survey also reveal that manufacturing firms in SSA region show that the expected loss is on average 5.8%. The statistics are significant for measuring firms' performance in terms of output and productivity. Statistically, manufacturing firms in SSA are the highest users of electricity from generators accounting to 26.74 among geo-economic regions.

Table 1.1: Electricity Infrastructure Problem

Region	power outages per month(Days)	Outages in hours (duration)	Output lost due to power outages (%)	Electricity from generators	Delay In Obtaining Electrical Connection
Sub Saharan Africa	10.30	6.70	5.84	26.74	31.94
East Asia & Pacific	5.19	3.14	2.76	12.31	21.65
Latin America	2.68	7.59	4.19	18.40	34.45
South Asia	42.21	4.56	10.81	25.94	48.42
Middle East &North America	2.87	3.45	4.21	16.16	49.08
World	8.48	5.56	4.86	19.77	36.68

Source: World Bank's Investment Climate Surveys Data

There have been a lot of arguable facts about the impacts of high electricity costs on firms' productivity. Firstly, the analysis presents evidence of electricity cost and firms profitability. Sub-Saharan Africa has the lowest electricity consumption per capita of 535 kWh relative to china 1123 kWh given the population difference (Khraief, Omoju, & Shahbaz, 2016). This shows that Sub-Saharan Africa lags in terms of socio - economic development and productivity in the world. This is since no economy can develop without enough electricity making the cost of electricity high in Africa. With regular power outages, firms resort to generators generating at the cost of 0.40 kWh (IRENA, 2020). Galloping electricity and generator bills have a general impact of reducing firms' profitability.

Electricity costs should be incorporated while predicting a firm's Labor productivity. High electricity costs may cause firms to shift from more electricity- intensive to less electricity-intensive industries. This will force firms to reduce labor force due to firms expenditure cut off (Abeberese, 2017). The decline in employment opportunities in the manufacturing sector of Nigeria is due to a high cost of production and inadequate power supply (Galadanci, 2010). This is because firms may lack incentives to shift to high productivity incentives having high level of technological sophistication since reliance on electricity comes

with the cost of having to rely on exorbitantly priced electricity. In a competitive economy, the electricity-supply shocks lead to larger decreases in output per worker in the competitive economy

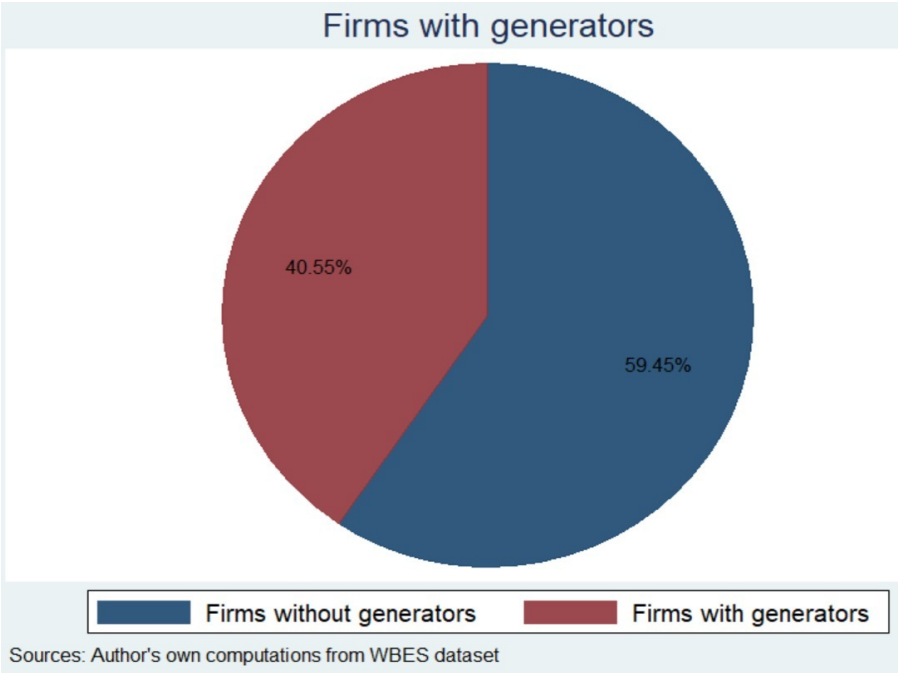

Figure 1.1: Ownership and use of generators
Source: Author's Own Computation from WBES

There is an evident negative relationship between high electricity costs and output (Allcott,, Collard-Wexler, & O'Connell, 2016) shows that manufacturing industries reduce their consumption in regards to an increase in electricity prices. Resource misallocations discourage manufacturing firms from being productive taking little growth with time (Hsieh & Peter, 2014). Firms total factor productivity will decline since labor productivity and inputs of production has reduced.

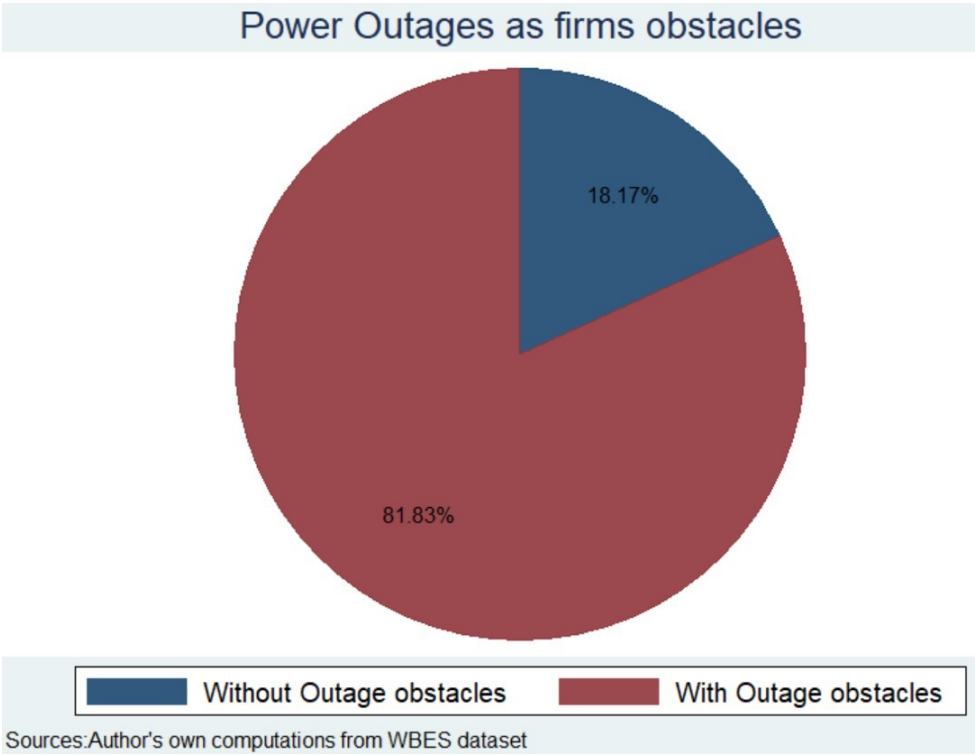

Figure 1.2: Power Outages as Obstacle to firms' performance
Source: Author's Own Computation from WBES

1.2 Statement of the problem

Unreliable electricity is widely known as a major constraint on firm productivity in developing countries. There is a greater gap between available energy resources and access to electricity in the African continent. Currently, more than 620 million people in Africa live without access to electricity. World's population is without access to electricity accounts for 12.6 percent, while about 40 percent of these depend on traditional cooking methods such as biomass (International Energy Agency, 2018). Although energy poverty patterns are uneven globally, Sub-Saharan Africa (SSA) and South Asia are the largest access deficit regions and account for 79 percent of the global access deficit (International Energy Agency, 2018)with over 80 percent of the energy-poor residing in rural areas.

Manufacturing firms in developing countries reduce their productivity due to constraints from inadequate electricity supply (World Bank Group, 2017). Sustainable electricity access has emerged as top priority to promote economic growth in developing countries. The critical issue in the development of renewable resources is the cost, which is a function of the resource availability, the geographic and topological characteristics of a studied area as well as the selected energy conversion technologies. The quantity of

delivered electricity in terms of losses between the point of generation and distribution impacting electricity cost.

