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Title: WHY COOKING ENERGY CHOICES AT HOUSEHOLD LEVEL IN RWANDA.

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DECLARATION

I, **Isaac MUSHINZIMANA**, hereby declare that the work presented in this Project Dissertation 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 Dissertation work will have been fully acknowledged.

Signature:  Date: **October 29, 2020**

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Date: October 30, 2020

DEDICATION

I dedicate this Masters dissertation to my God, the God who is above of all things, my shepherd and my Salvation, my source of power, wisdom, knowledge and inspiration.

I also dedicate this work to my **Mother NYIRAREKERAHO Nellie**, brothers and Sisters who helped in every things.

I dedicate this work to **Dr. BUSORO RUTEBEKA Theodore** and **Dr. NKURUNZIZA Joseph** for unconditional support for me to attain postgraduate studies.

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ABSTRACT

This investigation applies a multinomial logit procedure to demonstrate decisions of fuel for cooking in Rwanda. The decisions considered are five fundamental cooking powers: wood, charcoal, gas, lamp oil and generator; Using the Integrated Household Living Condition Surveys from 2010 up to 2017 (EICVs 2010-2017) data, the study identifies the driving forces that underpin and support the family unit's decision of energy for cooking and investigates the fundamental factors that decide decision of essential cooking fuel choices in Rwanda. The discoveries uncover that area of living arrangement, home possession, family unit size, type of marriage, household income level, and type of habitant play significant role in explaining the probability of cooking energy choices within households. Further the results show that cleaner energy is bound to be utilized in metropolitan families, where family unit with high income more often use LPG compare to others. The study also shows that main stream of family units in Rwanda depend on more on non-clean energy while cooking, and this is more pronounced in rural households.

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ABBREVIATIONS AND ACRONYMS

UR: University of Rwanda

CST: College of Science and Technology

ACEESD: African Centre of Excellence in Energy for Sustainable Development

ARI: Acute respiratory infections

EICV: Integrated Household Living Conditions Surveys

IEA: International Energy Agency

LPG: Liquid Petroleum Gas

LNG: Liquefied Natural Gas

MDG: Millennium Development Goals

MNL: Multinomial Logit

NISR: National Institute of Statistical of Rwanda

RUM: Random utility Model (RUM).

STATA: Statistical Software for Econometrical analysis

WHO: World Health Organization

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CHAPTER ONE: GENERAL INTRODUCTION

1. Introduction

2. 1.1 Background

For evolving nation states, issues identifying with cooking energy decisions and energy shifts are huge from a vital perspective. Endeavours at rousing and helping families to make replacements that will improve progressively effective in energy utilize and less adversative ecological, social, and wellbeing impacts are advanced in huge numbers of these nations (Ouedraogo, 2006). Yet, the compelling plan of public procedure around there needs, as a first stage, examination and investigation of the perspectives that influence cooking energy decisions and utilization setups in country and metropolitan regions of such nations. In rustic districts, decisions are restrained by low earnings, yet in addition by the nonappearance of admittance to more attractive energizes and commercial centres for energy utilizing hardware and apparatuses (Lhendup, T., Lhundup, S. and Wangchuk, T., 2010).). Frequently, the decision of fuel is resolved more by neighbourhood openness and exchange and opportunity costs associated with gathering the fuel (generally wood, fertilizer, and different biomass) as opposed to by family unit spending limitations, costs, and expenses. However, rather than provincial families, metropolitan ones frequently have a broad decision and more noteworthy attainable quality and openness to current lucrative energizes, electrical energy, and energy utilizing end-use instruments and machines, and subsequently, more prominent plausible for fuel trading (Farsi, M., Massimo, F. and Shonali, p., 2005). Therefore, with developing populace and inner-city ization after some time has been joined by a tremendous stream in the interest for family energizes and power, fair like country family unit energy, metropolitan family unit energy is a critical issue for non-industrial nations in like manner, and for less fortunate agricultural nations, for example, Rwanda, explicitly (Pandey, V.L. and Chaubal, A. , 2011).

By the side of the core of natural predicament in furthermost agricultural nations, including Rwanda, issues worried to pick of family cooking fuel energy classifications have gotten more proper than any other time in recent memory from methodology perspective. Most nations have boarded on crusades pointed toward motivating family units to change their energy classes towards more energy capable utilize and less adversative natural, social and wellbeing related effects. Enlarged reliance on the delivered biomass for fuel use and money returns by families has maintainability challenges

with long-standing dangerous impacts on woodland assets (Pandey, V.L. and Chaubal, A. , 2011). It adds to deforestation, backwoods mortification, and land corruption which destabilize the very establishment of financial movement due to quickening soil disintegration important in low efficiency. Utilizing crop residues as wellspring of fuel, as an option of transforming it into excrement for soil fruitfulness updating, adds to land debasement and this outcomes into decreased horticultural efficiency. The utilization of biomass as cooking fuel has been associated with indoor air contamination prompting family unexpected issues (Ouedraogo, 2006).

As per gauges by World Health Organization, about 1.5 million inconvenient away passing yearly are because of indoor air contamination related causes through the utilization of solid fuels (International Energy Agency, 2006).

In Rwanda, family unit energy use is needed to experience the longings for cooking and water warming and for lighting and working electrical instruments and machines (Dubin, J.A., McFadden, D.L., , 2005). However, most of energy utilized in Rwandan families even today is for cooking. Subsequently, a comprehension of cooking energy utilization configurations is predominantly significant.

Against this background this examination goes far to create comprehension of the angles influencing the family unit decisions on fuel decision which is fundamental for the plan of public procedure highlighting invigorate spotless, sterile and continued cooking and lighting fuel energy. The examination accentuations on cooking fills, which is expected to establish the preeminent portion of family energy prerequisites in Rwanda.

There are restricted examinations on main impetuses to settle on decision of cooking energizes at disaggregated level Thus, this investigation attempts to analyse the determinants of family unit's decision of cooking fuel in Rwanda. Family energy utilization alludes to the amount of energy assets that are being spent by families on various apparatuses utilized by the families. The few energy assets include: biofuel and squander, Kerosene, power, gas, oil, diesel, and sun based (IEA, 2014). Energy establishes one of the main parts of human life. It is aware that is essential for the presence of present day life (Eakins, 2013).

This is on the grounds that in each economy, all areas going from private, producing, agribusiness, transport just as administrations areas depend to a huge degree on different fuel sources to work.

Notwithstanding, in spite of that the significance of various end utilizes for energy shifts essentially from nation to nation in light of contrasts in climatic conditions, approaches, level of monetary turn of events and different variables (Bhattacharyya, 2011),), it is commonly concurred that the family area is one of the main energy utilization areas(Sathaye, J. and S. Tyler , 2010).

1.2 Statement of the problem

The complete family units' utilization significantly relies upon the accessibility of fuel sources to make such utilization conceivable. Such fuel source can be LPG, power, lamp oil or potentially conventional biomass, for example, kindling, plants build-ups and creature manure. Nonetheless, it is contended that about more than over two billion individuals World over decided to rely significantly upon the conventional biomass fuel as their wellspring of energy for cooking, warming and lighting (Malinski, 2008). For example, Onoja (2012) contended that confirmations from China have indicated that there are impressive quantities of family units (in certain areas, larger part e.g Wolong district) that decided to utilize conventional biomass fuel regardless of their admittance to power. In any case, the utilization of fuel-wood is absolutely not earth friendly (Bruce, N., Perez-Padilla, R. and Albalak, R. , 2014). It has contrary effect on air and people groups' lives (Ouedraogo, 2006). Aside from deforestation, desertification and soil disintegration, the utilization of fuel wood has a low warm effectiveness and the smoke is additionally unsafe to human wellbeing, particularly to ladies and youngsters who generally do the cooking at homes (NEPD, 2003). Besides, around 1.5 million passing consistently from respiratory diseases can be ascribed to the climate, including the impacts of indoor and open air contamination (Malinski, 2008). households in Rwanda spend up to six hours per day for firewood collection and up to third of their income for their energy expenditures, national wide almost 82.59 percent of family units used wood as their principal source of food preparation energy (EICV5, NISR, 2016-2017), and most of them likely collect firewood for free, hence acquiring and preparing cooking fuel are time consuming tasks for most households as one of the determinants of cooking energy choice, in Rwanda we also need to observe the other determining factor influencing the family unit cooking fuel decision option despite of modern, clean and less time consuming energy accessibility.

