Explaining household expenditure on cooking fuel: Role of income and Socio-economic status

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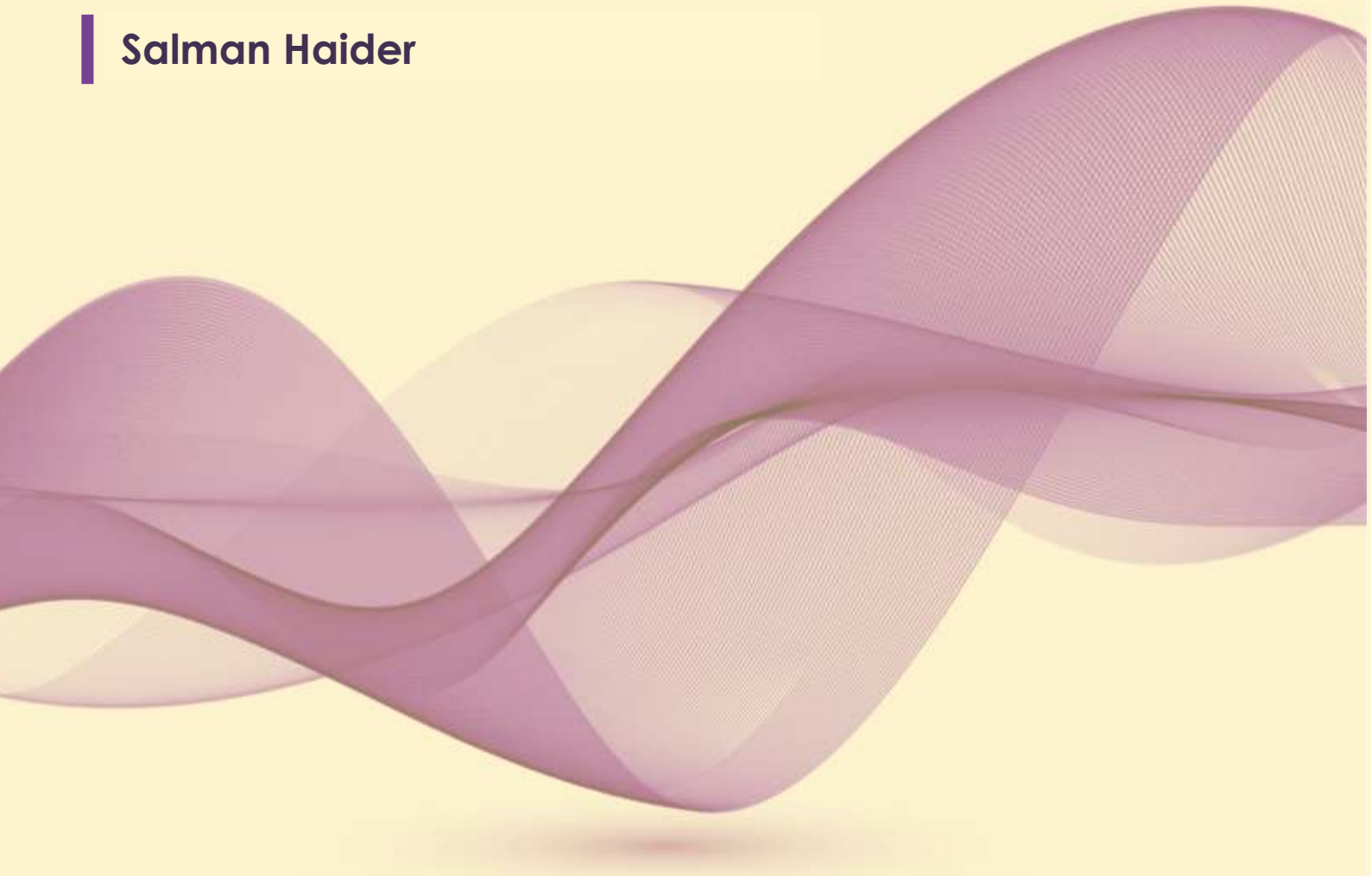