1.3 Objectives

1.3.1 General Objectives

The general objective of this study is to determine relationship between electricity cost and firms productivity.

1.3.2 Specific Objectives

The specific objective of this study is;

To determine the relationship between electricity cost and labor productivity

To examine the effects of electricity cost on total factor productivity

1.4 Research Questions

What is the relationship between electricity cost and labor productivity?

Does electricity cost affects total factor productivity

1.5 Scope of the study

The purpose of this paper is to show the impacts of electricity cost on productivity of manufacturing firms in Sub-Saharan Africa. Firms' productivity is measured by indicators such as profitability, total factor productivity and labour productivity. Electricity cost is the price paid by firms for electricity consumption per year. Electricity shortages forces firms to self-generate by use of generators which are expensive sources of energy hence increasing electricity cost. Firms using generators for production will be used as controls.

The study will utilize data from World Bank Enterprise Surveys to examine the impacts of electricity cost on manufacturing firms' productivity in 6 countries in Africa from 2006-2016. To account for time and country variations in the dataset, year and country fixed effects are applied in the estimation The data set contains a comprehensive data on individual characteristics, manufacturing firms characteristics and electricity cost from random samples of medium and large firms from a set of the African countries.

1.6 Expected Outcomes and Significance of the Study

1.6.1 Expected Outcome of the Study

This study aims at providing evidence on the impacts of electricity cost on firms' productivity. Electricity shortages leads to increased demand of energy for production. Firms would respond to shortages by using

power supplied by generators. High electricity costs would force firms to shift from more electricity intensive to less electricity intensive industry. Firms will reduce their labor productivity to cope up with high electricity costs. Access to affordable electricity promotes economic development due to increased production of goods and services. On the contrary, unreliable electricity leads to reduction in productivity hence loss of profits. Firms output, labor productivity and profitability will reduce as a result of high prices. High electricity costs will negatively impact firm's productivity growth rates.

With Unreliable supply of power, manufacturing firms shift away from energy-intensive capital and divert some investments to diesel generators. Presence of credit constraints and market imperfection can lead to these inefficiencies. In a situation where alternative sources of energy restrain, firms end up sending workers home which decreases labour productivity. Most empirical results derived from different specifications and econometric methodologies highlighted the adverse effects of power outages to the performance of manufacturing firms in the western region, in terms of sales (output) and labour productivity growth rates. Unreliable power and electricity supply is widely suspected by policymakers to be the biggest problem on firm productivity in the developing economies. A lot of empirical studies of how power and electricity cost affect firm productivity and performance conclude that eliminating outages would lead to steady productivity increases.

1.7 **Organization of the study**

The rest of the chapters is organized as follows; chapter 2 review related literature on the impact of electricity cost on firms productivity and presents both empirical and conceptual framework, Chapter 3 presents the empirical model, estimation strategy, describe the dataset and variables used in empirical analysis and their measurements, Chapter 4 presents summary statistics, results and discussions of empirical findings. Lastly, chapter 5 presents the conclusion, policy implications and areas of future research.

CHAPTER 2: LITERATURE REVIEW

2 Introduction

There is an enormous body of research both empirical and conceptual on the impact of electricity cost on Firms performance. Electricity is a classic example of an input with the following characteristics (i) grid electricity is rationed and provided at a low price (ii) Firms produce their own electricity using generators to insure themselves against regular and unforeseeable power outages (iii) The cost to firms which self-generate electricity is always higher as compared to the cost of grid-connected electricity (iv) The electricity sector in most economies is highly misinterpreted, and in most cases prices are held below-market levels in developing countries. Unreliable power and electricity supply is widely suspected by policymakers to be the biggest problem on firm productivity in the developing economies. A lot of empirical studies of how power and electricity cost affect firm productivity and performance conclude that eliminating outages would lead to steady productivity increases. This paper study the implications of electricity cost in the electricity sector both empirical studies and conceptual framework.

2.1 **Empirical studies**

The effects of electricity cost has been disregarded by researchers and policy makers for a long time. It is important to understand the impacts of electricity cost on firms' productivity. This will facilitate the accurate

preparation of electricity price policy and advocacy at regional and international level. Most researchers who studied the impacts of electricity prices on economic growth and firms productivity analyzed the relationship and included electricity prices as an intermittent variable (Odhiambo, 2012), (Madhavan, Sharma, & Karunagaran, 2010) & (Bhattacharya, Paramati, Ozturk, & Bhattacharya, 2016)

With power shortages, firms experiences losses in productivity of labour and output (total factor productivity). Manufacturing firms can responds to power shortages in different ways; firstly, firms tends to make innovations when resources are scarce. For example, (Borenstein & Farell, 2007) discovered that firms in the Gold sector in USA used x-inefficiencies to cushion themselves against barriers to entry. Secondly, Firms may self-generate electricity using generators crowding out other investment opportunities, reducing productivity (Reinikka & Svensson, 2002). Thirdly, outsourcing which implies less use of labour inputs, capital inputs in production of intermediate goods. Any of these responses will lead to losses in firms output and labour productivity. Other costs will be incurred when arranging and adopting new ways of production due to outages (Jyoti, Jenkins, Gleen, Ozbafli, & Aygul, 2006)

In literature, the impacts of electricity cost on firms' productivity in Africa have not been explored. The analysis will opt to use available literature studies to base our investigation on the impacts of electricity cost on firms' performance in Africa. A study by (Abeberese, 2017) provided evidence on how electricity prices affect a firm's industry choice and productivity growth in China. He constructs an instrumental variable for electricity price to show the association between coal price and thermal generation share in total electricity generation capacity. The results showed that firms shift to less electricity-intensive production in relation to an exogenous upsurge in electricity price making firms reduces output and productivity growth rates. In this case, electricity constraints limit a country's growth by leading manufacturing firms to operate in industries with fewer output and productivity-enhancing opportunities.

(Allcott,, Collard-Wexler, & O'Connell, 2016) in their study estimated the effects of electricity cost on Indian manufacturing sectors. The study utilized supply shifts from hydroelectric power availability as an instrumental variable. The findings estimated that India's reduces the profitability from 10 to 5 percent. Electricity Shortages distort the distribution of the plant size, since it affects plants without generators hence affecting significantly generator costs.

On the other hand (Rud, 2012a) in his paper investigated the impacts of electricity provision and cost on industrialization using a panel of Indian states for 1965 to 1984. To address the endogeneity in electrification, the study introduced new agricultural technology- intensive irrigation as a natural experiment. Rud adopted available groundwater to predict and quantify the impact of electrification on industrial outcomes. Results

showed that an increase in the measure of electrification is associated with an increase of about 14% in manufacturing output for the Indian state.

Another study carried out by (Moyo, 2012) in line with specific countries in SSA. In his analysis of manufacturing firms in Nigeria, he found a negative effect of power outages on productivity. He noted that the main cause of power shortages in Nigeria are inadequate power infrastructure and poor build electricity infrastructure. He also indicated that the increase in demand for electricity by manufacturing sectors due to rapid urbanization is also another main cause of power disruptions. He proposed that there is need for deliberate efforts by governmental to improve power supply and the power infrastructure. The assessment of the effects of electricity cost on firm productivity by use of a dataset of manufacturing firms in Senegal was carried out by (Cissokho & Seck, 2013). Their findings indicated that electricity disruptions lead to increases in production costs, and that they negatively impact production efficiency of firms. They note that large firms adjust to the effects of power outages slowly compared to small firms.

The existing studies of the effects of electricity cost on firms' productivity have gained fairly impacts. (Hardy & Mccasland, 2019) found that high electricity cost reduces productivity by 10 to 13 percent in Ghana but no effects on productivity in different firms while (Grainger & Zhang, 2017) estimated decrease in productivity of less than one percent in Pakistan. (Scott, Darko, Lemma, & Rud, 2014) found that insignificant and small correlation between electricity shortage and labor productivity in six countries.

