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RESEARCH ARTICLE

DETERMINANTS OF HOUSEHOLD TRADITIONAL FUEL DEMAND FOR COOKING IN TIGRAY, ETHIOPIA: THE CASE OF MAICHEW TOWN

***Kebede Abrha Mengstu**

Department of Marketing Management, College of Business and Economics, Mekelle University, Ethiopia

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ABSTRACT

This study investigates households' traditional fueldemand for cooking and, their determinants in Tigray: the case of Maichew Town. The results were estimated using the binarprobit model. Traditional fuel was by far the most dominant source of cooking fuel for the households surveyed in the town. Traditional fuel such as firewood, animal residue, crop residue and charcoal were the main source of cooking in the study area used by 71.25% of the households surveyed. The findings of the study also provide support to the energy ladder hypothesis that household income is a major determinant of household fuel demand. Furthermore, socio-economic and demographic factors like household head's education, sex of the household head, age of the household head, house type, and occupancy status and responsibility of cooking were key determinants of traditional cooking fuel demand. The researcher, thus recommend intensification of income poverty reduction programs to improve households' incomes, educational status and awareness. The benefits of such a policy is to move majority of households towards the upper levels of the energy ladder. This then implies a move away from over dependence on traditional fuels, which will be compatible with the energy strategic policy of Ethiopia, to more efficient, clean and modern energy sources.

INTRODUCTION

Background and justification

According to IEA (2006), the switch from traditional fuels to modern, safe and efficient energy sources has the potential to increase the welfare of over 2.5 billion people whom continue to rely on inefficient fuel such as firewood, animal dung and agricultural residue for their cooking energy needs. Although Ethiopia is endowed with a variety of clean energy sources, such as hydropower, geothermal, wind, and solar energy, both rural and urban Ethiopian households rely heavily on biomass fuel for their energy needs. Data for the year 2009 showed that only 8% of the total energy consumption in Ethiopia came from modern fuels (MoWE, 2011). The heavy reliance on biomass fuels has been one of the prime causes of forest degradation and deforestation in Africa in general and Ethiopia in particular. Though there were some empirical results in the rest of the world, there was no research to date on the study area regarding determinants of household traditional fuel demand for cooking. Therefore the researcher had a motive to find out this and contribute to the scanty literature or knowledge.

****Corresponding author: Kebede Abrha Mengstu,***
Department of Marketing Management, College of Business and Economics, Mekelle University, Ethiopia.

Objectives

1. Investigate the level of traditional fuel demand in maichew town.
2. Analyse the determinants of households traditional fuel demand for cooking in Maichew town.
3. Infer the barriers in switching from traditional fuel demand tomodern fuels from the results of the binary probit model.

MATERIALS AND METHODS

Study area

Maichew, is a town in the Tigray Region of Ethiopia. It is located at 665 km north of Addis Ababa along Ethiopian Highway 1 which runs to Mekelle (the capital city of Tigray region) with an altitude of 2479 m. According to Ethiopia's agro-ecological setting, Maichew and its environs are classified under the Weinadega (semi-temperate zone). According the 2007 census, the population of Maichew town was 23,419 of whom 11,024 were men and 12,395 women. Energy consumption for domestic uses in Tigray, where Maichew town is not an exception, could be divided into two as modern fuels and traditional bio fuels. However, the traditional bio fuels dominate despite their presence and that modern fuels such as petroleum and electricity are also used.

Data source, type and methods of data collection

Both qualitative and quantitative data were incorporated in this study. Besides, both primary (data from households) and secondary data sources were employed for this study. The data collection methods were both close and open ended questionnaire to collect primary data from the households. Careful Review of secondary sources had been conducted to access the secondary data.

Sample and sampling technique

Formal survey had been conducted with sample households of Maichew Town. The local government areas consisted of four (4) districts (kebeles). A sample frame containing the list of districts was constructed. A two-stage sampling technique was applied in selecting the sample households. First, sample districts were randomly selected and then sample households were selected from the selected districts, such that every household had the same chance of being included in the sample. Subsequently representative households who had been in residence for one year or longer were only considered. 160 households were selected with proportionate random sampling from the randomly selected 01 and 04 districts.