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Explaining household expenditure on cooking fuel: Role of income and Socio-economic status[1]

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Abstract

This study aims at analysing the determinant of cooking fuel expense at household level in Uttar Pradesh (UP). For this purpose, panel data from CPHS (CMIE) and the household fixed effect model have been used. As clean cooking fuel demands larger expenditure, it is expected that higher expenses on cooking fuel represent transition to clean cooking fuel. Cooking fuel expenses show positive elasticity with respect to per capita income. However, this elasticity is lower for the higher income (consumption) group than for the bottom income group. Looking at the caste angle, schedule tribe (STs) spend less while the general caste and schedule castes (SCs) spend more as compared to the other backward castes (OBCs). Households with less educational attainments show lower spending on cooking fuel, while households with better electricity access unravel a higher propensity. This suggests positive spill-over effects of modern energy services on clean cooking fuel. Finally, the present study has implications for designing policies to penetrate LPG as cooking fuel.

Keywords: Cooking fuel expenditure, Energy cost burden, Sustainable development, India, Survey analysis

1. Introduction

There has been considerable development in energy supply infrastructure to achieve universal access to affordable, reliable and modern energy services. Developing countries have been putting effort into ensuring better supply-side infrastructure and delivery of modern energy

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services to the lower section of society. Around 97.4 of Indian households have access to grid-connected electricity, while on average, they receive 20.6 hours of electricity from the grid daily (Agrawal et al., 2021). Nevertheless, recent data shows that only 58 % of the population has moved towards cleaner cooking fuel. At the same time, a wide gap is observed between rural (43.2) and urban (89.7%) adoption of clean cooking fuel (NFHS-5). Following goal 7.1 of the United Nations' Sustainable Development Goals (SDGs), India is committed to achieving universal access to affordable, reliable modern energy services by 2030. The Indian government started the Pradhan Mantri Ujjwala Yojana (PMUY) in 2016 to provide around 80 million (Liquefied Petroleum Gas) LPG connections to the below poverty line rural families. It aims to improve affordability by covering the cost of initial connection and one-time cylinder to nudge the adoption of clean cooking fuel. The programme has envisaged replacing traditional cooking fuels with LPG and empowering rural women. However, there is mixed evidence of the success of the PMUY programme in permanently modifying the choice of the household to prefer clean cooking fuel, particularly LPG over solid fuel. Ranjan and Singh (2020) have documented that around 43.2 million LPG connections went inactive in the year 2019, as compared to 35.8 million in 2017. Further, a study by Kar et al. (2019) found that the number of LPG refills among PMUY beneficiaries is less than half that of general rural consumers. Solid fuels for cooking within enclosed spaces causes indoor air pollution, which have serious health consequence. In India, 17.8 percent of total death is attributed to air pollution of which 6.1 lakh death is due to indoor air pollution Pandey et al. (2021). Basically, it cause various respiratory and lungs related diseases. Energy expenditure remains a crucial dimension for assessing energy poverty. It indicates household willingness to pay for modern energy services and other associated benefits. It is now the choice of the household to allocate the share of income for modern energy. If a household incurred a large share of their income on modern energy, then it indicates the household attached a higher value to it. While if they incur a tiny share of income on modern energy, then households do not value its benefits.

Furthermore, if poor households spend less on modern energy, then the affordability of energy access needs to be considered. In essence, the effectiveness of energy subsidies by the government needs to be examined to determine whether they make modern energy affordable for poor households. Households must allocate their resources to energy expenditure based on their preferences and income. It has been seen that poor household spends a high proportion of their income on cooking fuel. In India, households belonging to the general caste category are at the top of the social ladder compared to other castes. They are likely to spend more on

cooking fuel. The number of men and women in a family may also affect what fuels to use for cooking. A women-dominated household may be more likely to use cleaner cooking fuel as they understand its benefits better than men. With a rise in income, however, households are likely to use more clean energies like LPG. Further, households with more education are supposed to be more aware of the side effects of traditional fuels. They should also know the health and other benefits of cleaner energy sources. Explaining the factors behind differences in expenditure on modern energy may prove effective in designing clean cooking fuel policy.