Objectives

1.3.1 Major objective

To identify the determinant aspects that influence the family unit choice for food preparation fuel energy source in Rwanda

1.3.2 The specific objectives

- ✓ To determine existing relationship between energy consumption with other family unit consumption expenses welfare
- ✓ To decide on aspects that will facilitate improvement cooking fuel energy use in Rwanda
- ✓ To identify the trend in transition of cooking fuels in Rwanda at household level
- ✓ To identify and analyse the more used cooking fuels in Rwanda

2.3 Scope of the study

This investigation focus on establishing and analysing social and trade and industry factors determining family unit adoptions for cooking energy sources econometrically in Rwanda hence households transition to different of the cooking energy fuels and this analysis will be carried out in STATA tool.

2.4 Expected outcomes and significance of the study

2.4.1 Expected outcomes

Family Income has colossal valuable result demonstrating that development in pay prompts growing the probability of picking LPG as a cooking fuel over fuel and light oil (Farsi, Mehdi, Massimo Filippini and Shonali Pachauri , 2007). As pay develops the nuclear family substitute more and cleaner fuel sources. This shows positive association among pay and choice of fuel.

The impact of expansion in utilization of non-energy consumptions shows expanding the number family unit that relies upon kindling as principle wellspring of energy

The dimension of the family unit is an additional segment variable that decides the fuel decision of family unit. With the expansion in family size there is increment in the probability of consuming LPG

2.4.2 Significance of the study

There is still high dependency on biomass which resulted to environmental degradation, has been related with energy consumption in Rwanda with successful mediation to current energy like LPG projected to consequences to economic change.

CHAPTER TWO: REVIEW OF LITERATURES

Writing review comprise various examinations that are like this investigation which attempted to explore factors influencing fuel decision energy in family unit of agricultural nations. It does exclude the audit of studies that are directed in created nations in light of the fact that the energy utilization example of such nations is not quite the same as energy utilization example of family in non-industrial nations (Reddy, 2013). Studies in developing nation's emphasis around the impact of segment attributes, pay and cost on fuel. Following passages present the concise review of past investigations concentrating in on family fuel decision and exchanging techniques and feature existing information fissure (Vitali, 2013).

The investigation of (Farsi, Mehdi, Massimo Filippini and Shonali Pachauri , 2007) analyse cooking fuel utilization design in metropolitan families of India. It accepts that Primary fuel hotspots used in food preparation are kindling, lamp oil altogether with LPG as it were. The investigation picks cooking fuel on the grounds that a greater part of the energy utilized in family even today is for cooking (Ezzati, M. and D.M. Kammen , 2010). here decision of energy fuel portion by essential fills for food preparation is needy parameter of the model and cost of the fuel, family unit month to month pay, family month to month consumption per individual, age of the family unit head, number of individual in family unit, head of family with single part, family unit with female head, family unit earnings from easy-going work, instruction of family unit head which are further sub separated into unskilled, grade college with college training, living arrangement in metropolitan zone (Reddy, A.K.N. and B.S. Reddy , 2014).

The outcome of the examination displays that cost of the LPG and cost of lamp oil are huge and has undesirable effect so the expansion in the value outcomes move far after specific fuel towards other fuel.

The examination by Zhang and Hassen (2014), who utilize the probit model for family fuel decision for cooking, shows that there is replacement impact on cost of Liquefied Natural Gas (LNG), coal and fire wood. At the point when the cost of LNG builds, the likelihood of picking coal for essential energy for cookery additionally increments.

The investigation of (Alem, Beyene, Kohlin, and Mekonnen, 2013) led in metropolitan Ethiopia shows comparative outcomes that fuel costs are significant determining factor for energy decision. With the expansion in earnings and the increment for cost of fire wood, family unit will in general move to clean fuel source (Reddy, B.S., 2015). Fire wood is expected as sub-par merchandise; lamp fuel and LPG should typical products. Thusly, as change in cost of kindling will in general move towards ordinary products (World EnergyOutlook,, 2006).

In the study done by (Barnes, D. F., Krutilla, K., Hyde, W. F., 2005)displays that the fundamental driver for utilization of firewood as essential fuel source of meeting their fuel requisite is because of the way that different wellsprings of energy are encountering climb in cost. The Government gives electric energy endowment to metropolitan poor, and brings the month to month administration run after to urge helpless family unit to burn-through power (Davis,M., 2008).

In the investigation of China by utilizing probit model pay is appeared to a huge part in deciding family unit decision of fuel for cooking in metropolitan China (Heltberg, 2015).). As the pay expands, family incline toward LNG as essential fuel for cooking however the likelihood of picking fuel wood and coal as essential fuel for cooking has diminished (Alam, M., J. Sathaye, and D. Barnes, 2008). Likewise shows the positive connection among pay and energy utilization, an alternate methodology of expanding pay in energy utilization. There is positive connection among pay and family unit interest for marketable fuel (Chambwera, M., Folmer, H., , 2007.).

Yet, unique case was found in the investigation by Ado et al (2016) at Buchi Metropolis. The discovering shows as pay builds, family units will in general receive current fuel however not consummately subbing conventional fuel with present day or temporary energizes. Nigeria confronted fuel stacking conduct as earnings increments as opposed to energy stepping stool theory (Heltberg, R., 2004). Essentially, in the investigation of family fuel decision in Ethiopia by utilizing multinomial logit examination shows that pay assumes a huge part for fuel decision. As income builds, the family unit increment the quantity of fuel type utilized by family unit (Reddy, B.S., 2015). Another study on Myanmar shows significant inner-city areas are charged and as pay expands the utilization of current electric machines increments (Dubin, J.A., McFadden, D.L., , 2005).

In Nigeria there is negative connection among income and utilization of biomass (Saad and Bugaje, 2016). On the off chance that the income of family unit builds, the families attempt to substitute biomass fuel by present day energizes. Study led on the off chance that investigation of Dhulikhel of

Nepal by utilizing Pearson's coefficient outcomes displays there is promising connection among energy utilization with earnings (Barnes, D.F. and L. Qian , 2005).

There is positive connection between family size and likelihood of picking LPG (Farsi, M., Filippini, M., Pachauri, S., 2008). The expansion in size of family unit which may build the volume cooked and it requires more energy to prepare food is found in the investigation of rustic zone of Nigeria (Gangopadhyay, S., B. Ramaswami, and W. Wadhwa , 2003). (Ouedraogo, 2006) Suggests that, in metropolitan Burkina Faso, families with less individuals are twenty-6th times bound to receive LPG and more averse to utilize kindling for cooking.

Apart from traditional cooking energy fuels, LPG and Electricity as modern cooking energy fuels are often taken as better fuels alternatives from healthiness welfares perceptions and efficiency. However in emerging nations the families' choice to shift after traditional cooking biomass fuels to modern cooking energy cooking fuels was bounded by some constraints like the cultural, social and economic and environment obstructions (Koswari, R., & Zerriffi, H., 2011)

The utilization of the energy source for the households from the total of other alternatives supply choices organised in direction of technological aspect whether for remote or inner-city areas was taken as discrete choice (Campbell, B.M., S.J. Vermeulen, J.J. Mangono and R. Mabugu, 2003). As the demand for or supply of more non-modern fuels raised, there will be the great transition from charcoal and firewood trough kerosene to up-to-date energy like LPG and electricity made by energy users where the transition concept made was name as energy ladder (van der Horst, G.H. and A. J. Hovorka , 2008) ; (Leach,G., 1992)is not only determined by preference of energy , economic theory change and change in taste through microeconomics theories , energy carriers availability, technological change for energy sources (Campbell, B.M., S.J. Vermeulen, J.J. Mangono and R. Mabugu, 2003) and supply of energy options shifting (Zulu, 2010) but also energy prices (van der Horst, G.H. and A. J. Hovorka , 2008). The sophistication of energy sources has effect on family health and environment.