(Rintamaki, Siddiqui, & Salo, 2014) provided a comparative study of the German and Danish electricity markets. Their study examined whether renewable energy generation decrease/increase price volatility in the electricity markets in these economies. The results showed that, while wind power generation decreased the daily price volatility in Denmark, it increased the daily price volatility in Germany which contrast the conclusion of (J'onsson, Pinson, & Madsen, 2010) but confirms (Ketterer, 2014). However, they found that, solar power generation rather decreased the daily price volatility in Germany, which confirms the conclusion of (Tveten, 2013)

(Belke, Dreger, & Haan, 2010) incorporated energy prices in their study as the intermittent variable to explore the causal relationship between energy consumption and economic growth in 25 OECD countries. The data used in the study covered the period between 1981 and 2007. The results showed that different developments in different countries have a significant impact on the co-integration between real GDP and energy consumption. The Granger-causality results indicated a feedback hypothesis between energy consumption and economic growth. The results further suggested that an increase in energy prices leads to a fall in energy consumption and that economic growth affects energy prices.

(Odhiambo, 2012) Conducted a research to investigate the relationship between economic growth and energy consumption and included prices as the third variable. The study used data for three Sub-Saharan countries: Congo (DRC), Kenya and South Africa. The ARDL bounds tests revealed different results for various countries. A one-way Granger-causality flowing energy consumption to economic growth was established for Kenya and South Africa whereas the opposite direction of causality was found for the Congo (DRC). The results further showed a unidirectional causality flowing from prices to economic growth in Kenya while in the short-run, the direction of causality was found to be flowing from energy consumption to prices. The results for the Democratic Republic of Congo (DRC) described a one-way causality flowing from energy consumption to prices in the long term while in the short-term; the causality was found to flow from prices to economic growth

(Kaseke & Hosking, 2013) examined the impact of inadequate power supply on the economic performance of firms. They argued that inadequate power supply is as a results of low investment in electricity production, oil price shock, rapid population growth, political instability, conflict, and natural causes such as drought, ocean currents. They emphasized that inadequate power supply would decrease in economic growth rates and lower productivity levels in SSA. (Moyo, 2012) examined the relationship between power infrastructure and productivity of manufacturing firms in SSA. He found that poor power infrastructure adversely impacts productivity of firms – with more significant effects on smaller firms. He suggested that governments could tackle this problem by adopting suitable policies that would lead to improvements to the power infrastructure.

CHAPTER 3: RESEARCH METHODOLOGY

2.1 Introduction

This chapter describes the procedures and methodology used in carrying out the research work. It presents the methods and techniques used to solve research problem, which include (i) exogeneity checks and validation of potential instrumental variable (ii) Estimation technique for analyzing the impacts of electricity cost on firms' productivity and (iii) data and data sources. Section 3.2 presents the endogeneity and potential IV instrument, Section 3.3 estimation and identification strategy, section 3.4 present data sources and measurements.

2.2 Potential IV instrument

Regression analysis of manufacturing firms' productivity on electricity cost estimates may be biased and inconsistent due to endogeneity in prices. Endogeneity may be a result of unreliable electricity supply, transmission and distribution losses and other technical and management issues in the electricity sector. Controlling for firms fixed effect which is time-invariant may rule out potential endogeneity.

The correlation between the electricity cost and error term introduces biased estimates in OLS regression estimates (Durbin, 1984). This places the study in line with recent papers such as (Abeberese, 2017) assessed how different electricity cost affect performance of firms by using the interaction between thermal generation and retail prices of charcoal as an instrument for power outages (Dinkelman T. , 2011) constructed an instrument of terrain slope and its effect on the placement of transmission lines to assess the impact of electrification and water infrastructure on economic development while (Cavazzin & all, 2016) used the topographic layout of the hydrologic catchment upstream as an instrument for the costs of hydroelectricity to assess the impact of electrification on productivity.

Transmission and distribution of electricity can cause electricity shortages due to losses (outages). With shortages, firms tend to use generators in their production resulting in high electricity costs. The losses can emerge from technical and non-technical conditions which includes theft, inadequacy in managerial skills, network line losses, heat waves and varying weather conditions among others. They have negative impacts on the cost of electricity. To eliminate these challenges, we introduced an instrumental variable (Power outages) which need to be correlated with electricity cost and affects firms' productivity through cost. Other variables such as firms attributes was used as control variables in multiple equation setup.

The intensity of power outages is the measure of the total average number of times a firm experienced power failure in a day, month or year. Power outages can be also measured by the total number of hours a firm experience electricity blackout in a given month.

2.3 Estimation and identification strategy

To understand the impact of electricity cost on firms' productivity, we construct a regression analysis. Let fp_{ict} be the productivity outcome (including log of output, log of value- added, log of capital, log of inputs, log value added per worker) for firm *I in* country *c* at time *t,* ECt_{ict} is the cost the firm pays for electricity consumption in a year . If electricity cost was stable, we could derive the impact of electricity cost on firms' productivity ($\beta_{1)}$ by estimating the ordinary least square. This dataset also include other variables that influence the estimation of electricity cost. The statistical form of the empirical model in this study is expressed as follows;

$$\mathbf{FP_{ict} = \alpha + \beta_1 EC_{ict} + \Upsilon_i + \lambda_C + \acute{\emptyset}_t + \varepsilon_{ict}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(1)}$$

Where $\mathbf{\Upsilon_i}$ is the firm and $\mathbf{\lambda_C}$ is the fixed effect which accounts for unobserved firms and countries time-invariant differences, $\acute{\emptyset}_t$ is the year fixed effect which takes into control time variations during the survey period and ε_{ict} is the idiosyncratic error term.

However, some unobserved variables can influence firms' productivity hence making $\mathbf{(\beta_{1)\,OLS}}$ biased. To deal with such unobserved variables that can influence firm's productivity, we introduce a set of firms control ($\mathbf{FC_{ict}}$**),** Individual characteristics $\mathbf{X_{ict}}$ and estimate equation (2)

$$\mathbf{FP_{ict} = \alpha + \beta_1 EC_{ict} + FC_{ict} + X_{ict} + \Upsilon_i + \lambda_C + \acute{\emptyset}_t + \varepsilon_{ict}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(2)}$$

With FC_{ict} firms fixed controls such as number of years the company started, years it has been in operation,, number of employees, number of skilled employees, number of permanent and contractual employees; X_{ict} is the individual control statistics such as education level of firms top manager, gender and experience level of firms top manager.

Endogeneity

Having outlined our methodology, we analyze critically the possibility of endogeneity and how we can address it. Electricity cost is endogenous and might correlate with variables in our error term. Due to unreliable electricity infrastructure, some firms may have access to unreliable power supply while other may have access to reliable power supply. This makes some manufacturing firms experience outages while others may not. Due to unreliable power supply, they tend to use electricity from generators to ensure continuity in their production. Electricity from generators are relatively expensive than grid-connected due to high cost of

generators and fuels. Regression analysis of manufacturing firms' productivity on electricity cost estimates may be biased and inconsistent due to endogeneity in prices. Firms which experience power outages tends to have high cost of production. The high cost of production will directly affect electricity cost and indirectly affects firm's productivity.

However, even though we have all these controls in our model as shown in equation (2), firms experiencing power outages will have to pay higher electricity cost. Therefore, having varying electricity costs leads to additional biases when examining the impacts of electricity cost on firms' productivity. To eliminate those challenges we instrument our power outage measure as the number of days a firm experience power blackouts in a given month. For each firm i in country c at time t, we construct an instrument as the total days power outages occur in a firm in a given month as;

$$Z_{ict} = bj * PO_{ict} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where Where $\mathbf{ZC_{ict}}$ is the instrument (measuring number of days a firm experience power outages in a month) bj is a subset of (0 1) for manufacturing firms without generators and firms with generators respectively.

To eliminate endogeneity in prices, I incorporate power outages in my regression analysis. The system of equation and first stage regression is estimated below as follows;

$$\mathbf{EC_{ict} = \alpha_0 + \alpha_1 ZC_{ict} + \alpha_2 P_{ict} + rk_{ict} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)}$$

Where $\mathbf{ZC_{ict}}$ is the instrument, $\mathbf{P_{ict}}$ is the set of controls (all controls in equation 2) and $\mathbf{rk_{ict}}$ is the error term which is uncorrelated with electricity cost. By setting the regression equation and identification conditioning all controls, the regression analysis will be unbiased and does not affect our outcome variable.