Studies show that in developing countries, the households are increasing their expenditure on modern energy along the line of developed countries. The primary use of energy differs across countries. In European countries, natural gas is the primary energy source for heating homes, followed by electricity. Households in developing countries also allocated a considerable share of income to modern energy. The 66th round of the National Sample Survey (NSS) in India shows that 13.2 percent of the average household's expenditure was allocated to energy in 2010 (Alkon et al., 2016). The fact that poor households spend more than one-tenth of their money on energy shows that it is essential to understand how different socio-economic factors affect expenditure on cooking fuel, which is a significant component of energy costs. The research on energy poverty in developing countries does not explain why energy costs vary across households.

This article examines the socio-economic determinants of cooking fuel expenditure in the context of UP, India. It does not make causal claims but provides descriptive and regression analysis. For this purpose, nationally representative survey data from Consumer Pyramids Household Survey from 2014 May to Dec 2019 has been used. Given the state-wise variation in cooking fuel subsidy policy, we refrained from taking all India data and focused on one state (UP) with a uniform cooking fuel subsidy policy within the state. Another reason is to look at one of most energy poverty states having only 49.5 % of households that use clean fuel for cooking. The CPHS dataset lets us show the difference between urban and rural trends, which is essential for analysis. India's rural poverty has been quite sensitive to local social conditions, and policy measures are becoming less and less essential to determine what happens to India's rural poor.

The article has a twofold objective in this paper. The first objective is to reveal the link between income and expenditure on cooking fuel. Along the income, interaction terms have been used to capture any non-linear effect between income and energy expenditure nexus. We try to look

at any tapering off in the relationship between income and energy expenditure at a higher income level. Second, the role of various household socio-economic factors is examined to explain cooking fuel expenses. Our descriptive study demonstrates that the energy cost burden in Uttar Pradesh (UP) has grown over time, particularly in rural regions that spend more money than ever on energy. Consequently, it is essential to comprehend the reasons for heterogeneity in household energy expenditures.

Rest of the sections are arranged as follows. Section 2 provide brief literature review of issues related with cooking fuel. Section 3 detailed about the data sources and methods, while section 4 provides estimated results and brief discussion on it and finally section 5 conclude the study.

2. Literate Review

Several studies found that indoor air pollution caused by household cooking fuel negatively impacted the health of rural women in India (Smith & Sagar, 2014; Debbi, Elisa, Nigel, Dan, & Eva, 2014; Schilmann et al., 2019). In contrast, some studies examined the relationships between socio-demographic factors influencing the household cooking fuel choice. Only a few researchers have attempted to determine what motivates rural families to adopt LPG as their primary source of cooking fuel. Baquié and Urpelainen (2017) assessed subjective satisfaction factors such as convenience, cost, accessibility, and simplicity of use. Malakar (2018) tried to examine household decision-making in a microstudy of a village in Chittoor, Andhra Pradesh, using the example of adopting a TV and clean cooking fuel alternatives. Furthermore, Sharma, Parikh, and Singh (2019) examined the variables affecting the transition to LPG for cooking in Chhattisgarh and Jharkhand, highlighting socio-economic and other factors that may impact LPG transition.

Access to clean energy may not be sufficient for cooking as the household prefers to combine solid fuels and lacks a strong preference for LPG (Kapsalyamova, Mishra, Kerimray, Karymshakov, & Azhgaliyeva, 2021). Srinivasan and Carattini (2020) analyzed that rural households generally rely on solid cooking fuel despite the health issue, while social interactions and networks influence LPG adoption. Gupta and Pelli (2021) found an inverse relationship between electrification and LPG as cooking fuel, implying that the additional financial burden of electricity pushes back the rural poor on solid fuel. Sankhyayan and Dasgupta (2019) found that an increase in literacy rate/road density in rural areas will significantly impact electricity uptake.