At the point when family units climb on the energy stepping stool, the Indoor and open air contamination that prompts wellbeing respiratory procured issues/illnesses is diminished or killed with move to more refined sources as come about because of woods assets use decreases as less of kindling and charcoal are required (Mishra, 2003). The modernity of fuel sources has been

considered as progress of family unit's or/and nation's government assistance and with other socio-government assistance pointers that have been utilized to quantify the norm and personal satisfaction (Berenger, V. and A. Verdier-Chouchane, 2007).

The studies have attested the energy stepping stool as the essential model that impacts families' decisions as the change movement from customary cooking energy powers to cleaner current cooking energy fuels (van der Kroon B, Brouwer R and van Beukering PJH, 2013). According to the energy ladder hypothesis by covering the ceteris paribus with an increase in income, families not merely consume more quantity of the similar cooking energy fuels but then again also switch to the cleaner modern cooking energy fuels type. It is presumed that clean modern cooking energy are economically normal goods while traditional biomass cooking energy are considered as inferior goods (Rahut, D. B., Behera, B., & Ali, A., 2014).

CHAPTER THREE: METHODOLOGY

3.1 **Conceptual framework**

A family unit's fuel energy decision choice can be clarified by inspecting its fuel choice in a compelled utility improvement structure, where it boosts fuel utility, subject to a bunch of monetary and noneconomic limitations. The family's information on different powers impacts its fuel decision and fuel replacement choices. This fuel utilization choice is influenced by financial and noneconomic factors. Financial variables may incorporate market cost of fuel, family pay, and family consumptions and non-monetary elements may incorporate a bunch of family unit qualities, for example, family unit size, sex, training, house possession, kind of abiding, area of habitation, family age, separation to fuel source, and admittance to electric energy (Wickramasinghe, 2011)

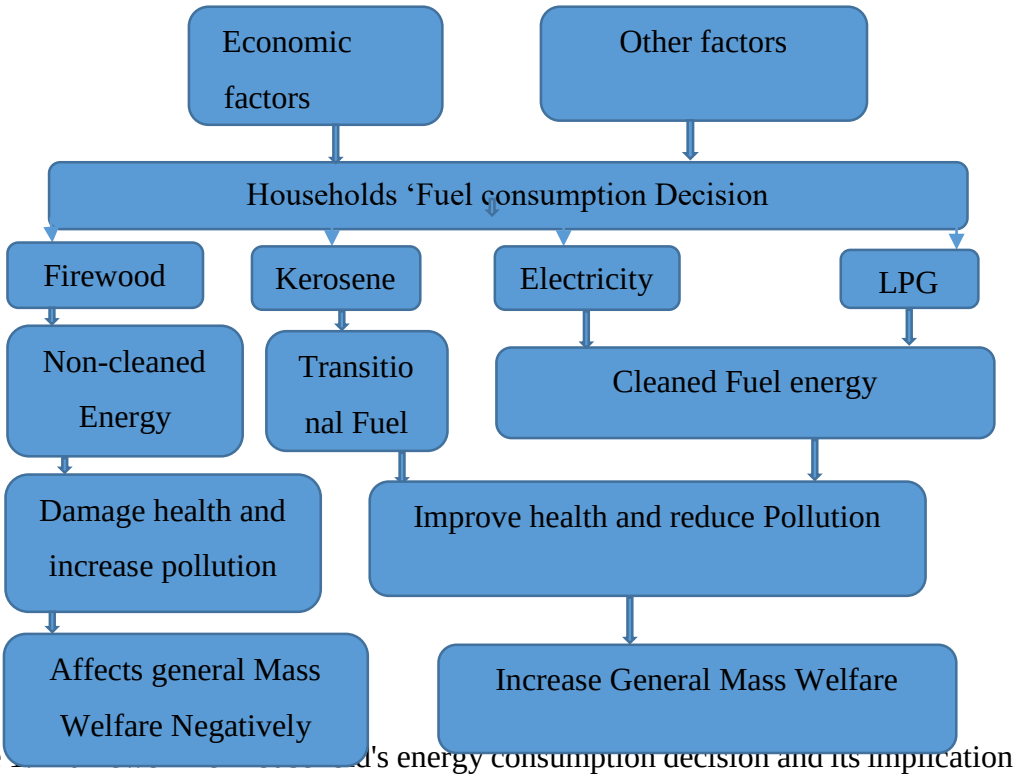


Figure 1: Household's energy consumption decision and its implication

The figure above shows how household's fuel consumption decision is influenced by socioeconomic factors, where household may decide to use traditional cooking fuel energy which are non- cleaned

and they damage health and increase pollution within environment also household decided to use cleaned cooking fuel energy which improve health and reduce pollution which lead to increase of general mass welfare which imply that there is the main factors influencing this cooking fuel energy choice (Ezzati, M. and D.M. Kammen , 2010).

3.2. **Modelling choice of fuel type**

A representative end user gets utility from a decent by disaggregating it into parts or characteristics that can't be accomplished freely. An assortment of these qualities make decisions from which a purchaser be able to pick (Hanley et al., 2001). (Lancaster, 2009)Advanced a premise of demonstrating such decisions for which requesting in the middle of decisions has no importance. These decisions can be spoken to econometric manner in end user hypothesis by utilizing a multinomial logit to demonstrate random utility Model (RUM). In this examination we utilize decision displaying for assessment of the utility related with fundamentally unrelated and exceptionally separated cooking and lighting fuels (McFadden, 2008). It obeys to the financial idea that the worth put on a specific fuel is an impression of its aspects (Lancaster, 2009). Optimal displaying has been brilliantly utilized in conditions where compromises amongst certain qualities were researched on (Blamey et al., 1999; Morrison et al., 1999; Bullock et al., 1998).

A family unit n chose among a bunch of totally unrelated fuel decisions, $j = 1..., J$. The chief secures a specific degree of utility U_{nj} from each substitute. The discrete decision model expands on the conviction that a family chooses the result that capitalize on utility. We don't watch family unit's utility, however watch a few qualities of the family which is defied by a choice to pick cooking a lighting fuel assortment. Subsequently, the utility is disintegrated into deterministic (expected utility which is assumed to be linear) φ_{nj} and random part:

$U_{nj} = \varphi_{nj}(X_i, Z_{ij}) + \varphi_{ij}$ ……...…………………….... [1]

$with\ \varphi_{nj} = \alpha Z_{ij} + \beta_j X_{i} + \in_{ij}, \qquad \varphi_{ij} = \emptyset_{ij} + \in_{ij}$

$X_i\ and\ Z_{ij}$ deliver characteristics of the individual choice maker and characteristics of the substitutes in the choice set respectively. If α =0, the model is multinomial logit (MNL). the model may be referred to as a ‘’characteristic of chooser model’’, if $\beta_j = 0$ the model is conditional logit and this

may refer to as a ‘’characteristics of alternative model’’, if α =0 and β_j = 0 for all j, then the resultant model is a mixed logit.

The behavioural assumption underlying all three variants of the logit model is the same i.e., identically and independently distributed (iid) extreme value distinner-city ces in a RUM model (Bourguignon, F., Fournier, M., Gurgand, M.,, 2007).

Be that as it may, we determine the likelihood of a specific result. The stochastic part has a distribution f ( ).). The joint distribution for a vector of the stochastic part is meant as f ($_n$). To delineate family unit n's decision of substitute I on a scope of J substitutes, we use likelihood:

$$P_{ni} = \Pr (U_{ni} > \quad , \forall j \neq i) \ldots\ldots\ldots\ldots \quad [2]$$

$$P_{ni} = \Pr (U_{ni} + {}_{ni} > \quad , \forall j \neq i) \qquad P_{ni} = \int I (U_{ni} + {}_{ni} > U_{nj} + \quad , \forall j \neq i) \text{ F } ({}_n) \text{ d}_n$$

Where I (.) is the marker work, equalling 1 when the term in bracket is valid and 0 else. This is a multidimensional basic over the thickness of the in undetected measure of utility f ( ) (Reddy, B.S., 2015). The multinomial logit model assumes independency of irrelevant alternatives (IIA) which implies that the ratio of the probabilities of deciding on any two options is independent of the other substitutes in the choice set. Nonetheless, this supposition that is unreasonable much of the time. Train (1990) takes note of that a supposition of IIA in multinomial logit model isn't as prohibitive as it first observes. A variation of multinomial logit is settled logit model. In this investigation, whole right hand side factors are singular attributes, along these lines, settled logit model will basically deliver comparative outcomes as the multinomial model (Econometric Society, 1982).

