Determinant of Household Adoption for Electric Injera Mitad in Deber Berhan Town, North Shewa Zone, Amhara Region, Ethiopia.

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Abstract

This paper examines the Determinant of Household Adoption for Electric Injera Mitad in Debere Berhan Town, North Shewa Zone, Amhara regional state, Ethiopia in 2017/18. A survey was conducted with a structured questionnaire for 269 households that were randomly selected from five kebeles and to provide empirical evidence on the adoption of electric injera Mitad. The study used Multistage sampling technique for sampling design and collected the cross-sectional data. The data were analyzed by using descriptive statistics and logistic regression analysis. The regression result reveals that Sex of household Head, Marital status, Family size, household head education level at post-secondary level, owning house, separate kitchen, owing of traditional Mitad, owning electric meter, and total amounts of household income are statistically significant at 1 % and 5 % level of precision. The results indicate that the significant variables have probabilities of explaining the adoption of Electric injera Mitad estimation. On the other hand, the remaining variables like age, own refrigerators and energy expenditure are found to be statistically insignificant. Thus, households' education level should be increased through adult education. Family panning should be more addressed intensively, household's income should be increased in different income generation schemes, the dissemination of electric meter should be accessed to all households and different modern improved electric injera mitad should be available to town households.

Key words: *Adoption, Electric Mitad, Logit, Injera, Multistage*

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1. Introduction

Energy is one of the basic elements of economic and social development. It contributes to health, education service delivery and helps to meet the basic human needs such as food and shelter (IEA, 2006). There are traditional and modern energy sources. Traditional energy sources are firewood, charcoal, crop residues and animal waste. They are also referred as biomass energy and are obtained from natural environment. The modern energy sources are kerosene, LPG and electricity. These energy sources are collectively termed as modern or commercial energy sources (Leach 1987; Getamesay et al. 2016). Access to modern, clean and reliable energy affects practically every aspect of economic development and human wellbeing. Besides, Modern energy services have important role in improving production and productivity. They relieve millions of women and children from daily burden of water fetching and firewood collection. Energy can help to extend the working time, increase individual income, invest children's time in schooling and deliver health services to the community (World Bank 2000).

Energy demand, supply and use is tightly interlinked with multiple environmental and socio-economic issues, and has emerged as one of the major sustainability challenges in developing countries. The number of people who depends on traditional energy sources in the world is estimated to be 2.7 billion in 2009. Among these, 2.6 billion people are from developing countries, of which 653 million people of which are from Sub-Saharan Africa. In case of Ethiopia, more than 67 million people are dependent on biomass energy to meet their cooking, heating, lighting and hygiene needs (UNDP 2009; IEA 2010; CSA 2012). Regarding access to electricity, 1.32 billion people in the world lacks access to electricity. From this, 1.3 billion people are from developing countries, of which 586 million people are from Sub-Saharan Africa. In Ethiopia, more than 56 million people live without access to electricity. Generally, 51% of the population of developing countries, 78 % of Sub-Saharan African population and 91, 6% of Ethiopian population depends on biomass energy for their energy use. Moreover, 25% of developing countries population, 69% of Sub-Saharan African countries population and 63 % of Ethiopian population have no access to electricity (UNDP 2009; IEA 2010; Getamesay et al. 2016; IEA, 2017).

Ethiopia is one of the least developed countries in the world. Approximately about 34% of its population lives below poverty line (UNDP 2018). It has one of the lowest rates of access to modern energy services, whereby the energy supply is based on biomass. With a share of 91.6% of Ethiopia's energy supply, waste and biomass are the country's primary energy sources, followed by oil, 6.1% and hydropower, 1.7% (IEA 2017). However, such heavy dependency on biomass energy sources creates more burdens on deforestation, land degradation, soil erosion and climate change (World Bank 2000; Alemu et al. 2008; Yonas et al. 2013). Thus, improving access to affordable and reliable modern energy services for cooking is essential for Ethiopia like other developing countries. In addition, urban households need to shift from solid biomass fuels to modern energy sources, like electricity. However, household switch to electricity use for cooking highly depends on the adoption of appropriate cooking appliances, easy access to electricity or stove technologies.

In Ethiopia like Sub Sahara Countries, plenty of programs and initiatives have been working to disseminate improved and modern cooking stoves, which have health, economic and environmental benefits. In spite of this, household demand and awareness of benefits of improved and modern cooking stoves (such as reducing indoor air pollution) remain low in Ethiopia. As a result, there are various challenges for modern stove adoption, like Other developing countries (Tigabu et al. 2014; Bensch et al. 2015 ; Hanna et al. 2016). Therefore, the government has tried to promote clean stove technology to societies by designing of different program and packages. In contrast, if traditional stove technology is more available, households are less likely to want to use a new stove. Thus, understanding of determinants of adoption of new cooking stoves is important for the design and implementation of effective energy policies to enhance access to clean cooking. It results for achieving the United Nations Millennium Development Goals (MDGs) for child mortality, maternal health, poverty eradication, gender equality, and environmental sustainability, but also, the adoption of modern injera mitad has enormous impact on social and economic development and overall quality of life of the population.