Rafi et al. (2021) find that energy poverty has a considerable detrimental impact on children's health and educational outcomes. Nguyen and Su (2021) found that reducing energy poverty tends to expand job options for women, notably in manufacturing and service sectors, resulting in more female wage and salaried employees than males. Reducing energy poverty reduces gender disparity in health indicators. Acharya and Sadath (2019) observe that energy poverty and socio-economic backwardness in India are highly correlated; Dalits and Adivasis have higher energy poverty and a lower rate in the reduction of energy poverty compared with the national average. Chindarkar et al. (2021) found that awareness of the health benefits of LPG and the dissemination of LPG within the community are the two most important factors of WTP for exclusive usage of LPG. Taale and Kyeremeh (2019) discovered that annual power spending might be described by household income, the quantity of electrical equipment, the number of rooms, and the household head's level of education. Ali and Khan (2021) found that age, gender, family size, social category, and economic level are critical determinants of access to clean cooking fuels. Sharma et al. (2019) discovered that energy poverty significantly impacts and varies across income levels. Although the amount of education of families has no significant influence on their energy poverty, their knowledge of energy-saving techniques is correlated with a decrease in energy poverty.

Meier et al. (2013) show that Engel's spending curves for energy are slightly s-shaped for the United Kingdom. They found that income elasticities of energy spending first decrease in income until an inflexion point is reached. Beyond this point, it increases again. Using NSSO data, Alkon et al. (2016) investigated monthly household expenditure on cooking fuel and electricity. In many Indian states, energy consumption has risen, but it is not due to higher family affluence. Kumar et al. (2016) suggested that the adoption and sustained use of LPG is impacted by affordability, accessibility, and awareness issues. Sankhyayan and Dasgupta (2019) discovered that availability is essential for increased adoption of electricity, but not LPG. Higher income and literacy rates have a more considerable influence on LPG adoption.

Based on the literature review, this study prepares a research framework to study the factors that affect the cost of cooking fuel in UP, India. The socio-demographic characteristics of the households are essential in deciding cooking fuel expenditure. In the same way, it has been thought that the ability of households to own assets affects their use of clean cooking fuels. Based on the data from the CPHS panel, we have looked at what makes rural and urban households in India spend more or less on cooking fuel.

3. Data and Methods

3.1. Data source

This study is based on the survey data provided by the Centre for Monitoring Indian Economy called as Consumer Pyramids Household Survey (CPHS) database. It is an extensive panel household survey covering over 170,000 Indian households across 27 states and 514 districts. Each household is interviewed thrice every year (three waves each year). Income and consumption data for four preceding months are collected during each wave, so CPHS have monthly data on income and consumption. This study used data from May 2014 (second wave) as there is over-sampling in wave 1 (Jan to April 2014) and then adjusted in the second wave. Hence the sample is selected from May 2014 to Dec-2019[2]. Fuel expenditure and total expenditure variables are adjusted for inflation with May 2014 price level. State-level (rural/urban) monthly fuel and general CPI are used.

We have only considered cooking fuel expenditure as there is a lack of data on what primary fuel household uses (solid versus LPG). There is only data on expenditure on cooking fuel. This includes household expenditure during a month on LPG (gas cylinders), piped gas for cooking, kerosene, wood or coal used for cooking. If wood is collected from the forest and used for cooking, then its imputed value is taken and reported in data based on recent market price. This is important because it means that the cost of energy for home production, which in practice means collecting firewood, must be thought of as lost revenue. It is intuitive to suppose that higher cooking fuel expense reflects higher willingness to pay and more likely to adopt cleaner cooking fuel. We used the number of hours of power supply in a day to proxy for electrification instead of expenditure on electricity. It is exogenously determined by current demand-supply conditions. Instead of using income data, the household's total consumption expenditure (excluding expenses on cooking and electricity) is used. It is a proxy for total income as income is more volatile over time, and households usually do consumption smoothing to maintain their standard of living.