The thickness for each in secret part of utility and the total dissemination are given, individually, by (McFadden, 2008);

$$\lambda({}_{nj}) = e^{-\varepsilon nj} e^{-e\varepsilon nj} \ldots\ldots\ldots\ldots \quad [3]$$

$$\Lambda(nj) = e{-}e\varepsilon nj \ldots\ldots\ldots$$

The likelihood that family unit *n* decide on alternate *i* amongst the *J* another possibility of food preparation energy is assumed by (McFadden, 2008);

P_{ni} = Pr (< $\varphi_{ni} - \varphi_{nj} + {}_{ni}, \forall\, j \neq i$)……. [4]

= $\int \prod j \neq i\ \Lambda\ (Uni + ni > Unj + nj, \forall\, j \neq i)\ \Lambda\ (\ )\ \mathrm{d}\ ni$

Thus, the choice probability is the integral over all values of $_{ni}$weighted by its density Λ (.) as defined in equation (3).

It is hypothesized that a person's decision of a viewpoint is controlled by a vector of socio-segment qualities. This contact between vector of socio-segment actual attributes and the reliant variable is perceived by assessment vector of boundaries utilizing log-probability technique.

Maximizing log-likelihood function for the parameter vector yields (Stern, S. 1997; (McFadden, 2008);

$\ln L(\delta) = \sum_{n=1}^{N} \sum_{j=1}^{J} y_{ni} \ln P_{nj}$…… …….. [5]

In equation (5), $_i$ is 1 when fuel *j* is chosen and 0 for all other fuels that are not chosen. Supposing each error term for all options *j* is identically and independently distributed, the logit probability $\varphi nj + x_n{}' \beta_j$ that a singular will choose alternative *j* will be;

$$P_{ni} = \frac{e(x_n' \beta_j)}{\sum_j e(x_n' \beta_j)} \text{……..……..…} \quad [6]$$

In the interim MNL is where regressors don't change over receptions, coefficients are assessed for any decision. The reliant variable is the cooking fuel decision (kindling, charcoal, and lamp oil, power, LPG or harvest deposits and so on) Holding the other indicator factors consistent, the normal coefficients give a level of the adjustment in the logit related with a unit change in the indicator variable. On one hand, positive coefficients demonstrate an enlarged likelihood that a family would choose an elective wellspring of fuel; while then again, negative coefficients show that a family is more averse to utilize substitute fuel source.

The reliant variable under this examination is the decisions of fuel for cooking in provincial and metropolitan families. As opposed to measure of energy burns-through by family unit, it portrays the classifications of fuel, including; kindling, lamp oil and LPG and power utilized by family units.in this examination, we remember the accompanying arrangement of controls for our relapses: absolute family unit pay ,family size of the family unit incorporates all the relatives living respectively under an equivalent rooftop and utilizing same kitchen; sorts of marriage inside family unit, types of education of household head, which describes whether the head of household has taken any basic formal education or not, age of household head, type of habitant for households, location of the household describing whether the households are located in rural or inner-city , home ownership describing who own the house in which the households live, total households non-energy expenditure describing the amount spent on non-energy commodities due to annual budget constraint.

3.3 **The data**

This investigation was centred on pooled cross-sectional survey data from Integrated Household Living Conditions Surveys (EICVs) data, conducted by the National Institute of Statistical of Rwanda (NISR) three waves (2010, 2013/14 and 2016/17). The Survey is a broadly agent test study intended to give data on the different parts of family unit government assistance in Rwanda. The reviews gathered data from three waves-based family units measurably intended to be delegate at both public, locale, metropolitan and provincial levels, empowering the arrangement of dependable appraisals for these levels.

The survey is carried out to gather an extensive arrangement of information on the distinctive part of family government assistance, for example, demography, utilization, earnings, lodging, work market, instruction, wellbeing, and other financial variables.

3.4 Data description for analysis

Table 1: Summary statistics of all explanatory variables used in Multinomial Logistic Regression

Variable	variable description	Mean	Std. Dev.	Min	Max
lnincome	log total hh income	12.49	1.63	4.61	21.82
hhsize	Household size	4.59	2.14	1.00	22.00
polygam	Marital status of household head	0.06	0.24	0.00	1.00

basic educ	Hh head with formal basic education	0.39	0.49	0.00	1.00
agehhd	Age of household head	45.10	15.82	14.00	109.00
typhbt	household type of habitat	2.32	1.64	1.00	6.00
inner-city	household location	0.16	0.37	0.00	1.00
homeowner	hh live in own house	0.81	0.39	0.00	1.00
lnnonenergy	log total hh nonenergy expenditure	12.48	1.63	4.53	21.82
Observation		43307			

Source: Author's computed using EICVs (2010-2011/2013-2014/2016-2017).

From the above table1, the average number of household members is 5 persons, it is shown that 39 percent of the household heads have taken basic formal education which 6 percent of the household heads are polygamous status, the household head was average aged to 45 years, 16 percent of the total number of households they live in inner-city areas which implies that approximately 84 percent of the households live in rural areas, 81 percent of the households live in their own homes and the total households income is monthly averaged to 12.5 US Dollars.

Table 2 : Average values of key variables

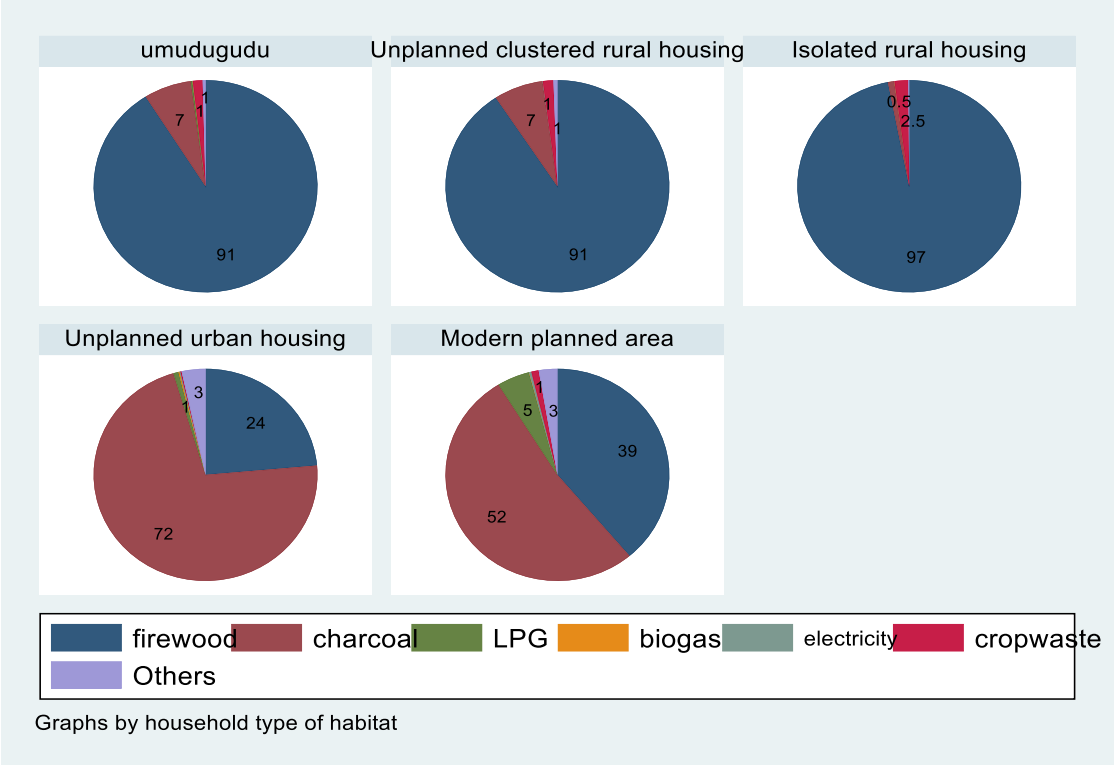
		wave1(2010/2011)		wave2(2013/2014)		wave3(2016/2017)	
Variables	**variable**	**mean**		**mean**		**mean**	
outcome variables							
Electricity	hh using electricity	399.98	2634.46	476.76	2092.99	535.56	2088.28
Charcoal	hh using charcoal	0.95	0.22	0.15	0.36	0.18	0.38
Kerosene	hh using kerosene	0.74	0.44	0.14	0.35	0.06	0.24
Other	exp on others	1.61	0.51	0.32	0.47	0.41	0.49
Generator	hh use generator	.009	.095		0.05	0.00	0.04