Equation (4) is the first stage regression equation where log of electricity cost is regressed against interactions of total day's power outages occurring in a firm in a given month and all the other covariates. Since we have a panel of firms, we are able to control for time-constant unobserved heterogeneity which may bias the results from cross-section studies if these unobserved factors correlate with electricity cost.

The coefficient of interest, β1, is an estimate of the change in the electricity price paid by the firm as a results of number of days a firm experience power outages in a month. This provides some assurance that our results are not influenced by endogeneity in varying electricity costs and rule out the possibility of biased estimates. Overall, our analysis shows that once the possible endogeneity between electricity cost and firms productivity has been taken into account, the estimate (β1) is unbiased.

2.4 **Data and variable Measurement**

The study will utilize data from World Bank Enterprise Surveys to examine the impacts of electricity cost on manufacturing firms' productivity in 6 countries in Sub Saharan Africa from 2006-2016. The manufacturing firms covered in this study include; textile, food, wood and furniture, electronics, machinery and equipment's, non-metallic sector among other manufacturing sectors. The study utilized the panel data from World Bank Enterprise Surveys and covered samples from six African countries (Kenya, Zambia, Cote d' Ivoire, Mali and Uganda) with 7276 observations.

The variable of interest is electricity cost and firms performance. Electricity cost is the rate paid by firms for the kilowatt hours of energy consumed. Apart from electricity cost, there are other variables that directly impact firm's productivity. They includes, firms attributes (Firm size, firms age, number of permanent versus temporary employees, skilled versus unskilled employees) and individual characteristics (managers education, managers gender, managers experience level). Some firms uses generators to cushion themselves against power shortages. We measure our productivity variables like total factor productivity by regressing total sales on capital inputs, labor inputs and material inputs total sales, number of material inputs while total labor productivity by dividing output per period by total number of employees.

Generator dummy takes the value 1 if a firm owns or uses generator and zero otherwise. Firm's age is calculated as the difference between the year of firm establishment the firm and the year of survey. To take into account for time and country variations in the dataset, year and country fixed effects are applied in the estimation. The results were estimated using OLS regression analysis. Power outages are controlled in our model. Power outages is our model is defined as the total number of days in a particular month a firm lacks electricity; number of hours a firm goes without power and the total loss in the firm due to power outages. With power outages, firms tends to use generators which are relatively expensive than grid-connected due to high cost of generators and fuels. This will directly affect electricity cist and indirectly affects firm's productivity.

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CHAPTER 4: DATA ANALYSIS AND PRESENTATION OF FINDINGS

This section presents a comprehensive analysis of statistical and panel data adopted for analysis to establish appropriateness of our strategy. In section 4.1 we examine the firm attributes and descriptive statistics on the key variables, section 4.2 presents relationships between key variables and output variable, section 4.3 presents the findings of the econometric analysis.

3.1 **Descriptive Results**

Table 4.1.1: Firm attributes and descriptive Statistics on the key variables

Variables	Mean values	Standard Deviation	Minimum	maximum
Ln elecost (electricity cost)	7.94	2.50	0	18.2

Temporary employees	17.21	42.8	0	487
Permanent employees	18.02	37.3	0	408
Productive employees	26.23	55.7	0	900
non_production employees	13.18	32.4	0	500
Unskilled employees	14.34	38.2	0	500
Temporary employees	17.21	42.8	0	487
exp_level (experience level)	13.83	9.50	0	61
Skilled employees	24.72	52.1	0	700
Manager education	5.03	2.20	1	12
Firms size	0.17	0.37	0	1
female	0.13	0.34	0	1
Electricity obstacle	0.83	0.36	0	1
Labour obstacle	0.51	0.49	0	1
Workforce obstacle	0.60	0.48	0	1
Secondary certificate	0.85	.035	0	1
N	7276			

Source: Authors own computation using data from WBES

Table 4.1.1 shows the descriptive statistics for all regression variables used in the study. The mean value for one unit of electricity cost is estimated at 7.94 and this deviates from the actual values by 2.5. Some firms don't pay for electricity because they exclusively use generators. The maximum unit of electricity paid my firms is on average 18.2 units. 83% of the firms argued that electricity is a major obstacle to the firms' performance. This is in relation to unpredictable power outages which leaves resources idle in the equilibrium. When the power is not available firms will tend to idle productive capital especially if they lack generator capital. When the power is available, firms will tend to leave generator capital idle. This is because the marginal cost of grid connected electricity is lower than electricity from generators (self-generated) electricity. From a sample of 7726 observations, 51% argued that labour is an obstacle while 60% stated that workforce is a major obstacle to the firm's productivity.

On average the manager's level of experience is 13 years with maximum experience level being 61 years with low variability between the variables. The firm size is a measure of the number of total employees employed in manufacturing firms. We introduced a dummy variable 1 if the firm has more than 100 employees and 0 if otherwise. From the findings 17% of the firms interviewed has more than 100 number of employees. There is high variability of firms with number of temporary employees and skilled employees. 85% of the top level managers has either secondary certificate, diploma certificate, university degree or master's degree, 25% don't have any certificate. In terms of the gender of top level manager, 13% of the firms are women-led while 87% of the firms are men-led. The values deviates from the actual means by 0.34.

In terms of skilled employees, on average a firm has 24 numbers of skilled workers and 14 unskilled employees. On average 17% of the total employees in most firms are permanent while 18 are temporary employees.

3.2 **Analytical Analysis**

Figure 4.2.1 show the relationship when female is a top level manager with both labour and factor productivity. Our main findings is that the contribution of female managers is significantly negative to labor productivity of the firm. This is due to the fact that few female led firms- than male-managed firms knows how to protect their firms from crime and power outages leading to high marginal utility of labor. Additionally, female-lead firms are less capitalized and have lower labor cost than male-lead in manufacturing sectors. Finally, our findings confirms results by (Hallward-Driemeier, 2013) that female managed enterprises, with labor productivity being approximately 11 percent lower among female- than male-lead firms. In addition, findings by in (Aterido & Hallward-Driemeier, 2016) confirms that participation of women led top manager in decision making is strongly related to a negative labor productivity than men-led firms.