Method of analysis

Two types of data analysis, namely descriptive statistics and econometric models had been used for analysing the data collected from households of the study area. In the descriptive statistics section, percentage, mean comparisons and Pearson chi-square test to present the nature of traditional fuel demand in general, and household socio-economic characteristics on the other were used. For the econometric analysis, careful look into the factors that determine demand for traditional fuel were taken. To do this employment of a model by grouping households into two categories according to the consumers or non-consumers was applied.

Model and estimation methods

In the binary probit model households made a discrete decision whether or not consuming traditional fuel. Hence, the researcher used the binary probit model, which follows random utility model and Specified as Wooldridge (2002).

$Y^* = Z'\alpha + \varepsilon_1$
$Y = 1$ *if* $Y^* > 0$
$Y = 0$ *if* $Y^* \leq 0$

Where,

Y^*= latent (unobservable) variable representing households' discrete decision whether demanding traditional fuel for cooking or not.
Z' = vector of independent variables hypothesized to affect household's decision to demand traditional fuel.
α = vector of parameters to be estimated which measures the effects of explanatory variables on the household's decision to consume.
$\varepsilon 1$ = normally distributed error with mean (0) and standard deviation of $\delta 1$, and captures all unmeasured variables.
Y = dependent variable which takes on the value of 1 if the households demand traditional fuel and 0 otherwise.

Since the probit parameter estimate does not show by how much a particular variable increases or decreases the likelihood of consumption, marginal effects of the independent variables on the probability of a household to consume/demand a traditional fuel were considered. Finally, the log likelihood function which is maximized to obtain parameter estimates and corresponding marginal effects were used to estimate the parameters.

$$LnL\left(\frac{\alpha}{\gamma}, Z\right) = \sum\nolimits_{y=1} LN(\emptyset(Z'\alpha) + \sum_{y=0} \ln\left(1 - \emptyset(Z'\alpha)\right)$$

RESULTS AND DISCUSSION

Table 1, reveals that there is a significant difference in demand of traditional fuel for cooking by household's income category. The demand of traditional fuel by various income categories reveals that the demand declines with rise in income (higher quintiles).

Table 1. Traditional fuel demand by self-reported income group

Self-reported Income group	Traditional fuel demand		Total
	consumers	Non-consumers	
low	33	4	37
Middle	78	28	106
high	3	14	17
Total	114	46	160
Pearson chi2(3) = 10.7922			Pr = 0.029

The observed patterns in the data are consistent with the 'energy ladder' hypothesis as the use rate of less efficient fuel types (at the lower rung of the ladder) declines with rising in income. Use of modern fuels rises with increase in income and thus regarded as the main cooking fuel for richer households. Table 2, shows the mean of the continuous variables as per the consumers and non-consumers classification of households. The average price of which non-consumers paying modern fuel is higher than the average price consumers paying for traditional fuel.

Table 2. mean value of continuous variables by traditional fuel demand

Traditional fuel demand	Log Price of fuel in birr	Log Monthly income of the household in birr	Household head age	Children under5 years of age	Level of education of household head
consumers	260.48	2150.02	48.5	.37	7.5
Non-consumers	390.74	5312.89	42.6	.56	12.87

Therefore, relatively households consuming traditional fuel were paying low price on average than the non-consumers. Though the average child under age six seems nearly equal, the average numbers of children under age six were higher in the non-consuming than the consumers. This indicates that looking after the kids may hinder the household not to devote time to collect to the traditional fuels with higher opportunity cost of collection (like firewood and charcoal) which by implication choose modern fuels. The mean age of the

households consuming traditional fuel is higher than that of non-consumers.

This indicates that the older households had a traditional fuel preference. This could be due to the developed habit and loyalty for traditional fuels like firewood and/or charcoal. The average household head's level of education in years is higher in non- consumers than consumers. This may emanate from the knowledge of the attributes of fuels and awareness of health risks that the educated ones were consuming modern over the alternatives.

with more of modern fuels when fuel prices increase and/or decrease the quantity demand in kilogram of traditional fuels.