The adoption of electric Injera Mitad is determined by many factors like energy price, household income, stocks of energy sources, population, level of urbanization, family size, level of technology and overall development and structure of the economy, etc. at macro and micro level are amongst the major ones to be mentioned (World Bank, 2000 ; Hanna et al., 2016). And, at household or micro level, different socio-economic factors like income, price, family size, education, technology, accessibility affects the adoption of this technology.

In developing countries including Ethiopia, different studies have been conducted on the determinants of adoption of Electric Injera Mitad. For example: (Chambwera 2004; Ouedraogo 2006 ; Troncoso et al. 2007; Inayatullah 2011; Pine et al. 2011; Nyembe 2011; Axen 2012; Nnaji et,al. 2012; Isaiah et al. 2014). Those studies listed above considered different factors to determine Adoption of Baking Stoves in general Electric Injera Mitad (Stove) in particular. the results showed from above studies that Household Energy expenditure, household size, Types of stoves, price of fuels, price of electricity, Household income, the number of rooms used by the household , owning of refrigerators, having separate kitchen, family head education level were the main determinants factor for adoption of Electric injera mitad in the study areas.

In Ethiopia context, most of the existing researches/studies like (Zenebe 2007; Dawit 2008; Zenebe et al. 2010; Damte and Koch 2011; Yonas et al. 2013; Tigabu et al.2014; Warkaw et al. 2015; Getamesay et al. 2016 ; Mebratu 2019) focused on main factors of adoption of electric mitad for their studies. From their findings: family sizes, age of household, education of family head, owing of electric meter, having separate kitchens, and adoption of baking stove were important variables for adoption of injera mitad.

Therefore, from reviewing of empirical studies carried out in various countries by different scholars, different socio-economic variables have been identified as important variables affecting for adoption of baking stoves. Determinants of adoption for stoves in general, electric injera Mitad in particular depends on price, total expenditure and the household characteristics (family size, age of family head, level of education, gender, occupation, separate kitchen, price of energy etc.). In many literatures, no standard rules were found for inclusion of household characteristics for demand analysis in many countries, despite their importance in shaping of household consumption behaviors. Therefore, this study tried to examine The Determinants of Households' Adoption of Electric Injera Mitad in Debere Berhan Town, Amhara Region, Ethiopia. by considering the socio-economic of the households like price of energy, income of household, wealth, age of household, sex, family size, own, electric meter, separate kitchen, education, owning of refrigerator, etc.

The rest of the paper is organized as follows. Section 2 provides methodology section that describes data and econometric analysis used in the study. Section 3 emphasis on discussion of results with its interpretation and finally Section 4 presents conclusion and recommendations of the study.

