

RURAL ELECTRIFICATION AND MICROENTERPRISES PERFORMANCE: SOME
LESSONS FROM MURANGA COUNTY KENYA

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DECLARATION

This research project is my original work and has not been submitted for the award of a degree in any other university.

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This research project has been submitted for examination with my approval as university supervisor.

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DEDICATION

I dedicate this work to the Almighty God and to my family for their encouragement and support throughout my studies.

ACRONYMS

IEA	International Energy Agency
KM	KiloMetre
KNBS	Kenya National Bureau of Statistics
MEs	Micro Enterprises
MW	Mega Watts
REA	Rural Electrification Authority
REP	Rural Electrification Program
SMEs	Small and Micro Enterprises
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa

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ABSTRACT

The purpose of this study was to assess rural electrification adoption by microenterprises in Muranga County Kenya. The study was guided by two specific objectives which are; to establish the determinants of rural electrification adoption by Micro and Small enterprises in Murang'a County, Kenya and to determine the effect of adoption of rural electrification on the performance of rural micro and small enterprises in Murang'a County, Kenya. This study adopted two stage least squares incase of violation of endogeneity. The population of this research consists of the 650 small and medium enterprises in Murang'a. The study used primary data. Results revealed that, amount of capital invested, nature of business activity and distance from market significantly influenced the predicted probability of electricity adoption. Results also revealed that electricity adoption was positive and significantly related with business performance. The results also indicated that gender, capital invested and workforce were positively and significantly related to business performance. It is recommended that Murang'a County should conduct business incubation programmes for businesses so as to boost the business performance/turnover as well as the capital invested. This will have a positive effect on electricity adoption since well performing businesses are likely to adopt electricity. They should also assist the businesses to get funds from youth fund and women enterprise fund and this will increase the capital. The study also recommends that Murang'a County and electricity providers should encourage electricity adoption through conducting awareness campaigns that would sensitize small business owners on the value brought about by electricity adoption.

Key words: *Electricity Adoption, Business performance, Probit, Two stage least squares*

CHAPTER ONE

INTRODUCTION

1.1 Background

Rural electrification can be defined as the provision of electricity to areas of Low demand and highly dispersed potential consumers. Electricity can be supplied to such areas through small-scale auto generation, local independent grids, or a central regional or national grid (Cecelski et al., 2009). Electricity is the backbone of socio-economic development of any country and is associated with provision of numerous services to people which directly enhances their quality of life. However, in today's world this situation becomes bit complex as not only continuous supply of electricity is important but it is equally essential to generate it in a green fashion.

There is little doubt that access to and use of electricity is a benefit to people, not only in the current electricity-dependent world but also in developing rural areas. While electricity may not bring development on its own it is a highly desired commodity and a prerequisite to rural development in long term perspective. In the first industrial countries massive electrification was initiated in the 1880's, to be completed only decades after the World War II; a huge effort backed by powerful institutions. The challenge is now to spread the same technologies in emerging economies with often very different institutional, cultural and financial conditions. One such region is sub-Saharan Africa where the electrification level is minute, especially in rural areas (Ahlborg et al., 2011).

It is universally accepted that electrification enhances quality of life at household level and stimulates economy at a broader level. The immediate benefit of electrification comes through improved lighting, which promotes extended hours of study and in turn

contributes to better educational achievements. Lighting can also benefit other household activities, such as sewing by women, social gatherings after dark, and so on. Electric gadgets such as radios and television improve the access to information by rural households and can provide entertainment to family members. In addition, economic activities of household, both inside and outside, improves as a result of use of electricity. For example, crop productivity can be increased by the application of electric irrigation pumps, businesses can be operated longer hours in the evening, electric tools and machinery can impart efficiency and productivity to industrial enterprises, and so on (Khandker et al., 2009).

Rural electrification projects are often justified because they are intended to promote household welfare by providing a better quality of life or more productivity. This view along with the significance of other sources of modern energy has resulted to modern energy being recognized as essential to fulfilling the Millennium Development Goals (United et al., 2005).

Lack of access to a reliable energy source is a major impediment to sustainable development in developing countries and to the harmonious progress of the global society. He believes that all nations on earth have a right and should have the means to pursue these benefits. This will become increasingly important in a world where opportunity is disproportionately divided between the industrialized countries of the northern hemisphere and the poorer nations farther south. Wider access to electricity in developing countries will be a key requirement for narrowing the north-south gap. He also states that if electricity is to truly promote human progress in developing countries, then the problem of rural electricity supply must be addressed (Khatib, 2006).

1.1.1 Rural Electrification in Kenya

The Rural Electrification Authority was established under Section 66 of the Energy Act, 2006 (No 12 of 2006) as a body corporate. The Authority was created in order to accelerate the pace of rural electrification in the country, a function which was previously undertaken by the Ministry of Energy. Its mandate is to accelerate the pace of rural electrification in order to promote sustainable socio-economic development. The REA efficiently provide high quality and affordable electricity connectivity in all rural areas and to achieve high standards of customer service through advancing community participation to ensure long term sustainability and socio-economic development (REA, 2014).

The total installed electricity generation capacity of Kenya at the moment is 1243 Mega Watts (MW) out of which 761 MW (65%) is generated through hydro power plants. Thermal electricity generation sources contribute 419.6 MW (30%), geothermal makes 163 MW (12%) and sugar factories contributes 26MW (1.9%) respectively. Since, Kenya is located across the equator; therefore, it has huge potential for utilizing solar energy as a source of electricity generation. Two main methods that are adopted in rural electrification program in Kenya are grid extensions (for integrated areas) and stand alone diesel operated / solar photovoltaic systems for areas located far from national grids. The master plan for the project was completed in 2009 in which 20,000 public installations were identified which were in need of electrification. Till now, 12,000 installations have been supplied with electricity (REA, 2014).

The Government of Kenya is the basic supporter of this initiative. REA is currently focusing on developing framework for the promotion of photovoltaic solar panels among

rural households and private sector and is open to have collaboration in this regard with foreign investors. This project is a practical example for the promotion of renewable energy sources at grass root level and the changes that it can bring into the lives of masses. However, the project still primarily relies on fund from government and foreign investors. There is a dire need to increase the market value of this project so that it would be able to generate revenue to sustain and grow further in years to come (REA, 2014).