The description of the data is given in Table 1. Several dummy indicators for castes, gender and education category of the household have been used. CPHS provides data on the household group for gender, caste and education. It categories sample households into groups based on the distribution of their members' characteristics in each wave. For instance, the education

[2] While there is limited attrition in the data, we restrict our sample to the 20,280 households for whom data is available for more than 12 months. Average number of months for which data is available for households is 49.62.

group of a household is determined by the distribution of education attained (highest degree) by household members aged 25 or older[3].

Table 1: Variable description

Variable	Definition	Symbol
Expenditure on Cooking fuel	It is household expenditure on cooking fuel per capita in natural log.	*Lncook*
Total expenditure	It is total expenditure excluding expenses on cooking and electricity, taken in per capita in natural log.	*LnTE*
Income group dummy	Four dummy indicators have been created based on total expenditure per capita quantiles. It is used for interaction with total expenditure. Low-income group is kept as a reference group.	I_D_{it} (dummy indicator) 1.High-income group (HI) 2. Upper-middle income group (UMI) 3. Lower-middle income group (UMI)
Education group of household	Households are categorized into four groups based on the education of members. The highest education level, i.e. the graduate majority, is kept as a reference group.	*edu* (dummy indicator)
Gender group of household	Households are categorized into three groups based on the distribution of members by their gender. A balanced age group is kept as a reference group.	*gen* (dummy indicator)
Caste of household	Households are categorized into four casts. OBC is kept in the reference category, while other categories are SC, ST and OBC.	*caste* (dummy indicator)
Power Availability in hours	The number of hours electricity is available.	*power*
Household size	It is the total number of members staying in a house.	size

[3] Age at which the majority of persons complete high school.

The assignment of a household as belonging to a specific education or gender group is based on guidelines established by CMIE since a household may have several persons with varying levels of education. This is different from the head of household socio-economic characteristics used in the survey data analysis[4]. It may be more meaningful as there may be several other members that are educated. Hence CPHS has taken socio-economic characteristics based on all relevant members of the household. We prefer to use these groups dummy in this study. Intuitively, it will provide a better approximation and improve the regression results than just based on HoH characteristics. The gender and education composition of the household may change over time, whereas the castes remain same.

3.2. Methods

Since the panel data is available from consumer pyramids CMIE, this study prefers to use the household fixed effect model. Cooking fuel expenditure could also depend on the price of different fuels. Energy expenditures may also be affected by the cost of various fuels. For instance, if electricity or LPG prices increase significantly, then access to these energy sources may not necessarily affect energy spending. Moreover, this might result in reduced energy use. In contrast, a decrease in pricing might increase families' energy expenditures if access is available. Hence to capture the difference in preference and unobservable specific factors, household fixed effects models have been used throughout our analyses.

Three models have been estimated: 1. Combined sample 2. Rural sample 3. Urban sample. As the fixed effect model is used, region dummy is not added in combined regression. Total expenditure and cooking fuel expenditure are taken in per capita and log form so that that coefficient can be directly interpreted as elasticity. While the interaction of income group dummy (I_d_i) and income (LnTE) is added to capture the difference in the income elasticity concerning cooking fuel expenditure of different income group households. A robust standard error has been applied that is clustered at the household level to take care of heterogeneity and autocorrelation. Since normality is required for linear regression estimation, logarithm of these two variables has been used, both of which may have skewed distributions.

$$Lncook_{it} = \alpha_i + \beta_0 t + \beta_1 LnTE_{it} + \sum_{j=1}^{3} \beta_{2j} (I\_d_{it} * LnTE_{it}) + \sum_{j=1}^{2} \beta_{3j} gen_{it} + \sum_{j=1}^{3} \beta_{4j} castes_i + \sum_{j=1}^{3} \beta_{5j} edu_{it} + \beta_6 power_{it} + \beta_7 size_{it} + \varepsilon_{it} \quad (1)$$

Where *i* is the index for household and t index for time. α_i captures the household fixed effect, and β_0 is the time trend coefficient, which is used instead of the time fixed effect to know the trending pattern of cooking fuel expenditure. ε_{it} is usual error term. β_{2j} are coefficients of interaction term of *LnTE* with income group where j = 1, 2, 3. $\beta_{3j}, \beta_{4j}, \beta_{5j}$ are the coefficients of j^{th} group of factor variable gender, caste and education respectively and omitting the reverence group. The reference group for factor variables is given the Table 1, which is excluded in the regression.