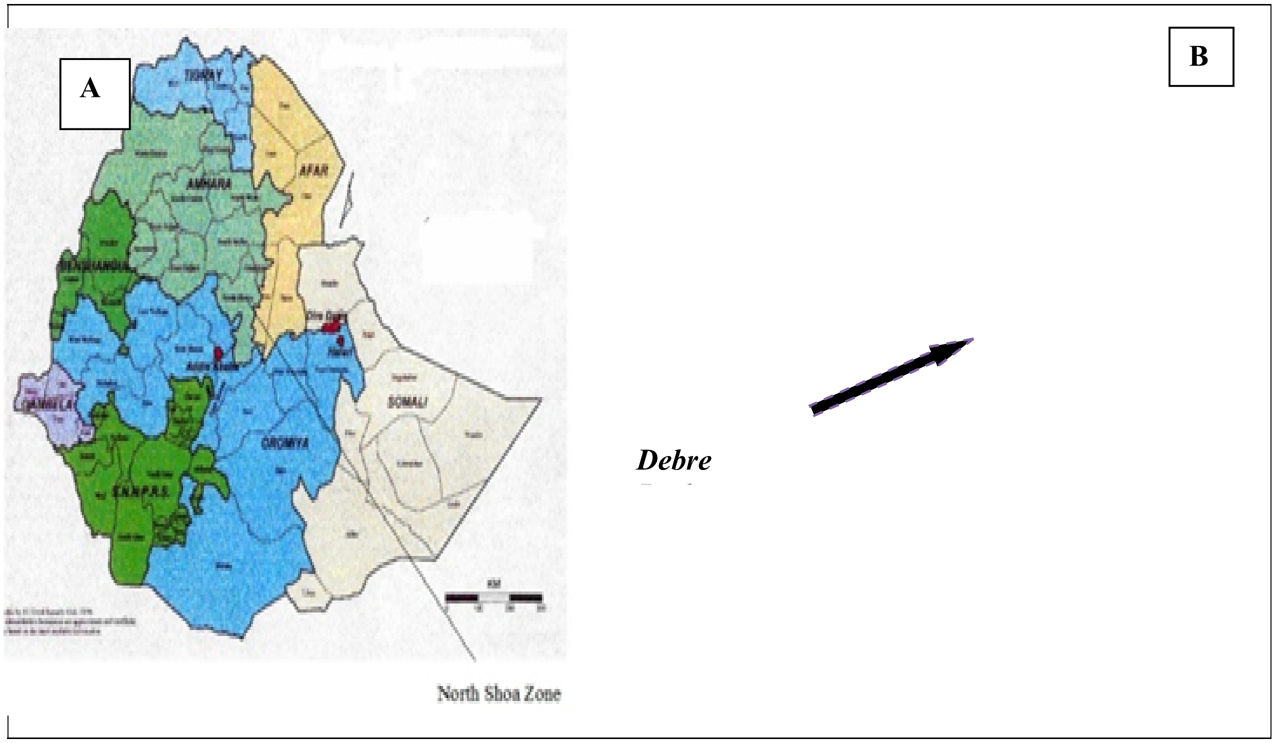
2. METHODOLOGY

2.1. Description of the study areas

Figure 1. Shows the map of Debre Berhan town, North Shewa zone, Amhara regional state, Ethiopia. The town is located in the North Shewa Zone of the Amhara Region, about 120 kilometers north east of Addis Ababa on the paved highway to Dessie, the town has a latitude and longitude of 9°41′N 39°32′E.It was an early capital of Ethiopia and afterwards, with Ankober and Angolalla, was one of the capitals of the kingdom of Shewa. Today, it is the administrative center of the North Shewa Zone of the Amhara Regional State. The town is located along Ethiopian Highway one which connects Addis Ababa with the north of the country (DBTA, 2013).According to Debre BerhanTown Administration the projected population of the City in 2017 is reach 84,944 people, out of this 41,248(48.6%) are males and 43,696(51.4%) are females. Out of the total number of the Population of the city's administration 38,588 people live in urban area, while the remaining 46,356 people live in the sub urban area of the administration. Besides, the suitability of the town for investment is location advantage (near to Addis Ababa), better economic performance, good governance and other related issues (DBTA 2013; CSA 2018).

The residents of Debere Berhan town use both modern and traditional energy sources for domestic energy activities. The sources are firewood, charcoal, animal dung, sawdust, barks, roots, leaves, kerosene, LPG and electricity (German Technical Cooperation-Sun (GTZ-Sun, 2010). Many factors were considered for selecting the study area. The key reasons for selecting Deber BerhanTown are: large numbers of the population live in the city, shortage of firewood, charcoal, kerosene and LPG, and the accompanying rise of their prices, and the sustainability challenges of energy supply. The other important energy feature of the town is that there are some peri-urban kebeles that have no access to electricity. In the town, there is less expansion of electricity grid, price fluctuation of different energy sources, and physical inaccessibility of more kerosene and LPG.

Figure 1. Map of Ethiopia (A), North Shewa Zone (B), Debre Berhan Town (Thick arrow)



Source: Mereja.com 2019. www.maplandia.com/ethiopia/amhara.

2.2 Data Source and collection procedure

Primary data were collected through the administration of a semi structured and personal interview by a team of 5 trained enumerators to 269 households considered. Furthermore, secondary data were collected from published and unpublished reports, researcher's website and already available documents from Debre Berhan town Administration Finance and Economic office, the central statistics authority and other relevant documentary sources.

The data collection procedures are as follows: first, the questionnaire was first prepared in English, translated to Amharic and back to English to ensure language use consistency. Second, all the data collection tools were pilot tested to check reliability and validity before the actual data collection. Therefore, taking the information of the pilot study, reliability was tested by Cronbach's alpha, with a value of 0.766 indicating strong reliability. Finally, the actual data collection was performed with the formal permission written letter from Debre Berhan University with approval of Debre Berhan town administration.. The quantitative data collection was carried out by the face-to-face interview of smallholder farmers by trained data collectors. The data collectors were University graduates from Deber Berhan University and selected on their performance. They were assigned after given training of how to data collection for each sampled kebele properly and correctly.. For ensuring data quality, all the interviews were performed in the local language (Amharic). As well, on spot checks, re-interviewing and vigilant examination of completed questionnaires and quality of the recordings were performed through daily supervisions with the close attendant of the researcher.

2.3. Sample Size Determinations

Table 1 presents the sampling designs and procedures that were employed for this study. To make generalization about the whole population different sampling designs and procedures are used to the get the truly representative sample (Creswell 2009). Thus, The study used primary data that were collected from 269 households in 2017/18. The study employed a multistage stratified random sampling technique to choose the sample households. The multistage random sampling technique is used for large scale enquiry covering large geographical area such as a state, large or medium city or town. Deber Berhan Town is the largest city in Ethiopia and has nine Kebeles with more than 80,000 populations. In the first stage of multi-stage sampling, Debere Berhan town is divided in to two stratums like stratum 1 and 2, in the second stage, Kebeles were selected randomly from the two strata and, and finally households were selected randomly from each kebele.

The stratification criteria are based on: geographical location (distance from the center), boundaries with surrounding rural areas, size of geographical areas, population size and economic activities. Stratum one (outer town) has five Kebeles, namely Kebele 01, 06,07,08 and 09 and the major economic activities of the people are trade, services, transport, hotel, manufacturing, urban agriculture and animal husbandry. And, Stratum two (inner town) has four kebeles, namely Kebele 02, 03, 04 and 05 and the major economic activities of the people are trade, services, transport, hotel and tourism. After classifying the town into strata, three Kebeles (60%) were randomly selected from the first stratum, i.e. Kebele 01, 07 and 09 and two kebeles (50%) from second stratum – Kebele 03 and 05. After selecting five kebeles from two strata randomly, then, 269 households were randomly selected from the selected kebele for the study. Therefore, the sample size (n) of the study is

$n = \frac{N}{1+N(e2)}$, where" n=Sample size, N=total number of households, e= level of precision (0.060)

$n = \frac{8184}{1+8184(0.06*0.06)}$

$n=\frac{8184}{1+294624}$

$n=\frac{8184}{304624}$

n = 268.65Hhs

n = 269Hhs.