1.1.2 Microenterprises in Kenya

Globally, Micro and small enterprises (MSEs) have been accepted as the means through which accelerated economic growth and rapid industrialization have been achieved (Harris & Gibson, 2006). In most developing countries, MSEs are generally regarded as the driving force of economic growth in job creation and poverty reduction. In Kenya, according to the Economic Survey (2006), the sector contributed over 50 percent of new jobs created in the year 2005 but despite the challenges of failure of at least three out five within the first few months of operation. (K N B S, 2007). Despite the challenge, the sector has generated income and provided a source of livelihood for the low income in the country accounting for 12-14 % of GDP (Ngugi et al., 2012). According to Maundu (2007), the term Jua kali is a term derived from two Kiswahili words 'Jua' meaning sun and 'kali' meaning hot which is synonymous with micro enterprise that employ between one ten employees including the owner.

According to Boswell, (2003), Growth of micro and small scale enterprises depends on the changing industry patterns and management; Storey, (2004) states that the growth of an enterprise is influenced by the background and the strategic decisions taken by the owner/manager. Kibera (2000) reaffirms that micro and small scale enterprises are

engaged in a number of business activities characterized by the economic and political environment existing in the country. McMohan (2001) feels that business growth and performance by human capital outcomes are correlated. Starting and operating a small business includes a possibility of success as well as failure. Lack of planning, improper financing and poor human resources management has been suggested as the main causes of failure of small enterprises.

Numerous research on challenges facing micro-enterprises cite lack of planning, improper financing and poor human resources management as the main cause of failure of growth small business in Kenya (Longneck, 2006). A simple management mistake like over or under employment is likely to lead to death of the enterprise (Kings & MacGrath, 2002). While the government has put good policies in place, it is imperative to note that entrepreneurs do not take the challenges in engaging qualified human resources to produce high quality goods and services, hence their goods are rejected in preference for high quality goods (Kibas, 2012). According to Jay & Barry, (2004), human capital remains as one of the necessary ingredients not only for production but also for an enterprise's survival.

1.2 Problem Statement

Electricity service is one of the factors, which may have both a direct and indirect impact on small micro-enterprises development. Despite the importance, contributions and potential of Micro-enterprises in the Kenyan economy, there are several factors that hinder their establishment, growth, decline and closure. One of the factors, which may contribute to these problems is grid electricity services, because without available and reliable electricity services there is no possibility of utilizing modern electrical

appliances, welding kits, and machinery which may pave the way to small and cottage industries. There also no convenient lighting in businesses such as bars and retail shops, which reduces the number of customers.

Maleko (2005) conducted a study on the impact of electricity services on microenterprise in rural areas in Tanzania and found out that there is a possibility of rapid emergence and development of MEs in rural areas of the same characteristics as Kilimanjaro region if the electricity services supplied should be available, reliable and affordable to most of rural poor. Abdullaha et al (2009) investigated the major issue impeding the rural electrification programs in rural Kenya (high connection payments) and found out that the government needs to reform the energy subsidies, increase market ownership and performance of private suppliers, establish financial schemes and create markets that vary according to social-economic and demographic groups. Ahlborg et al (2011) conducted a study seeking to establish the specific drivers and barriers for rural electrification and off-grid solutions in Tanzania and Mozambique and found out that there existed country-specific institutional, financial and poverty-related drivers and barriers to grid and off-grid electrification. However none of the study focused on the determinants of rural electrification adoption by microenterprises in Muranga County Kenya. This is the research gap that this study wishes to address.

1.3 Objectives of the study

1.3.1 General Objective

The general objective of this study is to establish the determinants of rural electrification adoption by microenterprises in Muranga County Kenya

1.3.2 Specific Objectives

The specific objectives that shall inform the conduct of this study are as follows;

- a) To establish the determinants of rural electrification adoption by Micro and Small enterprises in Muranga County, Kenya.
- b) To determine the effect of adoption of rural electrification on the performance of rural micro and small enterprises in Muranga county, Kenya.

1.4 Value of the Study

The study will be of value to Small and micro enterprises as they will be able to appreciate the impact of electrification on their growth and profitability drawing from the best the study recommendations. The lessons brought out in the study can be used by the operators of the micro enterprises to improve operations. The findings of the study will also encourage specifically those who prospect to start up their own micro enterprises.

In the development of government policy papers, the role of the micro enterprises in the growth of the economy has been brought out. The policy makers will be able to know how well to incorporate the sector and how effectively to ensure its full participation. The suggestions from the study would lead to new orientation in formulation and implementation of policies affecting micro enterprises which could enhance micro enterprises services in Kenya.

Murang'a County Government will benefit from the findings of this study. The results of this study will reveal the extent to which micro enterprises have benefited from rural electrification. This will be a spur to even increased electrification leading to establishment of new micro enterprises and growth of the existing micro enterprises.

Finally, the results of the study will contribute towards filling the information gap on the subject matter. It is hoped that the findings of the study will make valuable additions to the literature in the field of SME electrification and stimulate further interest in the field of small and medium enterprises electrification.

CHAPTER TWO

2.1 Introduction

This chapter will discuss theories relevant to the study. Literature related to the study is also reviewed with the aim of identifying literature gaps. The literature review will also guide the relevance of the study findings.

2.2 Theoretical Review

This section focuses on theories relevant to the study.

Diffusion of Innovation (DOI) Theory, developed by E.M. Rogers in 1962, is one of the oldest social science theories. It originated in communication to explain how, over time, an idea or product gains momentum and diffuses (or spreads) through a specific population or social system. The end result of this diffusion is that people, as part of a social system, adopt a new idea, behavior, or product. Adoption means that a person does something differently than what they had previously (i.e., purchase or use a new product, acquire and perform a new behavior, etc.). The key to adoption is that the person must perceive the idea, behavior, or product as new or innovative. It is through this that diffusion is possible. New information technologies represent innovations for potential adopters: “an idea, practice, or object that is perceived as new by an individual or other unit of adoption.”(Rogers, 1995).