4. Results and Discussion

Table 2 provides the summary statistics for the full, urban and rural samples at the household level. The mean per capita cooking fuel expenditure in rural regions is 86.77 INR and 109.19 INR for the urban regions. Hence it is quite evident that urban households spend more on cooking fuel as they use LPG. Whereas urban regions have higher variability compared to rural regions. On the similar line, per capita total expense of urban regions is higher than rural regions and has higher variability. When we look for power availability, there is a narrow gap between rural and urban regions. As the electrification rate has gone up, power availability has also improved, but it requires further improvement as rural households get only 12 hours of power supply on average. Both rural and urban regions have similar household sizes.

Figure 1 shows the cooking fuel cost burden (share of cooking fuel expenditure in total expenditure) of UP from May 2014 to Dec 2019. The plot provides trends for upper and lower-income groups formed by the cut-off point given by the median level of total expenditure. This classification will help to understand how cooking fuel cost burden differs for rural and urban regions for higher and lower-income groups. The figure reveals that lower-income households have higher cooking fuel cost in both regions. For both regions, the cooking fuel cost burden ranges from around 7 to 10%, which is relatively higher than the cooking fuel cost burden of 5 to 6% in the upper-income group. For both regions, the energy cost burden rose from May 2014 to 2018 and then declined to almost 6% over the remaining period of study. The cooking fuel cost burden pattern in rural lower-income groups is quite different. It remained almost stagnant at around 7% from May 2014 to Jan. 2018, then crossed 8 percent and remained on a similar share over the remaining period. The trend shows that urban and rural lower-income households spend a significantly larger share of their income on cooking fuel, given their low-income base and bear a higher burden. Figure 1 depicts that rural lower-income households spend relatively less than urban counterparts. Hence they have tighter budget constrain to adopt

cleaner cooking fuel. They are also less willing to pay for cleaner cooking fuel due to less education and awareness than urban regions. They usually rely on solid fuel (for affordability) that absorbs a larger chunk of their income. Hence affordability of clean cooking fuel must be worked out.

Table 2: Descriptive statistics

Full Sample	Mean	Std. Dev.	Min	Max
Cooking_PC	101.77	61.57	0	2526
Exp_PC	1737.45	1275.8	0	356566
Education	2.552	0.978	1	4
Gender	1.760	1.324	1	3
Cast	2.30	1.272	1	4
Power	14.075	8.557	0	24
Size	5.416	2.207	1	30

Rural Sample	Mean	Std. Dev.	Min	Max
Cooking_PC	86.77	55.08	0.00	1217
Exp_PC	1426.78	1060.62	85.29	245926
Education	2.791	0.882	1	4
Gender	1.786	1.316	1	3
Cast	2.991	1.159	1	4
Power	12.262	8.088	0	24
Size	5.751	2.307	1	30
Urban Sample	Mean	Std. Dev.	Min	Max
Cooking_PC	109.19	63.24	0.00	2526
Exp_PC	1890.83	1343.47	0.00	356566
Edu	2.411	1.004	1	4
Gen	1.747	1.327	1	3
Cast	2.448	1.296	1	4
Power	14.944	8.638	0	24
Size	5.250	2.137	1	28