And, to determine minimum sample size in each kebele, the study considered proportional sampling technique for their sample size distribution, the total samples (269) to the selected kebeles proportionally. For each kebele sample size was computed as follow in table 1below,

Table 1: Sample size distribution in each Kebele

Stage-1				**Stage-2**			**Stage 3**
Strata	Classification of DB town	No of Kebele	Name of Kebeles	Selected Kebele	No of HHs in Each Kebele	Proportion of sample:n/N	Sample
Stratum-1	Inner town	4	Kebele **02,03, 04 and 05**	Kebele 03	1669	0.207	55
				Kebele 05	1497	0.181	49
Stratum -2	Outer /sub town	5	**Kebele 01, 06, 07, 08 and 09.**	Kebele 01	1630	0.199	54
				Kebele 07	1037	0.126	34
				Kebele 09	2351	0.287	77
Total		**9**	**9**	**5**	**8184**	**1.000**	**269Hhs**

Source: Own Computation, 2017/18.

2.4. Model Specification

Economics model precise in assessing the relationship between the dependent and explanatory variables and predicts its significance. According to Gujarati, 2009, multiple regression equation can be stated as follows:

$Y_i = \beta_1+\beta_iX_i + \varepsilon_{i}$---(1)

Where: Y stands for vector of "n" observations of dependent variable, $\beta_i$is parameter to be estimated, X_i is a vector of household characteristics and εi is an error term.

Therefore, Table 2 presents all variables which used for this study as Age of HHs head, Sex, Marital status, Family size, Education level of HHs head, Own House, Own Refrigerator, Separate Kitchen, Own Traditional Mitad, Own Electric meter, Energy Expenditure and Total expenditure, Those factors are specified as below

$$Y(1/0)=\alpha+\beta_1AGE+\beta_2SEX+ \beta_3MARST+ \beta_4FAMS+B_5EDU+B_6OWNHU+B_7OWNREF+B_8SEPKI+B_9OWNTM+B_{10}OWNEM +\beta_{11}ENEXP+\beta_{12}TEX+ \varepsilon$$

Table 2. Description variables used in the logit model

Variables	**Variables full name**	**Definition**	**Variable Type**	**Measurements**
Y	Electric Injera Mitad adoption	Whether Household Head Adopts Electric Injera Mitad or not	Categorical	1= Adopts, 0, not
Age	Age of Household Head	Age of Household Head	Continues	Number
Sex	Sex of Household Head	Whether Household Head is male or Female	Categorical	1= Male, 0 = female
Mar status	Marital status	Whether Household Head is Married or not	Categorical	1= Married, 0, not
Family size	Family Size	Total number of family	Continues	Number
Educa	Education level of Household Head	Educational level of household Head	Categorical	1= Above secondary, 0, not
Own House	Own Private House	Whether Household Head own house or not	Categorical	1= Own, 0, not
Own Ref	Own Refrigerator	Whether Household Head own refrigerator or not	Categorical	1= Own, 0, not
Sep kich	Separate Kitchen	Whether Household Head own separate kitchen or not	Categorical	1= Own, 0, not
Own Tr-M	Own traditional Mitad	Whether Household Head own traditional mitad or not	Categorical	1= Own, 0, not
Own Elc Met	Own Electric Meter	Whether Household Head own electric meter or not	Categorical	1= Own, 0, not
Eng ex	Energy Expenditure	Total amounts of energy expenditure	Continues	Birr
Total Ex	Total Expenditure	Total amounts of Expenditure	Continues	Birr

Source: Own Computation

2.5. Model Estimation

Logistic regression is a nonlinear regression model that forces the output (predicted values) to be either 0 or 1. Logistic models estimate the probability of dependent variable to be 1 (Y=1). This is the probability that some event happens (Cameron et al. 2005). Thus, the dependent variable (electric injera baking mitad adoption status) is binary, which takes a value of y = 1 if the household is adopter of electric injera baking mitad and the value y = 0 if the household is not adopter of electric injera baking mitad. Thus, the study considers for estimating the probability that the household is adopter of electric injera baking mitad, given the explanatory variables.
Logistic model expresses as,

$$P(y_i = 1|X_i) = \Lambda(\beta_0 + \beta X_i) = \frac{e^{(\beta_0+\beta X_i)}}{1 + e^{(\beta_0+\beta X_i)}}$$

Where

- $P(y_i = 1|X_i)$ is the probability that household *i*is adopter of electric injera mitad, given the explanatory variables,
- Λ is logistic cumulative distribution function,
- X_i column vector of explanatory variables and

- β row vector of slope of coefficients to be estimated.

Therefore, the logit model has potential to estimate the change in the probability of an event occurring as the result of a unit change in the value of a specific explanatory variable, with the effect of all other explanatory variables held constant. That means, the estimated coefficient of a variable gives the change in the coefficients or log odds associated with a unit change in the variable, holding all other variables constant (Gujarati 2009).