One popular and enduring conceptualization of innovation adoption behavior is Rogers’ theory of the diffusion of innovations. Although the overall theory is rich and complex, its essence views the innovation adoption process as one of information gathering and uncertainty reduction. Information about the existence of an innovation, as well as its characteristics and features, flows through the social system within which adopters are

situated. Potential adopters engage in information seeking behaviors to learn about the expected consequences of using the innovation. An assessment and evaluation of this information manifests itself in the form of beliefs about the innovation, and is then a proximal antecedent of adoption behavior. The theory also contains predictions regarding the spread of an innovation through a social system, i.e., the diffusion process, which is postulated to follow S-shaped curve. The S-shaped curve of cumulative adopters gives rise to a bell-shaped distribution of adopters. Rogers utilizes this distribution to distinguish between five categories of adopters – ranging from “innovators” to “laggards” – derived from their time of adoption of the innovation. Based on a meta-analysis of findings from a wide range of studies in several innovation domains, he also offers several generalizations regarding early adopters versus the rest related to the socioeconomic status of adopters, personality characteristics, and communication behaviors (Burkhardt et al., 1990).

This theory is relevant to this study as it is related to adoption of electricity by micro enterprises.

Adam Smith (1723) defined economics as follows: “Economics is the science of wealth”. He was the author of the famous book “Wealth of Nations” (1776). Adam Smith was of the view that economics was concerned with the problems arising from wealth-getting and wealth-using activities of people. He was interested mainly in studying the ways by which the wealth of all nations could be increased. The relevance of Adam Smith's writings was in advocating for large investments of capital and use of large scale machinery in a bid to produce wealth on a large scale.

This theory is relevant to this study as it shows how wealth could be increased by SMEs. It is through large investment of capital and use of large scale machinery. Rural electrification requires large investment of capital. Once rural electrification is adopted, it is expected to facilitate use of large scale machinery to produce wealth.

2.3 Empirical Literature

This section reviews general literature and studies from prior scholars regarding the rural electrification and the performance of microenterprises.

2.3.1 Adoption of Rural Electrification on the Performance of Rural Micro and Small Enterprises

The development of micro-enterprises in rural areas is linked with the increase in access and use of grid electricity services, leading to changes in micro-enterprises, and changes in livelihood characteristics of entrepreneurs, employees and community members in areas where these enterprises located.

Bose et al (2013) conducted a study aiming at evaluating the impact of electricity availability on the operation and performance of SMEs in the rural areas of Bangladesh. The results were based on a study from a survey carried out in two electrified villages in Paikgacha, Khulna. The study detected favorable changes on the production costs, profit margin, development and modernization of business, women empowerment, quality of life, and human development due to the electrification.

Muhoro (2010) conducted a study seeking to identify the factor that affect rural electrification in rural western Uganda. The study used both quantitative and qualitative methods, including informal surveys, intra-business energy allocation studies and

historical analysis, to analyze off-grid electricity access among micro-enterprises. Data was obtained from 56 micro-enterprises located in 11 village-towns within 3 districts in Uganda. Findings showed that Micro-enterprises in rural Uganda created income for the poor; they acted as resources for poverty reduction. Further findings indicated that without subsidies, credit-based sales and better financing options, it is unlikely that access to electricity will increase beyond the levels established in the existing cash market.

Peters et al (2013) investigated the impact of electricity on the performance of micro-enterprises by comparing the performance of firms in grid-covered and non-covered villages in Northern Benin. The study used firm-level data while the empirical analysis employed Propensity Score Matching techniques. Findings revealed that beneficial impacts are found from firm creation after electrification, firms that existed before showed an inferior performance compared to their matched counterparts from a non-electrified region. However, the performance gap was insignificant.

Maleko (2005) carried out a study in Tanzania and sought to find out the effect of adoption of electricity on the performance of microenterprises. Result revealed that the growth rate of micro-enterprises were noticeably higher in areas with electricity services than in areas without electricity services, but the proportion was low compared to micro-enterprises growth rate and time of electricity introduction. Fifteen micro enterprises owners (15) out of forty-three (43) interviewed said they had added at least one permanent employee since its establishment because there are enough activities and long working hours, which needed assistance from these permanent staff. In addition, the establishments of new branches/expansion of micro-enterprises within and outside the studied areas were observed. For instance, in Foo village, Hai district small Kiosk was

selling salt and kerosene but the business grew into many branches within the village and now there grain-milling machines, sunflower oil extraction machines and wood workshop, all these used electricity services for production.

Decline and closure of micro-enterprises was observed in the study area at a very low rate. These declines of business were caused by high competition and market saturation. Introduction of electricity services created more MEs of the same nature without having a good plan for the markets of their products. This ended up with market saturation. The market saturation caused low turnover, low saving from electricity services and high running costs (Maleko, 2005).

There is evidence that access to electricity services in rural areas in the developing world has lead to technological change in existing ME's. For example, in rural areas of Indonesia some shoes workshops changed from the use of manually operated machinery to electrical machines with an associated enhancement of productivity (Smyth, 2004). In Philippines, many ME's activities transformed their technical and economic efficiency by going over to modern technology powered by electricity.

In Brazil and Mexico, the spread of electrification into rural areas stimulated an expansion of rural ME's activities through subcontracting, particularly of clothing and textiles production operations. Evidence of the impact of electricity from Elandskraal, Northern province in South Africa pointed out that electricity was a potential input for upgrading the condition of the ME's economy (Rogerson, 2007). Also Fakira (2004) used Elandskraal experience which provided strong support for the argument that the provision of electricity is an important precondition for the emergence and growth of diversified, dynamic small micro-enterprises.

A study undertaken in Namibia about impact of rural electrification on social–economic development showed that electricity services did not seem to have had a significant impact on growth of income generating activities (Wamukonya et al., 2001). The findings from the same study showed that the share of households with home-based income generating activities was highest among un electrified households. Furthermore, few home- based enterprises use electricity for income generating activities, and when they did, mainly made use of electricity only for lighting. None of the businesses using electricity started after rural electrification and hence electricity service could not have been the driving factor behind the establishment of the new micro-enterprise (Wamukonya et al., 2001).

Foley (2009) concluded that availability of modern energy services, particularly electricity, has had only a modest impact on creation of small industries. In addition, an increase in economic activities and higher living standards due to arrival of electricity was observed. Hence, it can be concluded that electricity service is among the factors needed in influencing the decisions of local entrepreneurs to invest in a variety of productive enterprise. However, due to lack of reliable information about impact of electricity services on MEs development, many local entrepreneurs have little use of electricity services for production.