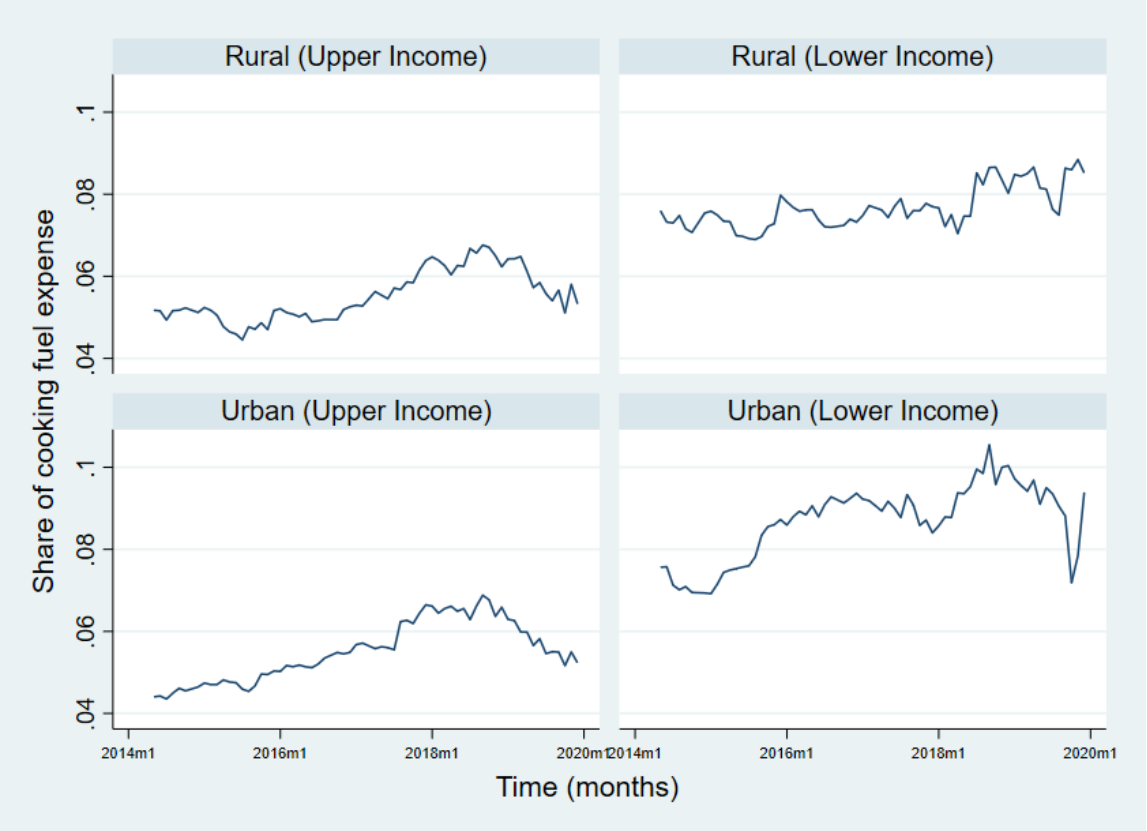

Figure 1: Weighted mean cooking fuel cost burden (share of cooking fuel expenditure in total expenditure)

The coefficient of total expenditure can be directly interpreted as elasticity. As discussed in the methods section, the estimated coefficients from three models have been given in Table 3. Results are almost similar for most of the variables. In comparison, there are differences in significance and magnitude of coefficients for some variables for rural and urban samples. The trend coefficient turns out to be positive and significant. Hence, over time, per capita cooking fuel expenditure has been increasing after controlling for household fixed effects. It may be due to various other factors or policy effects.

Total expenditure is positive and statistically significant. It shows that a higher income level leads to more cooking fuel expenses. The magnitude of the coefficient (0.19) is relatively lower for urban regions than for rural regions (0.36). Hence, cooking fuel expenditure is more responsive to increasing household income in rural regions than urban regions. Income is considered as the most influential factor for adopting clean cooking fuel. The significance of the interaction term signifies a non-linear relationship between income and cooking fuel expenditure. A positive and significant sign of interaction term for the lower middle income (LMI) category indicates that the effect of income is stronger to increase cooking fuel expenditure.