Sex of the household head (male): sex of the household head has negative and significant effect on the probability of demanding traditional fuel as their main fuel.

Therefore, it indicates that male headed households had 12.79% lesser probability of using traditional fuels as their main fuel than the female-headed households were.

Table 3. Binary probit estimation model results

tradtional_fuel_demand	Coef.	Std. Err.	z	P>z	[95% Conf.Interval]	
logprice_of_fuel	-.0081337	.0020641	-3.94	0.000*	-.0121792	-.0040881
sex_household_head	-.725675	.395821	-1.83	0.067***	-1.50147	.0501199
age_householdhead	.1032637	.0187148	5.52	0.000*	.0665833	.1399442
children_under5	.1747704	.2971375	0.59	0.556	-.4076084	.7571491
hhheducationlevel	-.114262	.056989	-2.13	0.045**	-.2259584	-.0025656
respocooking	-.6370992	.2568356	-2.48	0.013**	-1.140488	-.1337108
house_type	-1.068342	.417936	-2.56	0.011**	-1.887482	-.2492027
occupancystatus	-1.456634	.5193665	-2.80	0.005*	-2.474574	-.4386943
loghh_total_monthly_income	-.0001374	.000063	-2.18	0.029**	-.0002609	-.0000139
loghh_totalmonthexpendture	.0003989	.0001545	2.58	0.010*	.0000961	.0007017

***, ** and * represent: statistically significant at 10%, 5% and 1% respectivelyn=160, Wald chi2(10) = 42.33, Prob> chi2 = 0.0000

The average monthly income of the households is higher for the non- consumers than the alternatives. This could be the reason that higher income helped them afford the most expensive but safe and quality type of fuels.

Binary probit estimation model results

The result shows that log price of the fuel, sex of the household head, age of the household head, log monthly income of the household, level of education of the household head, responsibility of cooking, house type, occupancy status and log monthly expenditure of the household have significant effects on the probability of using traditional and inefficient fuels.

Marginal effects for traditional fuel demand

The marginal effects from the binary probit model were predicted and presented follows.

Hence this may justify that male headed households preferred the healthy and safe type of fuel than their female headed household counterparts.

Age of the household head: age of the household has a significant and positive effect on the probability of demanding traditional fuel type as a cooking fuel. This indicates that the older households have a traditional fuel preference than the other age groups. This could be due to the developed habit and loyalty for traditional fuels like firewood, animal residue and charcoal.

Household head's level of education: household head's level of education has negative and significant effect on the probability of demanding traditional fuels as their main fuel. Other things keeping constant as the level of education of the household head increases by 1 year the probability of demanding traditional fuel as a cooking fuel decreases by 1.40%.

Table 4. Marginal effects traditional fuel demand

tradtional_fuel_demand	dy/dx	Std. Err.	P>z	[95% C.I.]		X
logprice_of_fuel	-.01481	.00045	0.001*	-.002369	-.000593	300.819
sex_household_head	-.1279331	.06352	0.044**	-.252427	-.003439	.55
age_householdhead	.0188024	.00365	0.000**	.011649	.025955	48.1688
children_under5	.0318225	.05373	0.554	-.073484	.137129	.3875
hhheducationlevel	-.0140494	.00549	0.062***	-.015745	-.006817	9.275
respocooking	-.116004	.05036	0.021**	-.214705	-.017303	.9125
house_type	-.1740477	.0598	0.004*	-.291262	-.056834	.60625
occupancystatus	-.1912228	.0622	0.002*	-.313133	-.069313	.7125
loghh_monthly_income	-.000250	.00001	0.052***	-.00050	1.7e-07	5644.02
loghh_monthlyexpendture	.007260	.0003	0.018**	.000120	.001330	3916.56

***, ** and * represent: statistically significant at 10%, 5% and 1% respectively n=160

Log Price of fuel: The price of fuel has significant and negative effect on traditional fuel demand. This indicates the price elasticity of demand. Other things keeping constant as the price of fuel increases by 1% the quantity demanded of traditional fuels decreases by 1.48%. This indicates that Households using traditional fuel are more likely to substitute

This indicates that, household heads with higher level of education are more likely to substitute traditional fuels with more of modern fuels.