Abdullaha et al (2009) investigated the major issue impeding rural electrification programs in rural Kenya (high connection payments). The study used estimates obtained from a stated preference study, namely a contingent valuation method completed in 2007, to examine the willingness to pay to connect to grid-electricity and photovoltaic services. The key findings suggested that the government needs to reform the energy subsidies,

increase market ownership and performance of private suppliers, establish financial schemes and create markets that vary according to social-economic and demographic groups.

Ahlborg et al (2011) conducted a study seeking to establish the specific drivers and barriers for rural electrification and off-grid solutions in Tanzania and Mozambique. The study was done across a stakeholder spectrum. It was part of a larger research effort, undertaken in collaboration between Swedish and African researchers from natural, engineering and social sciences, aiming at an interdisciplinary assessment of the potential for an enhanced utilization of available renewable sources in off-grid solutions. By qualitative methodology, data was collected in semi-structured stakeholder interviews carried out with ten national level energy sector actors. Findings revealed that there existed country-specific institutional, financial and poverty-related drivers and barriers to grid and off-grid electrification.

Chaieb et al (2011) conducted a study seeking to identify whether community perceptions affects rural electrification in parts of Tunisia. The study was conducted using participatory rural appraisals (community interviews and investigations) to discover the perceived benefits of introduced access to electricity in Tunisian communities. Linkages were discovered between rural electrification and the areas of education, basic health, family planning, and women's reproductive health. Many families had purchased (and now consistently watch) televisions, which prompted intellectual expansion, expose women to political happenings, and introduce families to messages concerning personal hygiene and health. Findings revealed that communities' perception increased economic

opportunities for women, who were choosing to sew or open hair-salons at home rather than travel to urban areas in search of work.

Barfour, (2013) conducted a study seeking to establish the barriers to rural electrification in Ghana. The results showed that there existed various challenges which include: level of the rural people; high cost of grid extension to thinly populated and remote areas; lackluster acceptability of off-grid systems; ownership, management and operations of renewable systems especially mini grid; inadequate funding from government budget; low level of electrification levy and lack of private capital lack of commitment of the utilities.

Hisaya et al (2011) explored intra-state disparity in access to electricity and examined the determinants of electrification at the village level in Bihar, one of the underdeveloped states in India. Data was collected through field survey of 80 villages in 5 districts conducted in 2008–09. The econometric analyses demonstrated that location is the most important determinant of a village's electricity connection. Results showed that 48 villages (60%) were electrified. Further finding revealed that rapid progress of rural electrification under the recent government program and the tendency to connect the villages that are easily accessible, the collective bargaining power of the village, which used to significantly affect the process of electrification, had lost influence. This adversely affected remote villages. The researcher recommended that the government needs to consider other options for sustainable electricity supply, such as decentralized distribution of electricity rather than the conventional connection through the national/local grids so as to extend electricity supplies to remote and geographically disadvantaged villages.

Nanka (2010) conducted an analytical study of the socio-economic factors which have a significant impact on rural electrification development in sub-Saharan Africa. The study employed cross-sectional data for 24 of the 47 countries in the sub-Saharan region. Findings revealed that there existed several factors which include the Human Development Index, wealth distribution, institutional development and urban population size of a country to have a significant impact on rural electrification development. A detailed policy survey of four countries from the sample; two countries categorized as over-performing (Nigeria and Madagascar) and two as under-performing (Tanzania and Chad), highlighted that collaboration with international partners, integration of national policies and strategies and the use of renewable energy sources enhanced the development of rural electrification in sub-Saharan Africa.

2.3.2 Rural Electrification on the Performance of Microenterprises

The SMEs worldwide are recognized as a key contributor to economic growth. There are few factors found to be critical for accelerating SMEs in any country. Rural electrification is one of those key factors. Rural electrification is well recognized as one of the important pre-requisites in uplifting living standards of the geographically and economically disadvantaged communities in developing countries (Chaurey, 2004; Bhattacharyya, 2005). It also assists the business conduction of diversified types of businesses.

Microenterprises can be distinguished according to the nature of activities and type of energy services they use for production or performing their services. Micro-enterprises such as brick burning, local beer brewing, ceramic firing, salt drying, fish drying and smoking, and charcoal production depend on biomass fuels as a source of process heat. Other micro-enterprises like retail shops, salons, restaurants and bars, wood processing,

welding, depend on electricity services for lighting, refrigeration, entertaining customers (playing Radio, Music systems and Television), cooking, baking, shaft power, grain grinding and oil processing (Sawe, 2003).

In Tanzania, the electricity consumers identified in four districts located in rural areas (Same, Sumbawanga, Njombe, and Babati) can be classified as light commercial and light industrial. However, most light commercial industries do not really depend on electricity for their operation. The light industries like welding workshops and garages use electricity for running electric motors and for lighting. The average electricity consumption for these small industries is higher, ranging between 394 to 924 per month while for the residential and light commercial consumers; the range is between 100 and 200 per month (Kjellstrom, 2002). Based upon the observations made in four rural villages by Kjellstrom and co-workers, they concluded that productive uses of electricity have resulted in a modest expansion of small-scale industries. In Sumbawanga, a small factory, making nuts, screws and bolts had been established after electrification. In Kilimanjaro, six industrial projects had been started after electrification (Kjellstrom, 2002).

There is evidence that access to electricity services in rural areas in the developing world has led to technological change in existing microenterprises. For example, in rural areas of Indonesia some shoes workshops changed from the use of manually operated machinery to electrical machines with an associated enhancement of productivity (Smyth, 2004 and Rogerson, 2007). In Philippines, many Microenterprises activities transformed their technical and economic efficiency by going over to modern technology powered by electricity.

Micro enterprise activities such as beauty parlours, photocopying, ice making and battery charging in Indonesia came into existence after electrification. In rural Peru, a similar experience of the growth of new retailing microenterprises was observed and there was a definite positive correlation between use of electricity and the emergence of new commercial establishments (Rogerson, 2007). In Brazil and Mexico, the spread of electrification into rural areas stimulate an expansion of rural ME's activities through subcontracting, particularly of clothing and textiles production operations.

2.4 Summary of Research Gaps

The above chapter reviews the various theories that explain the independent and dependent variables which are in a bid to inform the two research objectives. The chapter also entails previous studies on in line with the objectives. The next chapter contains research methodology.