2.6 Diagnostic Tests

Before fitting important variables into the multiple regression models, it is necessary to test multi-co-linearity problem among continuous variables and check associations among discrete variables, which seriously affect the parameter estimates. According to Gujarati, 2009, multi-co-linearity refers to a situation where it becomes difficult to identify the separate effect of independent variables on the dependent variable because the existing of strong relationship among them. In other words, multi-co-linearity is a situation where explanatory variables are highly correlated. There are two measures that are often suggested to test the existence of multi-co-linearity. These are Variance Inflation Factor (VIF) for association among the continuous explanatory variables and Contingency Coefficients (CC) for dummy or discrete variables. Another diagnostic test for heteroscedasticity: heteroscedasticity, that is, diverse variances between residual terms. To detect heteroscedasticity problem the study uses Breusch-Pagan / Cook-Weisberg test. The result shows that even variance is constant at H0Prob>chi2 =0.000 tells us reject H0, that means there is problem of heteroscedasticity. To minimize this problem the study regressed by robust Logistic regression.

3. Result and Discussion

3.1. Descriptive analyses

The study used descriptive statistics and econometric models. According to survey results, the average age of a household head is 47.69 years and its ranges from 23 years to 90 years old. The average number of family size is 4.7. The family size of a household varies from one person to twelve persons. Besides, 73, 6% of the sample households are male headed family while the remaining 25.4% of the households are female headed. Out of 269 households, 67.66% of the household heads are married. The remaining22.34% of the household heads is widow, single or divorced. Regarding to educational level, 33.43% of the household heads are post-secondary school or above grade 12 or college graduates. In the case of own house, 38% of the households live in their own houses and the remaining 62% of the households live in rented houses from kebele administration and government houses agency, live in rented houses from private house owners, or live in their own condominium or live in their family houses. Therefore, the majorities of the households live in kebele administration and agency for government houses, then, private owned houses and rented from private house owners than their own (See Annex II).

Out of 269hhs, 55 percent of the sampled households adopted the electric injera mitad for their injera baking activities. Whereas, the remaining 45 percent of the respondent households were not adopted the injera mitad. The reason for not adoption is that the baking mitad price is very much expensive than other traditional mitads. Besides, 72 % of the households' access electricity by their own electric meter. The remaining 28% of the households' access electricity from their neighbors, families or from others. In the case of energy appliances, 56% of the households have refrigerator to cool or preserve their food for long time. 54.6% of the households use traditional mitad for baking activities and, 53% of the households have separated kitchen for their cooking purposes. In addition, In the case of total expenditure, Household's total expenditure used as a general indicator level of household income. The total household expenditure is a proxy of total income. An average household's monthly expenditure is 3022.18 Ethiopian birr per month. From this, a household spends on average 386 Ethiopian birr or 12.7 % for energy and, the remaining amounts 87.3 % expends for food and other activities (See Annex II).

4.2. Determinants of Adoption for Electric Injera Mitad at Household Level

Table 3 presents the econometric estimation of all variables by logit model, in which variables that significantly affect adoption of electric injera mitad. In logit estimation of adoption of electric injera mitad, Sex of household Head, Marital status, Family size, household head education level at post-secondary level, owning house, separate kitchen, owing of traditional Mitad, owning electric meter, and total amounts of household income are statistically significant at 1 % and 5 % level of precision. According to the Logit output results, the significant variables are the main determinants factors for adoption of Electric injera Mitad estimation. On the other hand, the remaining variables are found to be statistically insignificant.

The data was estimated using Stata software application version 11.2. From the logit regression result depicted in the below table, we can observe that the explanatory variables identified in the model sufficiently explain variation in the dependent variable, which was shown by high value of Pseudo R^2 (=0.3756). Moreover, probability of chi^2 is statistically significant at 1 percent, which indicates that all explanatory variables taken together are significant in explaining the model. Before estimating, the study used different diagnostic test for[1]Multicollinearity is tested by the [2]VIF, [3]TOL test and [4]Spearman's correlation coefficient matrix for energy poverty model. From the findings, the correlation coefficient values are not found to show perfect correlation (negative and positive) between the variables.[5] Heteroscedasticity is also tested by Breusch-Pagan test. The test assures the presence of heteroscedasticity (has not constant variance in the ε_i) and study regressed by robust Logistic regression to solve the problems. Therefore, the model can be valid to determine variables that significantly affect adoption of electric injera mitad by households in the study area.

After identifying the main determinant factor for adoption of electric injera Mitad by logit model, the marginal effect of method used to estimate the explanatory variables on dependent variables. AS can be seen from Table 3, sex, marital status, household head education level at post-secondary, owning of separate Kitchen and owning electric meter the main determinant factors that affects to adopt electric injera Mitad at household level and those variables are found to be statistically significant at 1 % level of precision. Besides, Family size, own of traditional mitad and total expenditure are the main determinants to adopt and those variables are found to be statistically significant at 5 % level of precision. On the other hand, the remaining variables like Age, Own refrigerator and Energy expenditure are not found to be statistically significant. Thus,

Table 3. Logit Estimation for adoption for Electric Injera Mitad

Explanatory variables	**Dependent variable Y 1 = Adoption for** Electric Injera Mitad, 0, otherwise	
	Logit Output	Marginal effects dy/dx

[1]Multicollinearity means the existence of perfect or exact linear relationship between two or more explanatory variables in the regression model.