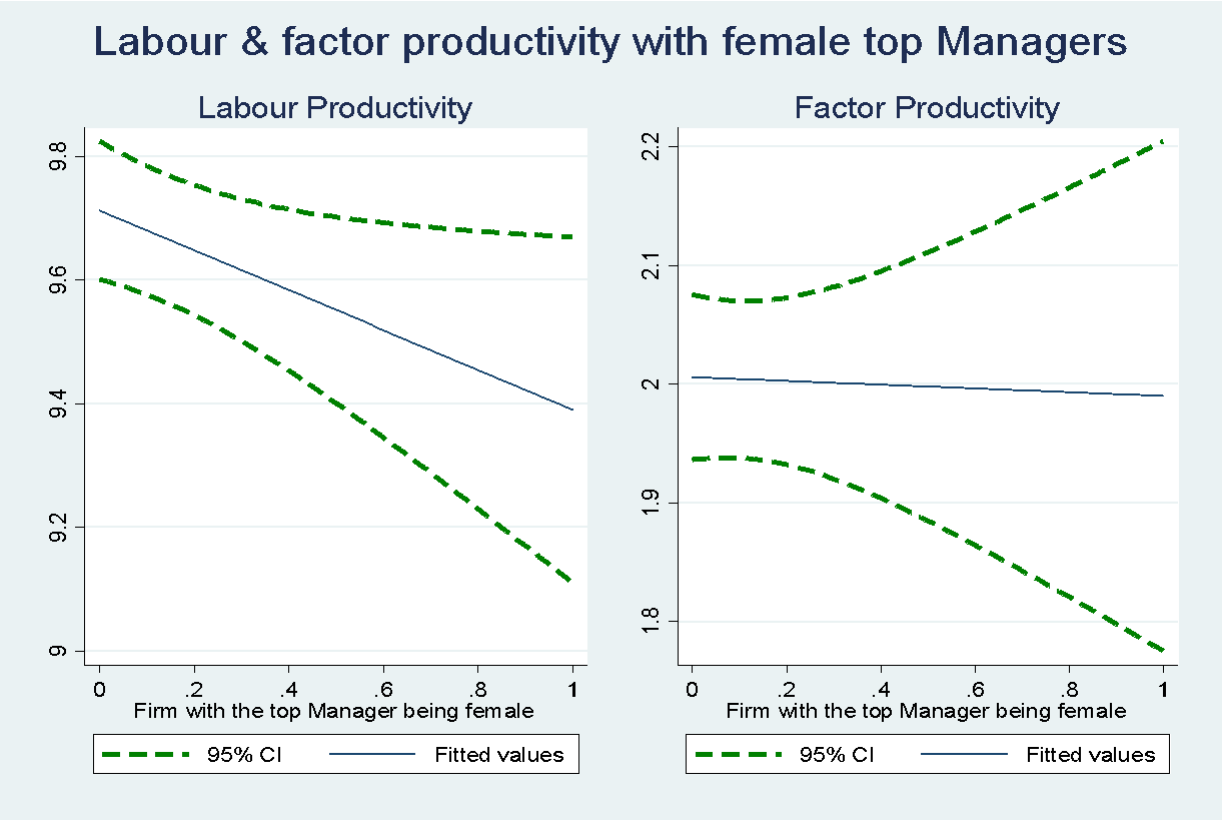

Figure 4.2.1: Labour and Factor productivity with Female as Top level Manager

Source: Authors own computation using data from WBES

The results from this study shows that female led firms have a negative relationship with total factor productivity of the firm. The proportion of women among top executives are more risk averse compared to men which can make productivity negative when it comes to evaluating financial and investment decisions making them not to invest in some profitable businesses. Female lead firms are less likely to have additional investment (capital) and smaller in size than male-managed firms. This generally tends to have a negative impact on firms total factor productivity.

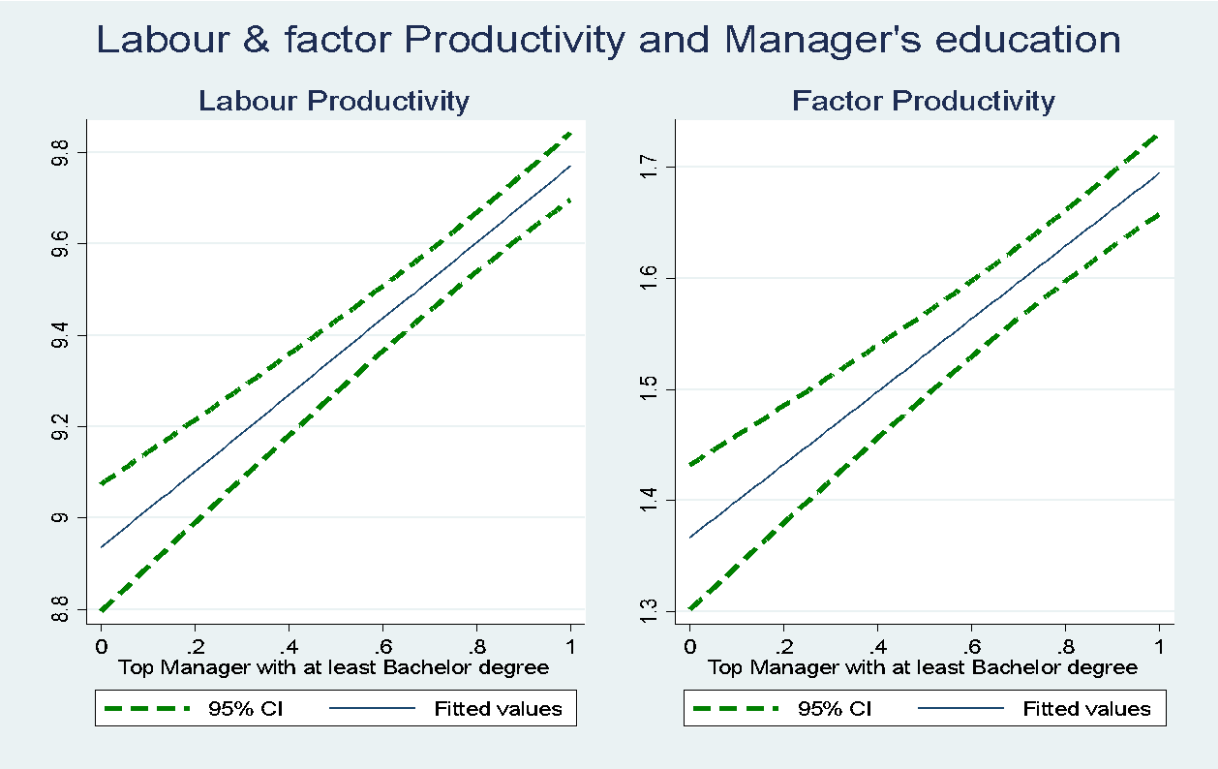

Figure 4.2.2 Labour and Factor productivity with Managers Education

Source: Authors own computation using data from WBES

Figure 4.2.2 shows the relationship between manager's education and both labour and factor productivity. The findings from the study show that the positive firms performance effects are mainly associated to managers with a university degree while managers who do not hold a university degree have a much smaller or insignificant effect on firm performance. The justification applies in both labor and factor productivity, with later having widespread variation.

An educated manager has a higher work efficiency through education which increase work value in addition. With education, a manager is likely to contribute more to production of firms output and effective management of workers. Education plays a positive role through endogenous technical progress and competitive diffusion to improve know how through innovation and imitation (Sarquis & Arbache, 2021).Education is a necessary condition to realize total factor productivity, productivity of labour and firms' growth due its contribution to both creativity and innovation. Manager with higher education level have the knowledge to manage effectively firms factors of production such as tangible and non-tangible assets. This studies confirms the findings of (Hua, 2015)that higher proportions of highly-skilled workers relative to low skilled workers would be expected to lead to higher growth.

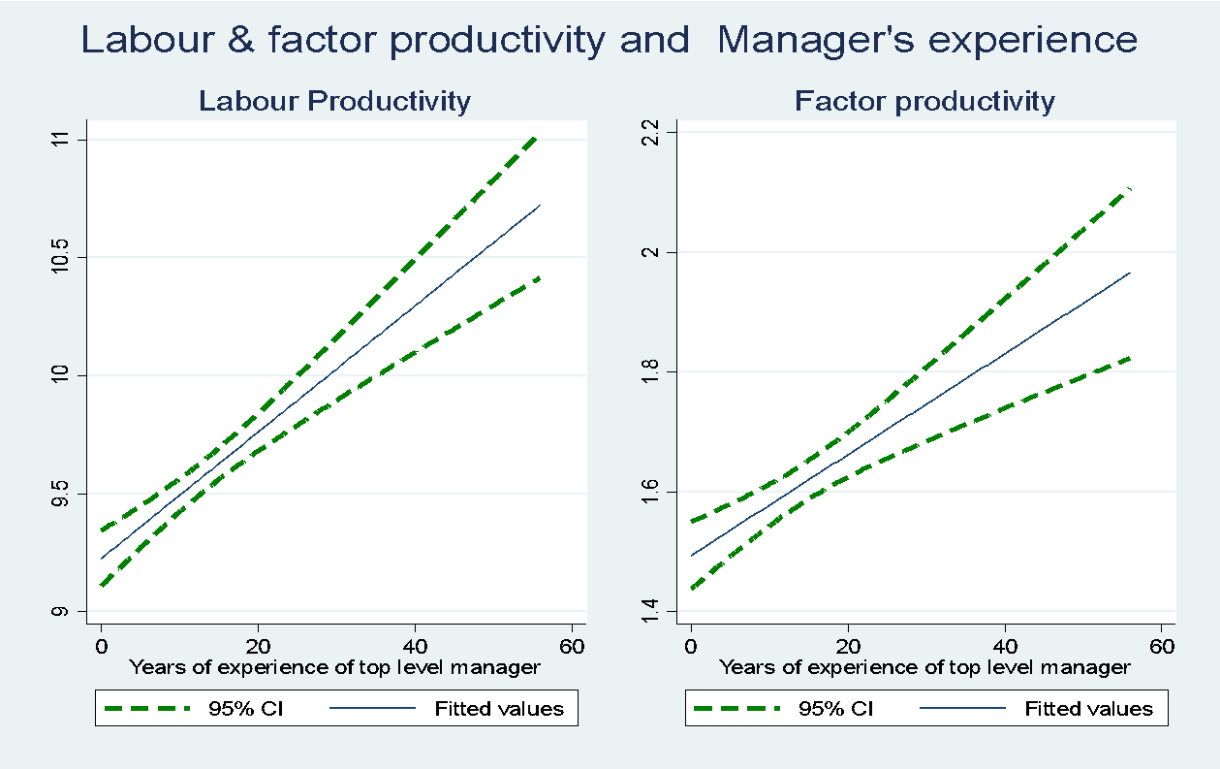

Figure 4.2.3 Labor and Factor productivity with Managers Experience

Source: Authors own computation using data from WBES

Figure 4.2.3 shows that both labor productivity and total factor productivity has a positive relationship with managers experience. That is with experience, managers are most likely to influence firms profits through devising strategies for greater sales and output in the firm. Managers acquire training, knowledge and skills through various work experience. Manager with many years of experiences provides a better productivity. It is a presumption that a managers who has worked in one or more positions with a company are more productive. They tend to have a standing record of past achievements and good business management skills that makes them valuable to the firm. Mostly, experienced managers understands best procedures to increase firms sales and output to realize profits in a firm