A review of literature indicates that several conceptual and contextual research gaps exists. For instance, the studies by Kjellstrom, (2002), Muhoro (2010), Nanka (2010) and Hisaya et al (2011) have a contextual gap since they did not cover specifically the determinants of electrification of Micro Enterprises in rural areas. Other studies, for instance Bose et al (2013), Chaurey (2004); Bhattacharyya (2005), Maleko (2005), Peters, Vance et al (2013) have significant research gaps in terms of concepts as they addressed the impact of rural electrification on the performance of SMEs but failed to address the determinants of rural electrification adoption. In addition, all the mentioned studies focused on other geographical areas and ignored Muranga County. The environmental dynamics of Muranga are unique and different from others hence the need to concentrate on Muranga county.

CHAPTER THREE
METHODOLOGY

3.0 Introduction

This section presents the model, how it is estimated and how it can be used to project rural electrification on the performance of micro enterprises for the longer time-horizons.

3.1 Model Description

This study presents both the theoretical model and empirical model. The theoretical model is a collection of concepts and their hypothetical interrelationships. Theoretical model borrowed heavily from theories presented in literature review. The empirical model on the other hand is the econometric model that is modified from theory.

3.2 Theoretical Model

This study adapted two theories in a bid to inform the two research objectives. The first research objective was informed by theory of innovation. Specifically, Rogers diffusion of innovation theory informed the determinants of adoption of electrification by Rural MEs.

The second objective was informed by theory of economic growth advanced by Adam Smith in the Wealth of Nations. The theory of economic growth lays emphasis on large investment in capital for the purpose of creating wealth. The theory of economic growth is exemplified in a cobb douglas production function setting. In this theory electrification of Rural MEs is taken as a factor of production.

$$Y=F (K, L).....(1)$$

A general production function relates economic activity (measured in terms of output or income) to a set of economic variables with, at least, an implicit direction of causality flowing from these variables to economic activity. The analysis was presented in the framework of a simple neoclassical production function. In this framework, it is assumed that output is determined by a Cobb-Douglas production function of the form;

$$Y_t = A_t L_t^\alpha K_t^\beta + e \quad (2)$$

3.3 Empirical Model

The first empirical model was as follows

$$\text{Prob(adoption)} = \alpha + \beta_1(\text{entrepreneur characteristics}) + \beta_2(\text{business characteristics}) + \beta_3(\text{geographical characteristics}) + e \dots\dots\dots(3)$$

$$Y_1 = \alpha + \beta_1 X + \beta_2 Z + \beta_3 G + e \dots\dots\dots(4)$$

$$Y_1 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 Y_2 + \beta_5 Z_1 + \beta_6 Z_2 + \beta_7 Z_3 + \beta_8 G_1 + \beta_9 G_2 + e \dots\dots\dots(5)$$

The dependent variable was;

$$Y_1 = \text{Prob (adoption of electricity)}$$

X is a matrix of entrepreneurial characteristics

$$X_1 = \text{Education}$$

$$X_2 = \text{age}$$

$$X_3 = \text{gender}$$

Z is a matrix of business characteristics

Y₂= Business Performance

Z₁= Capital of the Business

Z₂= Number of Employees

Z₃= Nature of Business

G is a matrix of geographical characteristics

G₁= Distance to Shopping Centre

G₂= Distance to nearest transformer

β₁..... β₉, are the beta coefficients

e= error term

The second empirical model will be:

Performance (sales) =α+ β₁ (entrepreneur characteristics) + β₂ (business characteristics)
+e

$$Y_2 = \alpha + \beta_1 X + \beta_2 Z + e \dots\dots\dots(6)$$

$$Y_2 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 Y_1 + \beta_5 Z_1 + \beta_6 Z_2 + \beta_7 Z_3 + \beta_8 Z_4 + \beta_9 G_1 + \beta_{10} G_2 + e \dots\dots\dots(7)$$

The dependent variable was;

Y₂= Performance (Sales)

X is a matrix of entrepreneurial characteristics

X₁= Education

X₂= Age

X₃= Gender

Z is a matrix of business characteristics

Z₁= Capital of the Business

Z₂= Number of Employees

Z₃= Nature of Business

Y₁= Adoption of Electricity Use

Z₄= Intensity of Electricity Use

$\beta_1, \dots, \beta_{10}$, are the beta coefficients

e= error term

3.4 Measurement of Variable

Various variables included in the model were measured and operationalized. Variables were categorized according to the type of variable, measurement whether dependent /independent and expected sign.

Table 3.1: Operationalization

Variable	Variable Prefix	Type of Variable	Measurement	Dependent/Independent	Expected Sign
Adoption of Electrification	Y ₁	Binary	Yes/No	Dependent	
Performance of SMEs	Y ₂	Continuous	Sales in shillings	Dependent	
Entrepreneur characteristics					
Level of education	X ₁	ordinal	Academic institutional category	independent	+
Age	X ₂	ordinal	Age bracket	independent	+
Gender	X ₃	binary	Male/female	independent	+
Business characteristics					
Capital of the business	Z ₁	continuous	Ksh	independent	+
Number of employees(labor)	Z ₂	discrete	Number	independent	+
Type of business	Z ₃	ordinal	Service or non service oriented	independent	Ambiguous
Intensity of Electricity use	Z ₄	continuous	Cost in Kenya shillings	Independent	+
Geographical characteristics					
Distance to the shopping center	G ₁	continuous	Km	independent	-
Distance to the nearest factory	G ₂	continuous	Km	independent	-

3.5 Econometric Methodology

Probit regression was used for the first model while OLS was used for the second model. The choice of probit regression is justified by the observation that the independent variable is categorical in nature and hence suitable for probit analysis.

The dependent variable for the second model is a continuous random variable and hence suitable for estimation using OLS.

3.5.1 Normality Testing

Normality testing involved checking for outliers in data, data that had outliers exhibited significant skewness. A histogram was used to display the extent of skewness.

3.5.2 Heteroscedasticity Test

Heteroscedasticity checked whether the error term is constant across the observations. The condition was corrected by applying corrected standard errors/robust standard errors.

3.5.3 Endogeneity

Endogeneity exist when the X matrix is correlated with the error term. This called for use of instrumental variables and the consequent estimation of the model using two stage least squares if endogeneity is found to exist.