Battery	hh use battery	0.64	0.48	0.00	0.46	0.40	0.49
Gaz	hh use gaz	0.00	0.03	0.00	0.03	0.01	0.09
Wood	hh use wood	0.83	0.38	0.09	0.29	0.14	0.34
Lightbulb	hh use lightbulb	0.84	0.37	0.01	0.10	0.03	0.17
Candle	hh use candles	0.73	0.44	0.16	0.37	0.17	0.38
Matches	hh use matches	0.76	0.43	0.68	0.47	0.81	0.39
w1	share of electricity	0.09	0.29	0.19	0.39	0.24	0.43
w2	share of charcoal	0.16	0.08	0.03	0.11	0.03	0.10
w3	share of biomass	0.13	0.08	0.04	0.13	0.04	0.13
w4	share of kerosene	0.12	0.09	0.07	0.19	0.03	0.11
w5	share of candle	0.24	0.12	0.48	0.39	0.47	0.38
w6	share of others	0.26	0.12	0.20	0.31	0.21	0.28
household characteristics							
Inner-city	householdlocation	0.15	0.36	0.16	0.37	0.17	0.38
Typhbt	household type of habitat	2.48	1.47	2.35	1.70	2.15	1.73
Agehhd	Age of household	45.11	15.85	45.04	15.98	45.16	15.64
basic educ	Household head	0.73	0.45	0.23	0.42	0.23	0.42
Polygamy	hhhead martual	0.12	0.33	0.04	0.19	0.03	0.16
Hhsize	Household size	4.78	2.18	4.58	2.11	4.41	2.12
Homeowner	hh live in own	0.83	0.37	0.82	0.39	0.78	0.41
Lnincome	log total hh	11.81	1.78	12.44	1.59	13.19	1.15
Lnnonenergy	log total hh	11.81	1.78	12.43	1.59	13.19	1.16
Lnenergyexp	log energy	2.29	1.85	1.80	2.82	2.16	2.94
District	district location	35.58	13.36	35.58	13.37	35.14	13.62
observations		14308		14419		14580	

Source: Author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

From the above table2, its shown that, taking the wave1(2010/2011) as the base case for comparison, the total number of households using the electricity energy for cooking purposes were increased by 19 percent from wave1(2010/2011) to wave2(2013/2014) while 33 percent were an increase from wave1(2010/2011) to wave3(2016/2017), the total number of households using the charcoal energy for cooking purposes were decreased by 84.2 percent from wave1(2010/2011) to wave2(2013/2014) while 81 percent were a decrease from wave1(2010/2011) to wave3(2016/2017), the total number of households using the kerosene fuel energy for cooking purposes were decreased by 81 percent from wave1(2010/2011) to wave2(2013/2014) while 91.8 percent were a decrease from wave1(2010/2011) to wave3(2016/2017), the total number of households using the other fuels energy like crop wastes for cooking purposes were decreased by 80.1 percent from wave1(2010/2011) to wave2(2013/2014) while 74.5percent were decreased from wave1(2010/2011) to wave3(2016/2017), the total number of households using the gas fuels energy for cooking

purposes were increase to the average value of 0.01 from wave1(2010/2011) to wave3(2016/2017), the total number of households using wood fuels energy for cooking purposes were decreased by 89.1 percent from wave1(2010/2011) to wave2(2013/2014) while 83.1 percent were a decrease from wave1(2010/2011) to wave3(2016/2017).



Source: Author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

Figure 2 : Distribution primary source of cooking fuel with type of habitant for Household

From the figure2. Above it is shown that the households settlement and type of habitant influence a lot on the cooking fuel energy choice where in both umudugudu and unplanned clustered rural housing 91 percent of households use the firewood and 7percent use charcoal, for the case of isolated rural housing 97percent of the households use the firewood and 2.5percent use crop wastes for cooking purposes , here above it is shown that 72 percent of total households in unplanned inner-city housing use charcoal for cooking purposes,24percent use firewood and 3percent use other fuels like oil lamp, kerosene for cooking purposes , not surprisingly for the modern planned areas only 52 percent of the households use the charcoal, 39percent use firewood with improved cook stoves ,5 percent use LPG for cooking purposes and 3 percent use other fuels like oil lamp, kerosene for cooking purposes in there households.

CHAPTER FOUR: DATA ANALYSIS AND INTERPRETATION

4.1 Descriptive results

Table 3 shows that 84.55 percent of overall family units use firewood, tailed by Charcoal (12.57%) and crop waste (1.49%). Only 0. 0.60 percent 0.7 per cent, 0.06 per cent, 0.03 per cent of the family unit use additional energies, use gas (LPG) and Electricity correspondingly.

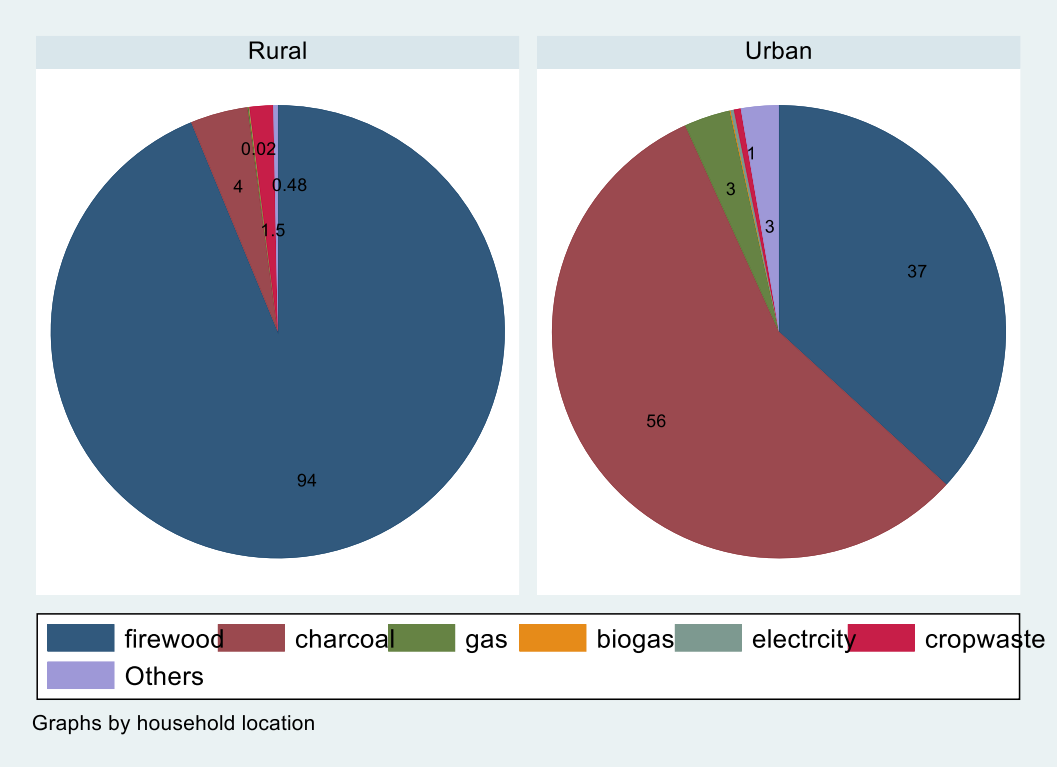
Within comprehensive, total of 86.04 Per cent of the family unit remain to depend on on little effective biomass energy (firewood, crop waste) for cooking.