The findings suggests that experience in the role of a management , not only organizational, planning, directing, staffing and controlling experience have a huge impact on managers performance and in general firms performance. These experiences would likely help managers performs tasks in many areas including: setting goals and strategies for decision making, effective interactions with clients, employees and relevant stakeholders in organization, monitoring productivity, inventory and financial handling in all departments of a firm, leading and understanding different problems the organization, and motivating staffs. Length of experience of a top level manager has a positive linear with labor productivity.

3.3 **Econometric Analysis**

Table 4.1.2 shows that the relationship between electricity cost, labour productivity and total factor productivity is negative. The variable of interest in this study is electricity cost and its interaction with labour and total factor productivity. The argument in this study shows that increase in electricity cost reduces the profitability of production and marginal productivity of labour and capital. The above results largely supports other studies such as ((Abeberese, 2017) & (Kessides, 2003). The results shows that high electricity cost reduces labour productivity by 34.3% and total factor productivity by 6.7%. Electricity cost variable is positive and significant with the size of the firm. This is partially supported by descriptive statistics that 66.06% of the firms view electricity outages as a major obstacle in a firm while 33.94% view as a minor obstacle (see figure 3 in the appendix).

Table 4.3.1 : OLS regression of Electricity cost, Labour and firm Factor Productivity

Variables in the model	Log of Labour productivity	Log of Factor productivity
Log of electricity cost (Frws)	-0.343***	-0.067
	(0.087)	(0.075)
Firms size (number of staff)	0.799**	0.913**
	(0.325)	(0.417)
Firms age (years of existence)	0.033**	0.014
	(0.015)	(0.009)
Number permanent employees	-0.010***	0.009***
	(0.003)	(0.003)
Years of experience	0.008	-0.014
	(0.018)	(0.013)
Female Manager in Firm	-0.053	0.440*
	(0.510)	(0.240)
Constant	6.771***	1.989**
	(1.451)	(0.761)
Observations	3,116	2,073
R-squared	0.552	0.249
Country FE	YES	YES
Wave FE	YES	YES

*Notes: This is the Ordinary regression. The outcome variables are log of labour productivity and factor productivity, respectively. We have controlled for the country and year of survey fixed effects to deal with heterogeneous differences across countries and year of surveys. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Individual experience in relation with the flexibility of working time influences positively firm's labour productivity (Eldridge & Nisar, 2011). The findings from our studies indicated that additional year of

experience increases labour productivity by 0.08% and can relate well with the recent studies. The negative relationship between employment length with both labour productivity and factor productivity is a "pessimistic" notion that when firms faces competition, they tend to lay-off workers with more length of employment. The findings rejects the notion that with high employment length comes with job resilience and flexibility, worker personal assessment performance, employer provision of versatile work practices which is associated with higher firms performance and productivity (Bloom, Kretschmer, & Van, 2009)

The findings from this study depicts that small firms tend to have lower productivity and low labour productivity. Mostly, small firms are flashed out of market due to high prevalence of high electricity cost. With power outages, small firm are unable to expand their production. Studies by (De & Nagaraj, 2014) found that large firms are more productive than small firms due to economies of scale, better access to government credit facilities and political clout. Recent studies by (Hallward-Driemeier & Steward, 2004) and (Dollar, Hallward-Driemeier, & Mengistae T, 2005) noted that lack of access to infrastructure in developing countries is a major obstacle to manufacturing firms, especially for small firms. Larger firms often have better market knowledge and resources, and the realization of economies of scale would render them less vulnerable to market shocks or crisis (Moyo, 2012).

The findings from the study shows that women being top level managers increases the total factor productivity by 4.4%. The results are in line with recent studies (Prommin, Jiraporn, & Jumreornvong, 2014) and (Safdar, Ullah, Nausheen, & Alia, 2021) .This is in relations that Women managers have the potential capacity to recognize in general the overall results of financial decisions such as making the suitable decision on cash management, available investment opportunities, and precautions for financial and budget plan. However, female-led firms are smaller than male-led firms, and less likely to pay for security or use a power generator. These factors contribute to negative impact on labour productivity (Islam, Gaddis, Palacios, & Amin, 2018)

Labour composition in firms measured by the number of skilled employee and productive employees, is expected to relate positively with firms' productivity. Our findings indicate a positive relationship with firms' productivity. It states that one percentage increase in number of productive employees increases labour productivity by 25% while one percentage increase in number of skilled employees increases labour productivity by 14%. This is in line with recent studies done by (Blundell, Dearden, Meghir, & Sianes, 1999). This is since human capital normally derived from training and education enhance firms' competitiveness and growth of productivity.

3.4 **Validation of Instrumental variable**

This section present the results of instrumental variable validation and reliability. Validity in terms of drawing important and valuable inferences from the survey instrument, while reliability of the instrument checks whether all the constructs are consistent with item responses (Creswell, 2014). The direction of correlation between firm productivity and electricity cost has been extensively elaborated in table 4.3.1,however, it suffer from potential endogeneity in electricity cost. Consequently, as stated in this discussion various firms might experience power outages while others may not. In relation to this, the direction of causality is the reverse (negative), i.e. firms which experience power outages are less profitable than firms which don't experience outages.

In order to deal with problems of potential endogeneity in equation (4), we estimate the models by the use of an instrument variable approach. The potential concern arises when power outages correlates with firms output and other explanatory variables. The validity of this instrument lies in two important criteria; (i) relevance that requires an IV to be correlated with regressor (electricity cost) and (ii) Instrument to affect firms productivity indirectly though electricity cost. The results of first stage regression in Equation (4) is presented in table 4.3.3 where log of electricity prices is regressed against interactions of total day's power outages occurring in a firm in a given month and all the other covariates. The first step is to examine if power outages is correlated with electricity cost and other covariates.

Table 4.4.1: The first stage: Monthly outages and electricity cost in the firms

Variables	(1)	(2)	(3)	(4)
Days of outages in a month	0.018*	0.018*	0.034*	0.033*
	(0.010)	(0.010)	(0.018)	(0.019)
Firms size		0.752***	0.554***	0.482**
		(0.125)	(0.195)	(0.194)
Firms age		0.046***	0.046***	0.046***
		(0.004)	(0.007)	(0.007)
Female manager			-0.346	-0.332
			(0.270)	(0.259)

Secondary certificate				1.806***
				(0.487)
Constant	8.106***	7.335***	7.774***	6.075***
	(0.079)	(0.092)	(0.183)	(0.491)
Observations	2,210	2,176	2,210	2,210
R-squared	0.077	0.159	0.146	0.165
Country FE	YES	YES	YES	YES
Wave FE	YES	YES	YES	YES

Notes: This is the first stage regression. The endogenous variable is the total cost of electricity within the firm while the treatment variable is the number of days per months the firm incurred the outage. The outcome variables are log of labour productivity and factor productivity, respectively. We have controlled for the country and year of survey fixed effects to deal with heterogeneous differences across countries and year of surveys. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The results from the analysis shows a very strong and positive association between electricity cost and power outages. The findings indicates that with power outages in any day in a month, firms tends to use electricity generated from generators which are highly priced compared to grid connected electricity price. The findings supports the arguments that power outages impose additional economic costs on the firm by generating opportunity cost associate with idle labour and machinery. Hence, the strong positive association between electricity cost and power outages in a firm. The findings are consistent with those of (Fisher-Vanden, Mansur, & Wang, 2015)

The regression results in column (1) shows that the coefficient for the instrument is positive and statistically significant. The coefficient indicates that one day of power outages in a month increases electricity cost by 1.8%. In column (2) we controlled for other variable (firms characteristics) that might correlates with electricity cost. The relationship of the coefficient remains positive and significant. In the (3) column, I controlled for individual characteristics and the co-efficient remains positive and slightly bigger than the estimate in column 1 and 2. The coefficient of instrument changes a little and is positive with the inclusion of both firms and individual controls. In terms of magnitude of 0.034 in coefficient of instrument in column (3), it implies that one day of power blackouts increases electricity cost by 3.4%, after controlling for the level of education.