3.5.4 Probit Regression

After correcting for heteroscedasticity and endogeneity, probit regression was run for the first model.

3.5.5 Ordinary Least Squares Regression

After correcting for heteroscedasticity and endogeneity bias, OLS regression was run for the second model.

3.6 Data Sources

The population of the study was 650 registered SMEs operating in Murang'a County. The sampling frame was a list of registered MEs operating provided by Murang'a Council.

A sample is a subset of population (Hyndman, 2008). According to Mugenda and Mugenda (2003) a large population of more than 10,000 requires a formula to come up with the sample. Determining a final population for a large population is assumed to be normally distributed at a confidence interval of 95% or significance interval of 5%. Based on the formula below the minimum target sample for a large population is 384 cases.

The sample for a large population is determined using the formula given as;

$$n = Z^2 * p * (1-p) / d^2$$

Where:

n = Sample size for large population

Z = Normal distribution Z value score, (1.96)

p = Proportion of units in the sample size possessing the variables under study, where for this study it is set at 50% (0.5)

d = Precision level desired or the significance level which is 0.05 for the study

The substituted values in determining the sample size for a large population are as follows.

$$n = \frac{(1.96)^2 * (0.5)(0.5)}{(0.05)^2} = 384$$

$$(0.05)^2$$

Therefore, the sample size was 384 respondents.

Given a population of 650 which is less than 10,000, the following formula was used to adjust the sample size.

$$n_0 = n / (1 + ((n - 1) / N))$$

$$242 = 384 / (1 + ((384 - 1) / 650))$$

This study used primary data collection instrument for data collection. A likert scale questionnaire was used to gather data. The study administered the questionnaire individually to all respondents of the study. The study exercised care and control to ensure all questionnaires issued to the respondents were received and to achieve this, the study maintained a register of questionnaires, which were sent and received. The questionnaire was administered using a drop and pick later method.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.1 Descriptive statistics

A response rate of 160/384(41.6%) was obtained for the study. The response rate was considered adequate given the logistical and geographical diversity of the study area.

The skewness of 0.424 for the variable business performance measured by last month turn-over revealed that the dependent variable was normally distributed. A histogram for the variable last month turn-over supported the skewness coefficients.

Descriptive results indicated that only 37% of small businesses located in Murang'a County are connected to the electricity grid. This implies that the majority of businesses in Murang'a County are not connected to the electricity grid. The findings agree with those of Fraser (2013) who found out that only 25 percent of people in Kenya have access to electricity. He also indicated that in rural areas the number drops to 5 percent. This further implies that the electricity access in Murang'a County is significantly higher than other areas.

On average, those with electricity connection paid Kshs 252 monthly. This implies that the electricity rates are subsidized in the rural areas. It can also imply that businesses in Murang'a County are not heavy consumers of electricity.

In relation to education level of the respondents, half (50%) had primary education as the highest level of education, 28% had secondary education as the highest level of education while 22% had college education as the highest level of education. This implies that majority of the respondents were poorly educated.

Descriptive results indicated that only 41% of the respondents were male implying that the majority (59%) of the respondents were female. The significant absence of men could be explained by rural-urban migration as most men travel to Nairobi to look for greener pastures and better employment.

On average, the small business monthly turnover was Kshs 89,498 while the average capital invested was Kshs 156,176. This implies a potential capital output ratio of 1.7. This is an indicator of poor capital productivity.

Descriptive results revealed that 65% of the small businesses had a work force of less than 10 employees. This implies that SMEs in Murang'a County are still struggling to create employment though they are far from solving the unemployment problem in the area.

In relation to main activity, the descriptive results indicated that 24% of the SMEs were retailers, 19% of the SMEs were wholesalers, 25% of the SMEs were both retailers and wholesalers while 32% of the SMEs practiced services oriented activities such as M-pesas, barber shops, salons, tailors and shoe shiners.

The average distance of the SMEs from the market was 2.45 KM and 2.70 KM from the transformer. This may have an implication on the adoption rate because distance may act as a disincentive to adoption of electricity as the associated cost is higher for longer distances.

Table 4.1: Demographics

Variable	Characteristic	Obs	Mean	Std. Dev.	Min	Max
Electricity adoption and usage	electricity connection	160	0.37	0.48	0	1
	last electricity bill	160	252.39	359.12	0	1087
Education	primary education	160	0.50	0.50	0	1
	secondary education	160	0.28	0.45	0	1
	college education	160	0.23	0.42	0	1
Gender	gender	160	0.41	0.49	0	1
Business Characteristics	last month turnover	160	89498.57	37838.94	26947	173337
	capital invested	160	156176.10	86445.44	35783	354770
Work force	None	160	0.29	0.45	0	1
	1 to 10 employees	160	0.36	0.48	0	1
	11 to 50 employees	160	0.35	0.48	0	1
Main activity	retailing	160	0.24	0.43	0	1
	wholesaling	160	0.19	0.40	0	1
	Both retailing and wholesaling	160	0.25	0.43	0	1
	other	160	0.32	0.47	0	1
Geographic characteristics	distance to market	160	2.45	1.23	0.2	8
	distance to transformer	160	2.70	1.28	0	5

4.2 Determinants of adoption of Electricity in Muranga County

The first objective of the study was to establish the determinants of electricity adoption in Murang'a County.

4.2.1 Coefficients

A probit regression was conducted to establish the determinants of electricity adoption in Muranga County. The coefficients were presented below. However, they were not interpreted as errors from probit regression are highly dependent on assumptions. The first assumption is that the errors are normally distribution with a mean zero and variance 1. The assumptions are made necessary because the dependent variable is a latent variable whose distribution is not known and can only be assumed. These assumptions make it impossible to interpret the regression coefficients.

The likelihood ratio of -10.61929 is the value that maximizes the likelihood that the observations are drawn from a normal distribution. The likelihood chi-square of 189.41 implies that the overall model is significant and this is also supported by a p value of 0.000. The Pseudo R squared of 0.8992 implies that 89.92% of the variations in the dependent variable are explained by the independent variables.

It was revealed by results that a unit increase in capital invested significantly increases the predicted probability of electricity adoption by 3.3407, holding all other factors constant. The implication is that capital invested may be associated with higher rates of electricity adoption. Hence, increase in the level of capital invested can be associated with higher high ability to pay for electricity. The findings agree with those in Abdullaha and Markandyab (2009) who investigated the major issue impeding the rural electrification programs in rural Kenya (high connection payments) and found out that the government needs to reform the energy subsidies, increase market ownership and performance of private suppliers, establish financial schemes and create markets that vary according to social-economic and demographic groups.