[2] Variance inflating factor measures the speed with which variance and covariance increase. It is computed as $VIF = \frac{1}{1-r2}$,

Where: r^2 is Correlation Coefficient, then, VIF=1.67, r^2=0.40

[3]TOL =1/VIF or $1-r^2$ = 1/1.67 = 0.60

[4]. All Spearman's correlation coefficients are below 0.8.

[5]The probability distribution of random variables (u_i) is the same over all observation of x, and in particular that the variance of each u_i is that same for all values of the explanatory variables $Var(u_i) = E\{(u_i – E(u_i)\}^2 = E(u_i)^2 = \delta^2$= Constant variance.

Heteroscedasticity is also tested by Breusch-Pagan test as $Chi^2(12) = 27.34(0.0069)$

Age	- 0.0065 (0.0161)	-0.0015 (0.0038)
Sex	-1.3456** (0.5229)	-0.2829*** (0.0949)
Marital status (1 if married)	1.3055*** (0.4864)	0.3212*** (0.1118)
Family size	-0. 2849** (0.1142)	-0.0589** (0.0272)
Hhshead education level (1 if Post-Secondary)	2.6592*** (0.4424)	0.5071*** (0.0624)
Own house (1 if own)	0.5961* (0.3698)	0.1365* (0.0830)
Own refrigerator (1 if own)	0.4863 (0.4380)	0.1154 (0.1039)
Separate Kitchen (1 if own)	0.8674*** (0.3356)	0.2038*** (0.0817)
Own traditional Mitad(1 if own)	-0.8362** (0.3536)	-0.1937** (0.0788)
Own electric meter (1 if own)	1.8597*** (0.4430)	0.4337*** (0.0907)
Energy expenditure	2.8763 (4.5024)	0.6808 (1.0636)
Total expenditure	0.0005** (0.0012)	0.0001** (0.000)
Constant	-2. 6664** (1.2995)	
Pseudo R^2	0.3756	-
Wald $chi^2(12)$	101.95	
Prob> chi^2	0.000	
Number of Observation	269	269

*** Significance at 1%, ** significance at 5%, * significance at 10%, Standard error is in bracket,
Source: Household survey, 2017/2018.

The coefficient of Martial status is positive; it indicates that, households with married status have more probability to adopt electric injera mitad than unmarried households. It means that, if unmarried household become married, keeping other variables constant, the probability of adoption increases by 31%. This can be due to the more individuals who are living in the married households than unmarried ones. This finding is similar to the works of (Damte and Koch 2011; Yonas et al . 2013 ; Warkaw et al.2015).

The coefficient of family size is negative. It indicates that, households with more family member have less probability of adoption of electric injera Mitad. It means that, if the family size increases by one member, keeping other variables constant, the probability of adoption decreases by6%. This may be due to small family member have more opportunity or possibility to use modern energy sources by having more income and can buy different energy appliances than large family member households. It has similar results to the works of Chambwera 2004; Ouedraogo 2006; Zenebe 2007; Dawit 2008; Zenebe et al. 2010 ; Isaiah et al. 2014).

The coefficient of households' head education level at post-secondary level is positive. It indicates that, households with high education level are more likely to adopt electric injera mitad than less educated family head. It means, if households head level of education increases to post-secondary level, keeping other variables constant, the probability of adoption of Electric injera Mitad increases by 51%. This can be due to the more educated households earn more income, spend more for modern energy technologies and uses different energy appliances than the households with less education level. This leads to increase more adoption. This finding is similar to the works of (Ouedraogo 2006; Zenebe 2007; Zenebe et al. 2010 Damte and Koch 2011; Inayatullah 2011; Yonas et al.2013; Isaiah et al. 2014; Tigabu et al. 2014 ; Mebratu 2019).

The coefficient of owning their private house is positive. It indicates that, households with own their private house have more probability to adopt electric injera mitad than households without own their private houses. It means, if households with own house, keeping other variables constant, the probability of adoption of Electric injera Mitad increases by 14%. This can be due to, the households with own private house have an opportunity to use modern injera baking mitad by having own kitchen to use or put the mitad. Besides, they have more opportunity to stay for long time in their house than households without it. This leads to increase more adoption. This finding is similar to the research works of (Ouedraogo 2006; Dawit 2008).

The coefficient of own separate Kitchen is positive. It indicates that, households with own their separate kitchen have more probability to adopt electric injera mitad than households without own their separate kitchen. It means, if households with own separate Kitchen, keeping other variables constant, the probability of adoption of Electric injera Mitad increases by 21%. This can be due to; Separate kitchen would induce to have or access permanent kitchen for Injera baking mitad than without own separate kitchen. This leads to increase more adoption. The finding of this is similar to the studies of (Dawit 2008; Damte and Koch 2011; Axen 2012; Tigabu et al. 2014; Getamesay et al. 2016; Warkaw et al. 2015).

The coefficient of owning traditional Mitad is negative. It indicates that, households with more modern injera baking Mitad have less probability of adoption of traditional injera Mitad. It means that, if households with one more modern injera mitad alternatives, keeping other variables constant, the probability of adoption Electric injera Mitad decreases by19%. This may be due to people with more alternatives especially the modern one leads to less use the traditional ones. This result is consistent with the works (Zenebe 2007; Nnaji et al. 2012).