The results from this analysis depicts that electricity prices is strongly correlated with power outages and other variables that vary with electricity cost. The sign, significance and magnitude of instrumented power outages is not affected by addition of other controls (individual controls and firms characteristics). This provides some assurance that our results are not influenced by endogeneity in varying electricity costs and rule out the possibility of biased estimates.

Table 4.4.2: Second stage: The effect of Electricity cost on firm yield & firm performance

Variables	Labour productivity	Labour productivity	Factor productivity	Factor productivity
Ln elecost (electricity cost)	-1.021	-1.075	-0.259	-0.318
	(3.314)	(3.510)	(0.758)	(0.997)
Firms size	1.253	1.147	0.643	0.682
	(1.920)	(1.746)	(0.673)	(0.829)
Firms age	0.073	0.070	0.021	0.024
	(0.153)	(0.150)	(0.043)	(0.055)
Female manager	-1.218	-1.219	-0.237	-0.289
	(1.205)	(1.231)	(0.870)	(1.093)
Secondary certificate		3.071		0.399
		(6.693)		(1.397)
Constant	17.670	15.291	3.859	3.976
	(25.934)	(21.415)	(6.247)	(6.977)
Observations	3,116	2,073	3,116	2,073
Country FE	YES	YES	YES	YES
Wave FE	YES	YES	YES	YES

Notes: This is the Second stage regression. The instrument is the number of days per months the firm incurred the outage while endogenous variable is the total cost of electricity within the firm. The outcome variables are log of labour productivity and factor productivity, respectively. We have controlled for the country and year of survey fixed effects to deal with heterogeneous differences across countries and year of surveys. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Having confirmed the validity of our instrument in Table 4.3.3, in Table 4.3.4 we present the results of second stage analysis in which power outages is instrumented with firm's yield and performance using data from WBES. Two outcome variables are used; total factor productivity and total labour productivity. In the second stage we include the instrumented power outages to control for possibility that power outages might influence firms yield and performance.

The analysis depicts a negative associations between power outages and firms productivity. This is due to the fact that with power outages, firms tends to continue operating using expensive electricity that they self-generate using generators. The use of electricity from generator affects the overall firms performance, causing increase in production cost, reduction in produced quantities which will eventually decrease sales and firms productivity. This results supports findings from other studies that shows that power outages affect

negatively firms total factor productivity and labour productivity. The findings are consistent with those of (Foster & Steinbuks, 2008), (Terjesen, Couto, & Francisco, 2016)

The sign and magnitude of the results are consistent with the results from OLS. The results shows that one day of power outages in a month reduces both total factor productivity and total labour productivity by 1.02 units and 0.259 units respectively. The impacts of power outages on firms productivity are negative and consistent even if the sample size is subjected to some firms and individual controls. When firms power outages is regressed against firm's productivity and education level of employees is controlled, the results still remains consistent. The magnitude implies that one day with black out reduces the units of total factor productivity and factor productivity by 1.07 and 0.318 units respectively. The results depicts that power outages affects firm's productivity only through electricity cost. The instrument coefficient with different controls remains negative and consistent (with slight variations) but not statistically significant.

CHAPTER 5: SUMMARY, CONCLUSSION AND RECOMMENDATIONS

The general objective of the study was to analyze the impacts of electricity cost on manufacturing firms' productivity. The study used the estimation strategy and econometric analysis to examine the impact of electricity cost on firms performance in selected countries in SSA. This paper utilize data from the WBES database, comprising of observations on manufacturing firms found in SSA region, to carry out the empirical analysis. The analysis covered six countries in Africa economies with a total of 7726 manufacturing firms. Firm productivity is depicted through two main indicators: total factor productivity and labour productivity. Unreliable power supply results to power outages disrupting electricity cost in manufacturing firms in different countries. Power outages has serious implications on overall firms productivity leading to increase in economic cost, reduction in quantities produced and eventually decrease in total factor productivity, output and labour productivity.

Results from this analysis provided evidence that an increase in electricity cost has a negative impacts on firm profitability, labor productivity, and total factor productivity. The analysis further explained that an

increase in one unit of electricity cost reduces labour productivity and total factor productivity by 34.3% and 6.7% respectively, when all the other variables are controlled. The experience level of top level manager, gender and education level has implications on firms' productivity. Both experience and education level are associated with positive relationship while the gender (female led) is associated with a negative relationship with both productivity of labour and total factor productivity. Firms' characteristics and attributes such as the total number of skilled, unskilled, age of the firm, total number of permanent versus temporary employees in the firm and firm size have significant implication on firms' productivity.

The estimation from this studies indicated that 81.3% of the sample viewed power outages as a major obstacle on firms' performance while 59.45% of the firms owns generators as for backup electricity in case of electricity failure. The analysis showed that with unreliable electricity supply, many firms self-produce electricity using generators. Grid connected electricity is substantially less costly than self-generated electricity for firms due to both the high cost of the buying generator equipment plus the high cost of the fuel. Continuous power blackout leads to increased firms electricity cost due to generator use. The study addressed the potential endogeneity in electricity cost by taking into account the effects of power outages. The results are quantitatively and qualitatively significant with a positive and constant coefficient with electricity cost.

The importance of this study of unreliable electricity supply and high-priced electricity cost on firms' productivity depicts the need to reform energy sector and improve electricity infrastructure in Sub-Saharan region. All these improvements should coincide with suitable policies and regulations at firms, country and regional level. Moreover, energy sector need increases in public investments, and allows participation of participation of the private sectors.

Future research studies needs to focus the non-technical impact of electricity cost on firms' performance. The study should address the potential endogeneity in electricity prices by taking into account the impacts of managerial and political interference on firms' productivity and performance. This is to get a clear picture of the magnitude of impact between technical and non-technical issues in energy sector and devise a suitable policy.