The predicted probability of electricity adoption was significantly higher for those businesses whose main activity was ‘other’ (service oriented activities) as compared with the businesses whose main activity was retailing, by 5.0265 holding other factors constant. The reason for this higher adoption of electricity by the service oriented activities, which include welding, tailoring, salons and barber shops, is that they need electricity for them to be in operation.

Further, the results also revealed that a unit increase in distance from market significantly decreased the predicted probability of electricity adoption by 0.8460, holding all other factors constant. The implication is that the cost of connecting to the grid electricity increases as the distance from the market increases. The findings agree with those in Ahlborg and Hammar (2011) who conducted a study seeking to establish the specific drivers and barriers for rural electrification and off-grid solutions in Tanzania and Mozambique and found out that there existed country-specific institutional, financial and poverty-related drivers and barriers to grid and off-grid electrification

Table 4.2 : Determinants of Electricity Adoption/Connection

Education level (1. Primary education = ref)	.
2.Secondary education level	0.7515
	(0.8971)
3.College education level	1.554
	(1.292)
Age	0.1147
	(0.0619)
Gender (Female = ref)	.
1.Male	-1.005
	(1.2037)
Ln last month turnover	4.744
	(2.6949)
Lncapital invested	3.3407*
	(1.4405)
Workforce (1.none=ref)	.
2.1-10 employees	4.045
	(2.2735)
3.11-50 employees	4.529
	(2.6794)
Main Activity (1.retailing = ref)	.
2.Wholesaling	3.1764
	(1.9208)
3.Both retailing and Wholesaling	2.2762
	(1.8446)
4.Other	5.0265*
	(2.3663)
Distance to Market	-2.4822*

	(1.094)
Distance to Transformer	-0.8460
	(0.5921)
_cons	-97.710*
	(1.108)
N	160
Log likelihood	-10.61929
Likelihood Chi square	189.41
Pseudo R square	0.8992
Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$	

4.2 Effects of Electricity adoption on Business performance

A 2 stage least squares regression was conducted as the error term of the model was assumed to be correlated with the x matrix. The situation of endogeneity was corrected by first running the electricity adoption against all instrumental variables. The instrumental variables in this case were “Distance to market” and “Distance to the transformer”. To control for heteroscedasticity the robust option was used.

Table 4.3 indicated that the model goodness of fit was satisfactory as revealed by coefficient of determination (R squared) of 0.4908. The Wald Chi square statistic of 157.32 indicated that the overall model was significant. This was supported by a p value less than 0.05.

Results indicate that electricity adoption was positive and significantly related with business performance. This is supported by a beta coefficient of 0.708. Those with electricity connection had higher business performance 0.708 compared to those who had not been connected to the electricity grid. The findings imply that the electricity adoption may have a positive role to play in small business performance. The findings agree with those of Bose, Uddin, and Mondal (2013) who detected favorable changes on the production costs, profit margin, development and modernization of business, women empowerment, quality of life, and human development due to the electrification. The findings disagree with those of Peters, Vance and Harsdorf (2013) who found out that beneficial impact are found from firm creation after electrification, firms that existed before showed an inferior performance compared to their matched counterparts from a non-electrified region. However, the performance gap was insignificant.

Results indicate that gender was positively and significantly related to business performance. Businesses owned by men out performed those owned by women by a factor of 0.114. This may have been brought about by gendered social structures such as where men own assets and access credit more quickly than women.

Results also revealed that capital invested was positive and significantly related to business performance. This was supported by a coefficient of 0.204. This implies that an increase in capital invested by one unit will result to an increase in business performance by 0.204 units.

Further, result revealed that the workforce had a positive and significant relationship with business performance. Those with a workforce of 1-10 employees had a higher business performance by a factor 0.156 compared to those who had no employees (business was

run by owner). Those with a workforce of 11-50 employees had a higher business performance by a factor 0.186 compared to those who had no employees (business was run by owner).

Table 4.3: Effects of Electricity Adoption on Business Performance

Lnlast month turnover	
Electricity connection (Yes=1, No=0)	0.708*
	(0.329)
1b.educ_level(Primary education=ref)	.
2.Secondary education level	0.0278
	(0.0643)
3.College education level	-0.0837
	(0.0732)
Age	0.00177
	(0.00282)
Gender (0.Female= ref)	.
1.Male	0.114*
	(0.0571)
Lncapital invested	0.204*
	(0.0958)
Workforce (1.none = ref)	.
2.1-10 employees	0.156*
	(0.0690)
3.11-50 employees	0.186*
	(0.0790)
Main Activity (1.retailing= ref)	.
2.Wholesaling	-0.0849

Lnlast month turnover	
	(0.0863)
3.Both retailing and Wholesaling	-0.140
	(0.0769)
4.Other	-0.0918
	(0.0779)
Last electricity bill	-0.000345
	(0.000304)
_cons	8.927***
	(1.108)
N	160
R squared	0.4908
Wald Chi square	157.32
Prob (chi square)	0.000
Standard errors in parentheses	
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$	

CHAPTER FIVE

CONCLUSIONS AND POLICY ISSUES

5.1 Conclusions

The study sought to establish the determinants of rural electrification adoption by small and micro enterprises in Muranga County Kenya. The results revealed that the amount of capital invested in a business influenced electricity adoption. The implication is that capital invested may be associated with higher rates of electricity adoption. Hence, increase in the level of capital invested can be associated with higher high ability to pay for electricity.

Similarly, predicted probability of electricity adoption for those businesses whose main activity was 'other' (service oriented activities) was higher compared with the businesses whose main activity was retailing.

Finally, the results also revealed that distance from market influenced electricity adoption. This may have an implication on the adoption rate because distance may act as a disincentive to adoption of electricity as the associated cost is higher for longer distances.

The study also sought to determine the effect of adoption of rural electrification on the performance of rural micro and small enterprises in Muranga County, Kenya. Results indicate that electricity adoption was positive and significantly related with business performance.