The coefficient of owning electric meter is positive. It indicates that, households with own electric meter have more probability to adopt electric injera mitad than households without own electric meter. It means that, if households with own electric meter, keeping other variables constant, the probability of adoption of Electric injera Mitad increases by 43%. This might be due to the easy accessing electricity by owning electric meter enhances to use more electricity for different energy purposes with energy appliances. This finding is similar to the works of (Ouedraogo 2006; Nyembe 2011).

The coefficient of total expenditure, it is a proxy of income is positive. It indicates that, the probability of adopting electric injera Mitad increases when the households with more income, i.e. households with more income are more likely to be energy non poor or more adopter. It means that, if household's income increases by 1%, keeping other variables constant, the probability of adoption of Electric injera Mitad increases by .01%. Because, more income creates more demand for modern energy sources and facilitates to purchase different energy appliances. This finding is similar to the works of (Ouedraogo 2006; Zenebe 2007; Zenebe et al. 2010; Damte and Koch 2011; Inayatullah 2011; Yonas et al. 2013; Isaiah et al. 2014; Tigabu et al. 2014 ; Mebratu 2019).

4. Conclusions and Recommendations

The findings of this study revealed that, in Debere Berhan town 55 percent of the sampled households adopt the electric injera mitad cooking appliance for their injera baking activities. Whereas the remaining 45 percent of the respondent households do not adopt the injera baking mitad. The reason for not adoption is that the baking mitad price is very much expensive to other traditional mitads.72 % of the households' access electricity by their own electric meter. 56% of the households have refrigerator to cool or preserve their food for long time. 54.6% of the households use traditional mitad for baking activities and, 53% of the households have separated kitchen for their cooking purposes. In addition, the average age of a household head is 47.69 years old. The average number of family size is 4. 7. Besides, 73, 6% of the sample households are male headed family. Out of 269 households, 67.66% of the household heads are married. Regarding their education level, 33.43% of the household heads are post-secondary school or above grade 12 or college graduates. In the case of own house, 38% of the households live in their own houses and the remaining 62% of the households live in rented houses from kebele administration and government houses agency, live in rented houses from private house owners, or live in their own condominium or live in their family houses.

Moreover, the regression result reveals that Sex of household Head, Marital status, Family size, household head education level at post-secondary level, owning house, separate kitchen, owing of traditional Mitad, owning electric meter, and total amounts of household income are statistically significant at 1 % and 5 % level of precision. It indicates that the significant variables are the main determinants factors that affects for adoption of Electric injera Mitad estimation. On the other hand, the remaining variables like age, own refrigerators and energy expenditure are found to be statistically insignificant. From the finding, the following policy recommendations are recommended for the expansion of more modern electric injera Mitad to town households. Thus, households' education level should be increased through adult education. Family panning should be more addressed intensively, household's income should be increased in different income generation schemes, the dissemination of electric meter should be accessed to all households and different modern improved baking injera mitad should be available to town households.

Finally, this study is a cross sectional study which is a one-time snapshot and did not enable us to see the dynamics of the adoption of modern injera Mitad in the study area. Hence, further studies are recommended by using panel data of town households to show the dynamics of the adoption of electric injera mitad by incorporating more determinant variables and use more sample size for further study in the town.

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Annex I: Conceptual Definition of few terms

1. **Adoption:** In this study adoption refers to the decision of households to acquire/adopt an electric mitad for baking Injera.
2. **Electric Mitad :** name for stove for injera baking and used electricity for its energy source.
3. **Household**: Here household refers to a group of people who eat together regularly and/or who sleep under the same roof together.
4. **Injera:** Ethiopian staple food which is baked on circular pan, and mostly prepared from “teff”.

Annex II: Result for Descriptive Analysis.

```
. summarize adopem age sex marstat familysize postprimary postsecondary ownhouse ownreferg separtekic ownemeter b9taeexp totalexp, s
> eparator(7)
```

Variable	Obs	Mean	Std. Dev.	Min	Max
adopem	269	.5539033	.4980125	0	1
age	269	47.69888	12.26946	23	90
sex	269	.7360595	.441589	0	1
marstat	269	.6765799	.4686534	0	1
familysize	269	4.743494	2.167691	1	12
postprimary	269	.5464684	.4987639	0	1
postsecond~y	269	.3345725	.4727203	0	1
ownhouse	269	.3828996	.4870002	0	1
ownreferg	269	.5650558	.4966737	0	1
separtekic	269	.5315985	.4999306	0	1
ownemeter	269	.7211896	.4492499	0	1
b9taeexp	269	386.8048	159.4745	48	1110
totalexp	269	3022.18	1335.949	690	7800