Responsibility of cooking (household head): the responsibility of cooking by the household head had a negative

and significant effect on the probability of demanding traditional fuel for cooking. Other things keeping constant when the responsibility of cooking is done by the household head the probability of demanding traditional fuel as cooking fuel is 11.60 % lesser than if spouse or house servant were doing the cooking task. This indicates if there is a direct participation in cooking by the household head the difficulty of cooking by traditional fuel could be sensed and preferred to consume modern fuel which is cleaner and not risky for their health.

House type (modern): Household living in a modern house type has a significant and negative effect on the probability of demanding traditional fuel as a cooking fuel. Other things keeping constant household head owning modern house has 17.40 % lesser probability of demanding traditional fuel as main cooking fuel type. This may mean that household living in modern houses were more probably aware of pollution caused by use of these traditional fuels and the health risks associated with such pollutions and able to calculate the high opportunity cost of accessing traditional fuel types.

Occupancy status: the marginal effect shows that occupancy status had a negative and significant effect on traditional fuel demand. Therefore, it can be observed that owning a house increases the probability of choosing modern and clean fuels than traditional fuel. Other things kept constant, it may be due to the case that those who were living in rented house may not have the capacity to afford the expensive modern fuel product in addition to the rent cost.

Log monthly income of the household: Household income has a significant and negative effect on the probability of choosing traditional fuel type for cooking. Other things keeping constant as the monthly income of the household increases by 1% the probability of choosing traditional fuel as main cooking fuel type decreases by 0.02%. This means that, when total household income increases, households using traditional fuel are more likely to substitute with more of modern fuels. This result shows that income is an important factor affecting fuel use and substitution (switching).

Log household monthly expenditure: Household monthly expenditure has a significant and positive effect on the probability of demanding traditional fuel type for cooking. Other things keeping constant as the Monthly expenditure of the household increases by 1% the probability of consuming traditional fuel for cooking increases by 0.72%. This means that, when total household expenditure increases, households could lose capacity to afford the expensive modern fuels and rely on the relatively cheap priced traditional fuels.

Conclusion and Recommendation

This study reveals a set of important factors that determine household traditional fuel demand for cooking using a household survey data in Maichew town. The binary Probit model was adopted to analyse the determinants of households demand of traditional fuels for cooking .From the binary probit model estimation Price of the fuel, sex of the household head, age of the household head, household head level of education, responsibility of cooking, house type, occupancy status, total household's monthly income and total household's monthly expenditure were found as significant determinate factors for demanding traditional fuel for cooking. Both the descriptive statistical analysis and the econometric results reported in the study suggest that the observed patterns in the data were consistent with the "energy ladder" theory.

The results also show that in addition to income, there are several socio-demographic factors, which are important in determining household traditional fuel demand. These results therefore suggest that income is not the only important factor that influences the demand for traditional fuel in Maichew town.

Recommendations (policy implications)

- Intensification of poverty reduction strategies to reduce household's income poverty so as to reduce the high dependence on the environment for the unsustainable supply of charcoal and fire wood as main (is required by the government of Ethiopia and its stakeholders) cooking fuel.
- Since the average age of the households is 48.5 and because household head's education level showed a significant effect on traditional fuel demand, policies on promoting adult education should be encouraged as they have varied implications on the demand.
- In order to encourage households make traditional fuel substitutions by modern and clean fuels that will result in more efficient energy consumption and less adverse environmental, social and health impacts, a subsidization of the modern fuel price like electricity, awareness creation regarding the risk and inefficiency of firewood and charcoal, a promotion of higher levels of education at household level could be effective instruments. This would also open up new venues for earning and enable the poor to consume a greater quantity of modern fuels, thereby, tempting them to reduce the consumption of traditional fuels to a level so low as would be commensurate with the proper living standards.

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