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APPENDEX

Table A.1: Data and data Sources

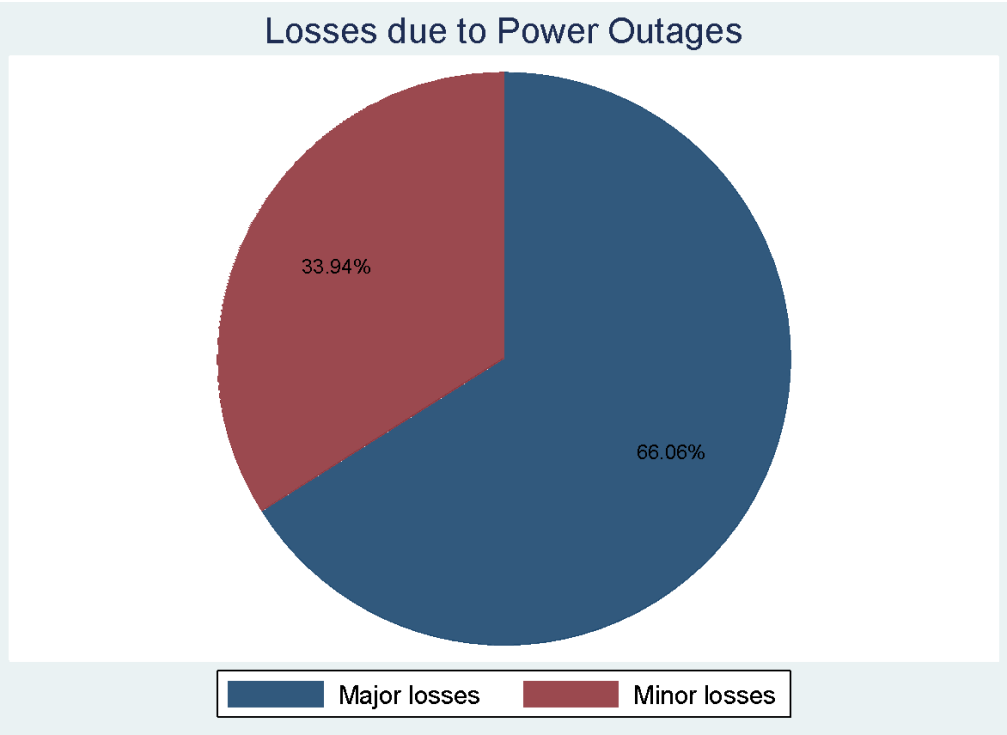
ata	**Measure/Indicator**	**Computation**
ependent Variable ● Firms productivity	● Value added ● Output	Total sales revenue less inputs(material plus intermediate)
Productivity indicators ● Labor productivity ● Factor Productivity	● Gross profit Margin	Gross profit/sales*100
	● Net profit Margin	Net profit/sales*100
	● Operating profits margins	Operating profit/sales*100
	● Value added per worker	Total output per period divided by total number of employees
	● Capital ● Labor ● Inputs	OLS regression of output on log of capital, log labor and log inputs
ummy variable	**1** if used generator	**0** otherwise
ontrols	**Firms characteristics**	Size of the firm Number of employees Skilled and unskilled employees Years of firms operation Permanent versus contractual employees
	Individuals Characteristics	Education level of top manager Gender of top level manager Experience
ndependent Variable	**Electricity cost**	Prices paid by firms for electricity consumption in a year

Table A. 2: Mean Values of various Electricity infrastructure in Countries under my study

Countries	Days with power outages in a month	Duration of Outages (hours)	Output lost due to power outages (%)	Electricity produced from generators
Kenya	**5.9**	4.3	9.1	15.3
Mali	4.8	3.3	10.2	13.4
Cote d'Ivoire	4.1	2.9	8.6	21.7
Uganda	10.2	7.1	15.5	23.1
Zambia	5.1	2.3	12.3	18.7

Source: Authors own computation using data from WBES

Figure A.1: Annual Losses due to power Outages



Source: Authors own computation using data from WBES

Figure A. 2: Map of African Countries Used in study

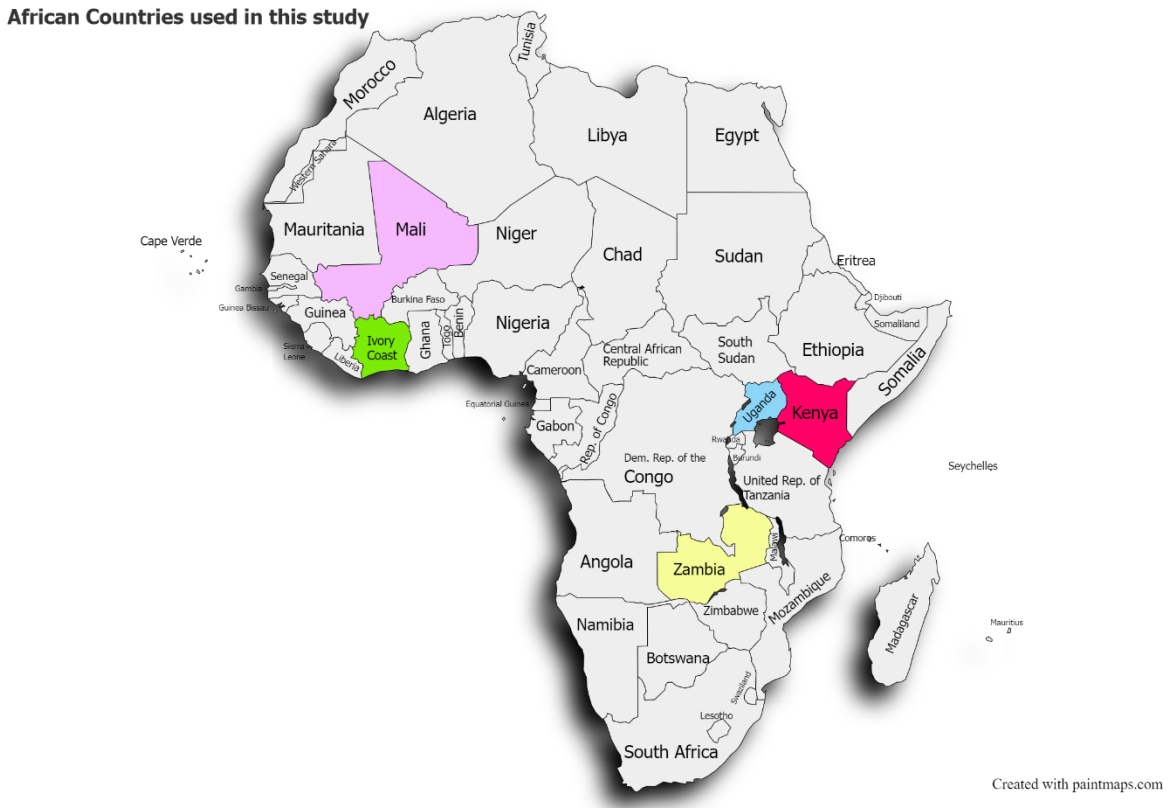
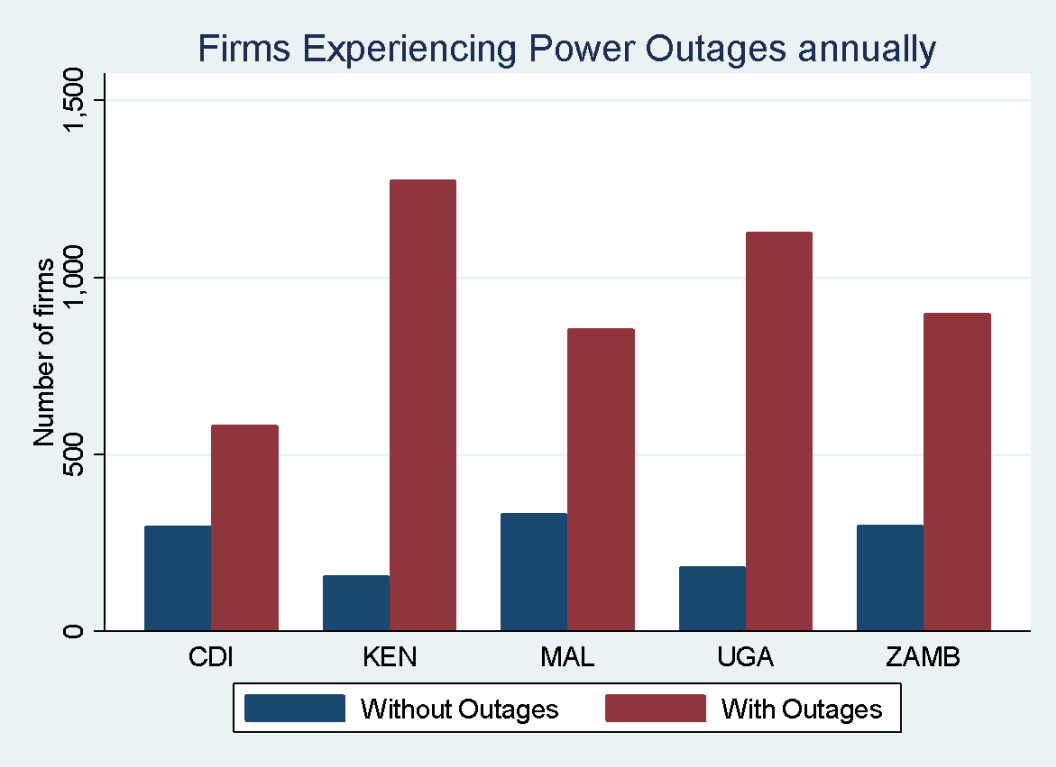


Figure A. 3: Number of Firms experiencing outages in countries used in the study



Source: Authors own computation using data from WBES