Annex III: Results for Logit with Robust standard error

```
. logit adopem age sex marstat familysize postsecondary ownhouse ownreferg separtekic owntradmitad ownemeter  averageee totalexp, vc
> e(robust)

Iteration 0:   log pseudolikelihood = -184.89035
Iteration 1:   log pseudolikelihood = -117.78407
Iteration 2:   log pseudolikelihood =  -115.4861
Iteration 3:   log pseudolikelihood = -115.45216
Iteration 4:   log pseudolikelihood = -115.45214
Iteration 5:   log pseudolikelihood = -115.45214

Logistic regression                               Number of obs   =        269
                                                  Wald chi2(12)   =     101.95
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood = -115.45214                 Pseudo R2       =     0.3756
```

adopem	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	-.0063865	.0163187	-0.39	0.696	-.0383705	.0255976
sex	-1.345608	.5229662	-2.57	0.010	-2.370603	-.320613
marstat	1.305546	.4864012	2.68	0.007	.3522169	2.258875
familysize	-.2489459	.1142117	-2.18	0.029	-.4727967	-.025095
postsecond~y	2.659263	.4424278	6.01	0.000	1.792121	3.526406
ownhouse	.5901848	.3698769	1.60	0.111	-.1347606	1.31513
ownreferg	.4863131	.4381738	1.11	0.267	-.3724918	1.345118
separtekic	.8674387	.3566739	2.43	0.015	.1683708	1.566507
owntradmitad	-.8362259	.353678	-2.36	0.018	-1.529422	-.1430298
ownemeter	1.859718	.4430538	4.20	0.000	.991348	2.728087
averageee	2.876394	4.502469	0.64	0.523	-5.948284	11.70107
totalexp	.0005267	.0002296	2.29	0.022	.0000767	.0009767
_cons	-2.666441	1.259522	-2.12	0.034	-5.13506	-.1978227

.

Annex IV: Results for marginal effects.

```
. mfx

Marginal effects after logit
      y  = Pr(adopem) (predict)
         =  .61536416
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
age	-.0015116	.00386	-0.39	0.695	-.009078	.006055	47.6989
sex*	-.2829307	.09492	-2.98	0.003	-.468964	-.096897	.736059
marstat*	.3112353	.11183	2.78	0.005	.092047	.530424	.67658
family~e	-.0589233	.02724	-2.16	0.031	-.112316	-.00553	4.74349
postse~y*	.507173	.06244	8.12	0.000	.384802	.629544	.334572
ownhouse*	.1365422	.08301	1.64	0.100	-.026151	.299235	.3829
ownref~g*	.1154326	.10394	1.11	0.267	-.088294	.319159	.565056
separt~c*	.2038427	.08172	2.49	0.013	.043679	.364006	.531599
owntra~d*	-.1937935	.07883	-2.46	0.014	-.348304	-.039283	.546468
owneme~r*	.4337913	.09075	4.78	0.000	.255931	.611651	.72119
averag~e	.6808168	1.06563	0.64	0.523	-1.40777	2.76941	.13951
totalexp	.0001247	.00005	2.29	0.022	.000018	.000231	3022.18

(*) dy/dx is for discrete change of dummy variable from 0 to 1

*Annex V: **Diagnostic tests***

(i)Multicollinearity by VIF for continues variables

. estat vif

Variable	VIF	1/VIF
totalexp	1.95	0.511947
familysize	1.88	0.531855
averageee	1.48	0.674489
age	1.37	0.728641
Mean VIF	1.67	

.

(ii)Diagonal matrix/Pair wise Correlation Matrix/Contingency Coefficient

. estat vce, correlation

Correlation matrix of coefficients of regress model

e(V)	age	sex	marstat	family~e	postse~y	ownhouse	ownref~g	separt~c	owntra~d	owneme~r	averag~e
age	1.0000										
sex	-0.0722	1.0000									
marstat	0.1732	-0.6500	1.0000								
familysize	-0.3827	0.0329	-0.1827	1.0000							
postsecond~y	0.2061	-0.1489	0.0150	0.2284	1.0000						
ownhouse	-0.0799	-0.0130	-0.0400	0.0143	-0.0118	1.0000					
ownreferg	0.0181	-0.0722	-0.0196	-0.2950	0.0315	0.0243	1.0000				
separtekic	0.0038	0.0232	-0.0837	0.1201	-0.2952	-0.0883	-0.0776	1.0000			
owntradmitad	0.0425	0.0034	-0.0042	-0.0608	0.1651	-0.0267	0.0150	-0.0959	1.0000		
ownemeter	-0.1511	0.1102	-0.0758	-0.0797	0.0110	-0.2995	-0.0658	-0.2096	0.0084	1.0000	
averageee	-0.0083	0.1685	-0.1163	-0.1239	0.0197	-0.0273	-0.2799	-0.0738	0.1148	-0.0380	1.0000
totalexp	0.0650	0.0615	-0.0641	-0.3924	-0.1046	-0.0544	-0.2885	-0.2432	0.1032	0.0502	0.5966
_cons	-0.5307	-0.2140	0.0224	0.1215	-0.2624	0.0770	0.2530	0.0694	-0.2672	-0.0551	-0.6784

e(V)	totalexp	_cons
totalexp	1.0000	
_cons	-0.5551	1.0000

iii.Heteroskedasticity Tests

```
. estat hettest age sex marstat familysize postsecondary ownhouse ownreferg separtekic owntradmitad ownemeter  averageee totalexp

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: age sex marstat familysize postsecondary ownhouse ownreferg separtekic owntradmitad ownemeter averageee totalexp

         chi2(12)      =    27.34
         Prob > chi2  =   0.0069
```

(iv)Ramsey test

```
. estat ovtest, rhs

Ramsey RESET test using powers of the independent variables
       Ho:  model has no omitted variables
                F(12, 244) =      1.78
                  Prob > F =      0.0517
```