Table 3.Household cooking energy expenditures by energy sources in region in all EICVs

Primary source of cooking fuel	household location				
	rural	Percentage	inner-city	Percentage	Total
firewood	22704	93.5	1720	37	84.55
Charcoal	994	4	2638	56	12.57
Gas(LPG)	20	0.16	154	3	0.60
Biogas	6	0.02	3	0.3	0.03
electricity	5	0.02	11	0.2	0.06
crop waste	407	2	23	0.5	1.49
Others	77	0.3	126	3	0.70
Total	24213	100	4675	100	100.00

Source: Author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

According to the results from above table3, a wide contrast in the utilization of kindling and gas (LPG) can be seen among remote and municipal families. In remote family units, about 93.5 percent use kindling and just about 0.16 percent use gas(LPG),whereas in metropolitan families just 37 percent use kindling and 3 percent use gas (LPG). Generally, it happens from the table 3 that the utilization of energy for cooking in Rwanda mirrors the common instance of a non-industrial nation that has hefty reliance on low productive biomass fuel and a wide distinction in the utilization of present day fuel among country and metropolitan zones respectively in the figure3.



Source: Author's construction using all EICVs (2010-2011/ 2013-2014/2016-2017).

Figure 3: Household primary sources of cooking fuel energy by location

From the figure 3 above is shown that rural households use firewood at 94 percent compared to the inner-city households with 37 percent while charcoal fuel was used at 4 percent in rural areas and 56 percent for inner-city areas LPG was use at 3 percent in inner-city areas while in rural areas was at 0.02 percent and other fuels like oil lamp, kerosene were use at 3 percent in inner-city areas whereas in rural areas were used at 0.48 percent , the crop waste fuels for cooking purposes were use at 1.5percent in rural areas whereas in inner-city were used at 1 percent .

Table 4: Percentage change in using primary source of cooking fuel from 2010 to 2016

Primary source of cooking fuel	year of survey			
	2010	2016	Increase/decrease (%)	Total
firewoods	12383	12041	-2.76	24424
charcol	1479	2153	45.57	3632
gas	11	163	1381.82	174
biogas	4	5	25.00	9
electrcity	8	8	0.00	16
cropwaste	340	90	-73.53	430
Others	83	120	44.58	203
Total	14308	14580		28888

Source: author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

From the table above showing the percentage change in primary source of cooking fuels used by households in different year of survey 2010 to 2016, It is shown that from 2010 to 2016 the households using firewood for cooking purposes decreased by 2.76 percent form 12,383 households using firewood in 2010 to 12,041 households using fire woods in 2016, also the households using charcoal increased by 45 percent and not surprisingly the households using gas for cooking purposes were increased by 138.2percent from 2010 to 2016.

Table 5: The associate of primary source of cooking fuel with type of habitants

(A)	household type of habitat						(A)	household type of habitat %					
	(a)	(b)	(c)	(d)	(e)	(f)		(a)	(b)	(c)	(d)	(e)	(f)
Firewood	12845	2395	7799	315	1070	24424	firewood	52.59	9.81	31.93	1.29	4.38	100
Charcoal	971	189	73	958	1441	3632	charcoal	26.73	5.20	2.01	26.38	39.68	100
Gas	34	0	0	10	130	174	gas	19.54	0.00	0.00	5.75	74.71	100
Biogas	4	0	2	2	1	9	biogas	44.44	0.00	22.22	22.22	11.11	100
Electricity	3	1	1	2	9	16	electricity	18.75	6.25	6.25	12.50	56.25	100
Crop	199	40	160	2	29	430	crop	46.28	9.30	37.21	0.47	6.74	100
Others	58	15	10	46	74	203	Others	28.57	7.39	4.93	22.66	36.45	100

Source: author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

(A): Primary source of cooking fuel

(a): Umudugudu (b): Unplanned clustered rural housing (c): Isolated rural housing

(d): Unplanned inner-city housing (e): Modern Planned area and (f): Total

From the table5 above it is shown that firewood were more used in the umudugudu settlement and isolated rural housing at 52.6percent and 31.9percent respectively, charcoal fuels for cooking purposes were more use in modern planned areas, umudugudu and unplanned inner-city housing at 39.7percent, 26.7percent and 26.4percent respectively, not surprisingly the gas fuels for cooking were more used in modern planned areas and umudugudu at 74.7 percent and 19.5 percent respectively. The households using the electricity foe cooking the highest is in modern planned areas at 56percent as expected and followed by 18.8 percent in umudugudu.

Table 6: The associate of primary source of cooking fuel with Regional provinces

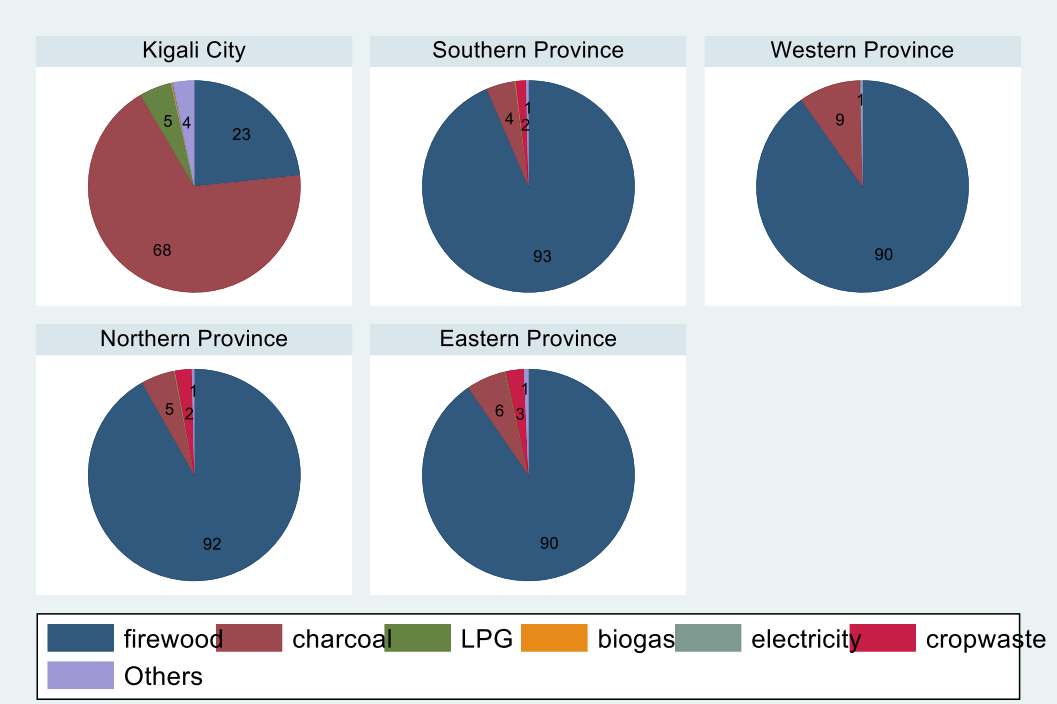
(A)	Province						(A)	Province				
	(K)	(S)	(W)	(N)	(E)	(T)		(K)	(S)	(W)	(N)	(E)
firewood	69	718	606	440	607	2442	firewood	23.	93.5	90.2	91.8	90.4
Charcoal	20	332	631	244	400	3632	charcoal	68.	4.32	9.39	5.08	5.95
Gas	14	7	5	5	12	174	gas	4.8	0.09	0.07	0.10	0.18
Biogas	3	4	0	1	1	9	biogas	0.1	0.05	0.00	0.02	0.01
electricit	6	2	5	3	0	16	electricit	0.2	0.03	0.07	0.06	0.00
crop	1	121	1	122	185	430	crop	0.0	1.58	0.01	2.54	2.75
Others	96	27	16	18	46	203	Others	3.2	0.35	0.24	0.38	0.68
Total	29	768	672	480	672	2888	Total	100	100	100	100	100

Source: author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

(A): Primary Source of cooking fuel (K): Kigali City (S): Southern Province

(W): Western Province (N): Northern Province (E): Eastern Province and (T): Total

From the above table 6, it is shown that southern province there were more household users for firewood at 93 per cent of the total cooking fuel energy used, households in Kigali city were more using charcoal at 68percent of the total cooking fuel energy used also Kigali city households were more users of gas for cooking purposes at 5 percent of the total cooking fuel energy used in Kigali, households in the Eastern province were the most users of crop wastes fuel energy for cooking at 3percent of the total cooking fuel energy used in the Eastern region as it is illustrated in figure 4.