The results also indicated that gender, capital invested and workforce were positively and significantly related to business performance. This implies that male business owners

were more likely to report higher business performance compared to women. This may further imply a gender bias on resources necessary for supporting businesses. Higher capital invested implied that the business could exploit more business opportunities and hence higher turnover. Higher workforce implied economies of scale and this may have led to improved turnover/sales.

5.2 Recommendations and Policy Implication

In a bid to increase electricity connection/adoption, Murang'a county government and electricity providers such as Kenya Power should target business owners who are mature and who have more business experience since they are more likely to warm up the idea of electricity adoption in their businesses.

It is recommended that Murang'a county should conduct business incubation programmes for businesses so as to boost the business performance/turnover as well as the capital invested. This will have a positive effect on electricity adoption since well performing businesses are likely to adopt electricity. They should also assist the businesses to get funds from youth fund and women enterprise fund and this will increase the capital.

The Murang'a county government should encourage businesses to grow and hire more workforce as this may lead to high electricity adoption. Similarly, the Kenya Power company should lower the cost of connection which is associated with electricity poles and length of electricity cables all of which are dependent on the distance from the market.

The study also recommends that Murang'a County and electricity providers should encourage electricity adoption through conducting awareness campaigns that would sensitize small business owners on the value brought about by electricity adoption.

5.3 Areas of Further Study

A comparative study should be done between various counties to compare and contrast the findings as far as determinants of electricity adoption are concerned. Other studies should focus on the determinants of adoption of solar energy as well as bio gas energy. Furthermore, future studies should focus on determinants of joint adoption of electricity, solar energy and bio gas energy.

Future studies should focus on the effect of electricity adoption on education, health and fertility.

5.4 Limitations of the Study

Some of the respondents' especially women were not willing to disclose business information such as turnover in the fear that the data collectors and research assistants were from the county council of Murang'a who were out to investigate business people without licenses. Business owners who had licenses were also fearful that the data collectors were from Kenya Revenue Authority who were out to investigate their tax payment records. This made it difficult to collect some information from some small and micro business premises.

The accuracy of the results were also limited to the extent that the respondents were honest with their responses. Finally, the ability to apply the results to the whole of Muranga county as well as other neighboring counties is limited by the small population

and sample size. This is because the study focused on the registered businesses only while there were other businesses that were not registered.

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APPENDICES

Appendix I: INTRODUCTORY LETTER

UNIVERSITY of Nairobi

SCHOOL OF Economics

This questionnaire has been developed to collect information for academic purposes.

All information will be treated as strictly confidential and will only be used for this purpose only.

Kindly answer the questions as objectively and honestly as possible.

Thank you,

Daniel Kariuki

Researcher

Cell– 0723-711-637

Student Number: x50/76512/2012

Appendix II: QUESTIONNAIRE.

RESPONDENTS' DETAILS

a) Name (Optional)

b) Business / Enterprise name (optional).....

1. When were you born?

2. What is your gender?

i. Male

ii. Female

3. What is your level of education?

iii. Primary

iv. Secondary

v. College

vi. University

3. What is your marital status?

a. Single

b. Married

c. Widowed

d. Divorced/Separated

4. If married, does your spouse support your business?

a. Yes

b. No

5. If yes to the above question, rank the nature of the support from your spouse?

Nature of Support	Always=3	Sometimes=2	Not at all=1
Financial			
Managerial			
Operational			
Other (please specify)			

6. Are you a member of a registered Association or lending group (Chama)?

a. Yes

b. No

BUSINESS CHARACTERISTICS

7. When did you start this business?.....

8. How did you start it?

a) Founded

b) Inherited

c) Bought

d) Others specify

8. What was your turnover last month?

9. How much money (capital) have you invested in this business?
.....

10. Main business activity

a) Retailing

b) Wholesaling

c) Both retailing and wholesaling

d) Others specify.....

11. How many people work in this business?

a. none

b. 1 to 10 employees

c. 11 to 50 employees

d. over 50 employees

12. Which of the following best describes the form of legal registration for your business?

- a. Sole proprietorship
- b. Partnership
- c. Limited Company

13. Is your business registered with registrar of companies?

- d. yes
- e. No

14. Do you keep financial records for your business?

- a. Yes
- b. No

15 Is your business connected to electricity?

- a. Yes
- b. No

16 If yes to the above question, how much was the last bill ?

Ksh.....

GEOGRAPHICAL CHARACTERISTICS

17. Approximate Distance in Km from the nearest market.....

18. Approximate Distance in KM to the nearest transformer.....

18. Is your business located in a hilly/rocky terrain Yes () No ()

Appendix III: Do File

```
gen primary_educ=1 if educ_level==1
replace primary_educ=0 if primary_educ==.
gen secondary_educ=1 if educ_level==2
replace secondary_educ=0 if secondary_educ==.
gen college_educ=1 if educ_level==3
replace college_educ=0 if college_educ==.

gen single=1 if marital_status==1
replace single=0 if single==.
gen married=1 if marital_status==2
replace married=0 if married==.
gen widowed=1 if marital_status==3
replace widowed=0 if widowed==.
gen divorced=1 if marital_status==4
replace divorced=0 if divorced==.

gen retailing=1 if main_activity==1
replace retailing=0 if retailing==.
gen wholesaling=1 if main_activity==2
replace wholesaling=0 if wholesaling==.
gen Both_retailing_and_wholesaling=1 if main_activity==3
replace Both_retailing_and_wholesaling=0 if Both_retailing_and_wholesaling==.
gen other=1 if main_activity==4
replace other=0 if other==.

gen none=1 if workforce==1
replace none=0 if none==.
gen _1_to_10_employees=1 if workforce==2
replace _1_to_10_employees=0 if _1_to_10_employees==.
gen _11_to_50_employees=1 if workforce==3
replace _11_to_50_employees=0 if _11_to_50_employees==.

gen lnlast_month_turnover1=log(last_month_turnover1)
gen lncapital_invested1=log(capital_invested1)

prob electricity_connection i.educ_level age i.gender lncapital_invested1 i.wor
> kforce i.main-activity distance_to_transformer distance_to_market

ivregress 2sls lnlast_month_turnover1 i.educ_level age i.gender lncapital_inves
> ted1 i.workforce i.main-activity last_elec_bill (electricity_connection=dista
> nce_to_transformer distance_to_market),robust
eststo model1
esttab using dan.rtf, se
```