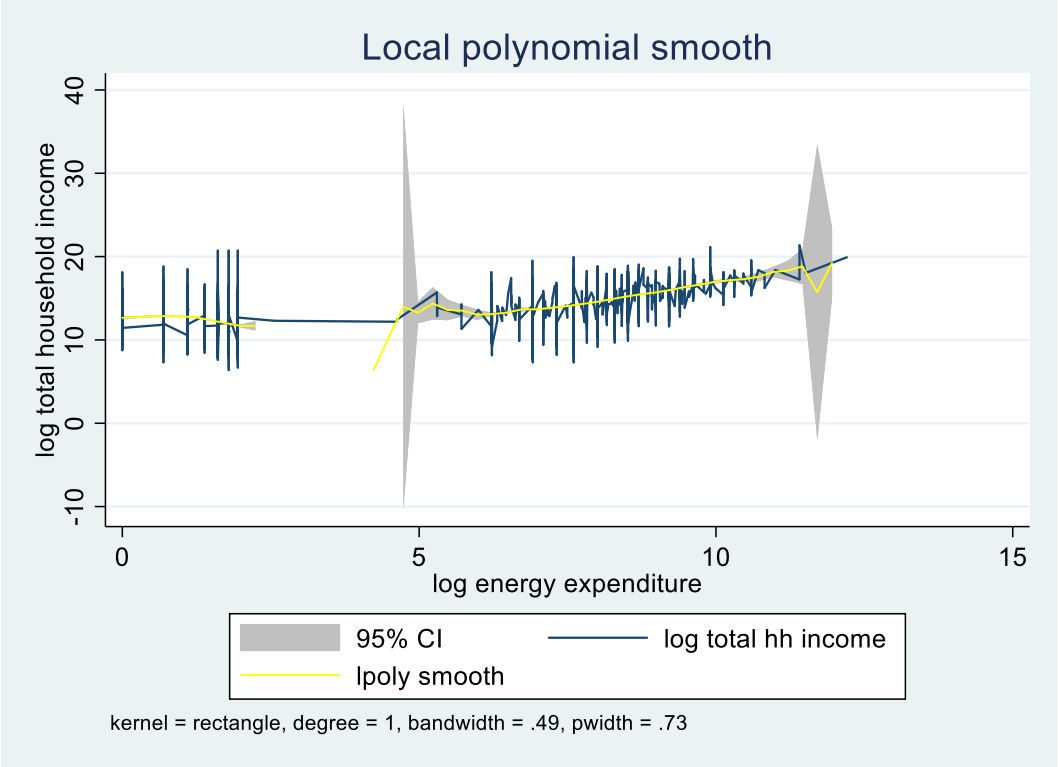


Source: Author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

Figure 4: The associate of primary source of cooking fuel with Regional provinces

4.2 Analytical Results

4.2.1 ECONOMETRIC ANALYSIS



Source: Author's construction using all EICVs (2010-2011/ 2013-2014/2016-2017).

Figure 5 : Household income and cooking energy expenditure relationship from 2010 to 2017.

From the figure 5 above which Shows the proportion of using total household income and energy expenditure, the smoothened yellow thick line local polynomial showed that energy expenditure for households raise with total income of the households with positive proportionality from 5units of energy expenditures and at confidence interval of 95 percent.

Table 7: Multinomial Logit Coefficients for Choice of Fuel for Cooking.

VARIABLES	Charcoal	kerosene	Gas	Wood	generator
Total household income	4.201*	-3.583***	1.226	-0.406	-415.4***
	-2.486	-0.944	-42.89	-0.863	-0.05
Home ownership	-0.329***	0.0759**	-0.404*	0.0212	0.039
	-0.0334	-0.0339	-0.225	-0.0327	-0.235
Household size	0.0628***	0.0691***	-0.065	0.0646***	0.0982***
	-0.00569	-0.00562	-0.0421	-0.00546	-0.0352
Type of marriage in household	0.763***	0.665***	-0.429	0.731***	0.0888
	-0.0491	-0.0444	-0.76	-0.0445	-0.274
Household head type of education	1.679***	1.406***	-1.197***	1.469***	0.626***
	-0.0241	-0.0237	-0.246	-0.023	-0.154
Age of household head	0.00271***	0.00844***	-0.01	0.00930***	0.00387
	-0.000766	-0.000766	-0.00806	-0.000743	-0.00503
Type of habitant	0.276***	0.0559***	0.0427	0.0580***	-0.000365
	-0.00804	-0.00819	-0.0518	-0.00792	-0.057
Household location	1.600***	0.245***	1.620***	0.151***	-0.423
	-0.0395	-0.0383	-0.291	-0.0371	-0.314
Non-energy expenditure of household	-4.503*	3.221***	-0.357	0.122	415.2
	-2.486	-0.943	-42.88	-0.862	0
Constant	1.659***	2.054***	-17.73***	1.289***	-3.792***
	-0.105	-0.105	-0.788	-0.101	-0.679
Observations	43,110	43,110	43,110	43,110	43,110

Notes_Titles
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's computed using all EICVs (2010-2011/ 2013-2014/2016-2017).

- ✓ Additional unit of income on households total income raise the likelihood for using charcoal and gas is increased by change factor of 4.2 and 1.226 respectively while decrease the likelihood of using kerosene and wood by change factor of 3.583 and 0.406 respectively.
- ✓ Polygamy headed households are less likely to use gas (LPG) by change factor of 0.429 while raising the likelihood of using charcoal, firewood and kerosene by change factor of 0.763, 0.731 and 0.67 probably because the polygamy-headed households are also economically requested more needs for the household family.
- ✓ Larger household size are more likely to use charcoal, kerosene, wood and generator by change factor of 0.0628, 0.069 and 0.065 respectively while reducing the likelihood for using gas by change factor of 0.065. The probable reason is that a larger household requires a higher

quantity of fuel which may be difficult to meet by the use of expensive LPG; consequently, they depend more on cheaper biomass fuel.

- ✓ Compared with inner-city households and rural households, inner-city households are more likely to use gas (LPG) and charcoal by change factor of 1.620 and 1.60 respectively and positive likely to use wood and kerosene by change factor of 0.245 and 0.151 respectively. This may be related to the accessibility and affordability of gas and charcoal which is much higher in inner-city areas than in rural areas.

4.2.1.1 Ordered logistic model for the overall model

Using the same set of the explanatory variables, an ordered logistic regression modelling has been estimated as an alternative to the multinomial logistic model. Here the dependent variable, ordinary variable (source of primary cooking fuel) is the one treated as ordinal based on the assumption of energy usage which says that the cooking fuel choice has a natural ordering from the most used fuel to the least used fuels. Therefore for this analysis , we arranged the primary cooking fuel from the most used fuel to the least used fuel in the following order: (1)firewood ,(2)charcoal,(3) crop waste, (4)others,(5)gas (6)electricity and (7)biogas.

The coefficient for total household income is positive and huge. It implies that an ascent in all out family pay would improve the probability of picking the most utilized fuel given different factors in the relapse model. This is in accordance with the outcomes from multinomial calculated relapse model. The subtleties of requested calculated relapse results are introduced in the table below.

Table 8: Results of ordered Logistic Regression

Explanatory Variables	Coefficient	Std. Err.
total household income	6.16	1.09
homeownership	-1.12	0.05
household size	-0.10	0.01
type of marriage in household	0.12	0.08
type of education of household head	0.17	0.04
age of household head	-0.02	0.00
type of habitant	0.22	0.01
household location	1.96	0.05
household non-energy expenditure	-5.77	1.09

Source: Authors' calculation using EICVs (2010-2011/ 2013-2014/2016-2017).)

Notes: Number of observations =28,693 LR chi2 (9) = 9978.18, prob. > chi2 = 0.000, Log likelihood = -10454.405, Pseudo R2 = 0.3231 Notes Titles: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

In additional for identifying the determinants of cooking fuel choice at the household level, the study also verifies the energy ladder hypothesis. In order to validate the link between income and the cooking energy choice, here the households were subdivided into two groups namely, households with non-farm business and households without non-farm businesses. A dummy variable is in the form of K=1for households with non-farm businesses and K= 0 for households without non-farm businesses. The model was then re-estimated with new dummy variable (non-farm) while retaining the other explanatory variables. The results in table9 show that in comparison to households without non-farm businesses, the households with nonfarm businesses are increasingly more likely to use gas in place of firewood by change factor of 0.672.

Table 9: Effect of non-farm business (binary variable) in the Household's Choice of fuel for Cooking.

Independent variable	wood	charcoal	kerosene	generator	gas
dummy for non-farm business					
	0.02	0.112***	0.03	0.00	0.672**
Non-farm	-0.02	-0.02	-0.02	-0.16	-0.32

Sometime the households without other activities different from farming activities they usually made choice of cooking energy fuels different from the choice sometimes made by the households with only farming activities which rely mostly on the traditional cooking energy fuels as a result of the fuels accessibility for instance . Then in this study we would like to include the control dummy variable which is equal to unit if the household have other non-farm activities and zero otherwise. The results (table 9) shows that in comparison to farm business, non-farm business households are more likely to use Gas (LPG) by change factor of 67.2 percent in place of other cooking fuel energy while the households with non-farm business are more likely to use the charcoal by change factor of 11.2 percent compared to the households without non-farm businesses.

Table 10*:* Marginal effects Coefficients and Predicted probability of a Multinomial logit estimates (Base fuel choice= wood).

VARIA	charco Dv/Dx pr(choice=.411		keros Dv/D pr(choice=.27		gene Dv/Dx pr(choice=		Gaz Dv/Dx pr(choice=		wood Dv/D pr(choice=.32	
Lninco	3.540	0.631	-	-	-	-	1.227	0.004	-0.473	-0.090
	-2.409	-0.429	-0.950	-0.170	-	-0.129	-	-0.123	-0.852	-0.162
Homeo	-	-	0.075	0.013			-	-		
wner	0.330*	0.0587	8**	6**	0.039	0.000	0.404	0.0011	0.021	0.004
	-0.033	-0.006	-0.034	-0.006	-	-0.001	-	-0.001	-0.033	-0.006
Hhsize	0.0628	0.0112	0.069	0.012	0.098	0.0004	-	0.000	0.064	0.012
	-0.006	-0.001	-0.006	-0.001	-	0.000	-	0.000	-0.005	-0.001
Polyga	0.763*	0.136*	0.665	0.119	0.089	0.000	-	-0.001	0.731	0.139
	-0.049	-0.009	-0.044	-0.008	-	-0.001	-	-0.002	-0.045	-0.008
basic_ed	1.679*	0.299*	1.406	0.252	0.626	0.0026	-	-	1.469	0.279
	-0.024	-0.003	-0.024	-0.004	-	-0.001	-	-0.001	-0.023	-0.004
Agehhd	0.0027	0.0004	0.008	0.001	0.004	0.000	-	0.000	0.009	0.001

	-0.001	0.000	-0.001	0.000	-	0.000	-	0.000	-0.001	0.000
Typhbt	0.276*	0.0492	0.055	0.010	0.000	0.000	0.043	0.000	0.058	0.011
	-0.008	-0.001	-0.008	-0.001	-	0.000	-	0.000	-0.008	-0.002
Inner-	1.601*	0.285*	0.245	0.043	-	-0.002	1.620	0.0046	0.151	0.028
	-0.040	-0.007	-0.038	-0.007	-	-0.001	-	-0.001	-0.037	-0.007
Lnnone	-3.842	-0.684	3.273	0.586	415.2	1.781*	-	-0.001	0.190	0.036
	-2.408	-0.429	-0.949	-0.170	0.000	-0.129	-	-0.123	-0.851	-0.162
Constan	1.674*		2.054		-		-		1.290	
	-0.104		-0.105		-		-		-0.101	
Observa	43,110	43,110	43,11	43,11	43,11	43,110	43,11	43,110	43,11	43,11

Standard errors in
*** p<0.01, **

From the table 10, above it shows the marginal analysis for cooking fuel energy, it is shown that additional percentage rise in total households income is associated with an increase in in the predicted probability of using charcoal and gas by 63.1% and 0.4% respectively.

Also the additional percentage rise in polygamy for household heads is associated with an increase in in the predicted probability of using charcoal, firewood and kerosene by 13.6%, 13.9% and 11.9% respectively.

As expected, the additional percentage rise in household size of members is associated with an increase in in the predicted probability of using charcoal, kerosene, wood by 1.12%, 1.24% and 1.23% respectively. Not surprisingly, the additional percentage rise in households living in inner-city areas is associated with an increase in in the predicted probability of using gas (LPG) and charcoal by 0.463% and 28.5% respectively.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

The study revealed the higher dependency on biomass cooking energy fuels among Rwandan households with 84.55 percent for firewood usage and 12 percent for charcoal usage for cooking purposes. The socio-economic attributes in inducing household's choice for cooking energy fuels have been identified. These include households' income, household location, age of household head, non-energy expenditures, number and composition of the members in households, type of habitant through different settlement methods, whether the household live in their own homes or rented homes.

There is straight relationship between household's non-energy expenditure with house household cooking energy source choice. Considering that the large proportion of households have likelihood of choosing either the firewood (84.55 percent) or the charcoal (12 percent). Although there was significant decline in the proportion of the family units using biomass energy sources for cooking purposes between 2010 and 2017 the total number of households using the charcoal energy for cooking purposes were decreased by 84.2 percent from wave1(2010/2011) to wave2(2013/2014) while 81 percent were a decrease from wave1(2010/2011) to wave3(2016/2017), the total number of households using wood fuels energy for cooking purposes were decreased by 89.1 percent from wave1(2010/2011) to wave2(2013/2014) while 83.1 percent were a decrease from wave1(2010/2011) to wave3(2016/2017), the condition seems to be persistent requiring energy sector targeted policies for taking care about this problem through introduction of other cleaner modern cooking energy fuels.

Taking into consideration of high demand for biomass cooking energy fuels especially for firewood and charcoal and yet the regeneration rate for wood is very low hence the high depletion rate resulted from the high pressure under the forest resources. To ensure the forest resources conservation, an intervention is required to reduce the high dependency for wood cooking energy fuels. The successful intervention would address the cost of energy and other consequences like health problems and environmental issues resulted from highly relying on wood cooking fuels. It is difficult to replace trees/forest for climate change mitigations at the desired pace for our country while it is possible to shift the family units from traditional cooking energy fuels to cleaner modern cooking energy fuels.

i. Therefore this study suggests the need of the urgent and deliberated energy for cooking policies interventions for the households to switch to cleaner modern cooking energy fuels from

traditional cooking energy fuels especially wood fuels and hence decreased impact of cooking energy fuels in the country.

ii. The government should not only increase the overall inner-city ization rate within the country since the study showed that households living in inner-city areas are likely to use the clean modern cooking energy fuels but also improve the settlement means within the country since the study revealed that type of habitant for households influence the households' cooking energy fuels choice.

iii. The energy companies within the country should improve the training programs about the cleaner modern cooking energy uses without relying only on the formal education for the households' heads as the study surprisingly showed that household head with formal education were likely to use charcoal and wood fuels while were expected to be more likely to shift to cleaner modern cooking energy fuels instead.

iv. The households were encouraged to carry out the non-farm businesses for raising the total household income as the study showed that households with higher income were likely to use wood fuels but more likely to use cleaner modern cooking energy fuels.

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