Table 3: Household Fixed Effect Model

Dependent variable: Log(Cooking fuel expense per capita)	Combine Sample	Rural Sample	Urban Sample
lnTE	0.251***	0.362***	0.196***
	(0.00582)	(0.0111)	(0.00661)
Date	0.00633***	0.00570***	0.00656***
	(0.000045)	(0.0000949)	(0.0000491)
HI* LnTE	-0.0119***	-0.0184***	-0.00899***
	(0.000696)	(0.00128)	(0.000809)
UMI * LNTE	-0.00192***	-0.00536***	-0.00108*
	(0.000505)	(0.000916)	(0.000594)
LMI * LNTE	0.00317***	-0.000246	0.00415***
	(0.000392)	(0.000677)	(0.000469)
Caste_SCs	0.0158***	0.0306***	0.00287
	(0.00409)	(0.00618)	(0.00533)
Caste_STs	-0.0225***	-0.0676***	-0.00223
	(0.00670)	(0.0128)	(0.00760)
Caste_Upper	0.00517	-0.0185	0.0142**
	(0.00607)	(0.0117)	(0.00690)
Female Dominated	0.00558**	0.0136***	0.000783
	(0.00255)	(0.00463)	(0.00297)
Male Dominated	0.0118***	0.0187***	0.00731**
	(0.00252)	(0.00458)	(0.00291)
Matriculates majority	-0.00405	-0.0109*	-0.000999
	(0.00287)	(0.00636)	(0.00321)
Literates majority	-0.00855**	-0.0166**	-0.00333
	(0.00362)	(0.00745)	(0.00411)
Iliterates majority	-0.00205	-0.00238	-0.00359
	(0.00370)	(0.00749)	(0.00426)
Household size	-0.108***	-0.0906***	-0.116***
	(0.00160)	(0.00263)	(0.00196)
Power_hrs	0.00215***	0.00365***	0.00179***
	(0.000250)	(0.000467)	(0.000289)
Constant	3.100***	2.147***	3.577***
	(0.0465)	(0.0870)	(0.0532)
Observations	636,506	222,340	414,166
R-squared	0.235	0.205	0.267
Number of hh_id	20,280	7,306	12,974

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

On the contrary, the upper-income category is less responsive to cooking fuel choice expenditure. The negative sign interaction term for HI and UMI indicate that the higher-income group spend less on cooking fuel than the lower-income group. Hence, as compared to the upper-income group, income and affordability are the critical factors for the lower-income group to spend a larger share on cooking fuel. Considering the price hike of clean cooking fuel, income and affordability are significant variables influencing rural areas' adoption of LPG. (Quinn et al., 2018; Ravindra et al., 2021; Kapsalyamova et al., 2021).

The regression outcomes for the castes group highlight another essential dimension for enhancing clean cooking fuel. There are only SCs and STs in rural regions and upper caste in urban regions that turn out to be significant. Hence, there is a rural-urban difference in cooking fuel expenditure due to castes. It is found that urban households belonging to the upper social class are more likely to have higher cooking fuel expenditure than the OBCs class. The coefficients of SCs and STs are insignificant for the urban region. On the contrary, only coefficients of SCs and STs groups are significant in rural regions. STs have lower energy expenditure, as expected, in the rural region. They usually reside near forest areas that are far from general infrastructure and hence primarily rely on free biomass. Some similar evidence on social category and access to clean fuel has been reported by earlier studies (Gould, Urpelainen, Hopkins, & J., 2020). Saxena and Bhattacharya (2018) stated that people of lower social classes often reside in hamlets outside villages and are subject to prejudice when obtaining a clean fuel supply. Whereas in the case of rural regions, SCs have higher spending than OBCs. As cooking fuel expenditure data also contain the implicit cost of freely collected biomass, it may lead to higher spending on cooking fuel than OBCs.

The male and female-dominated household groups' coefficients have similar expenditure patterns against the balance gender group. It is evident from the study that female-dominated families spend the same amount on cooking fuel as male-headed dominated. Previous studies found that female household head has a higher willingness to pay for cooking fuel as women are often responsible for food preparation and unsafe cooking practices directly affect women. They are more aware of the benefits of utilizing clean fuels for cooking, especially the health concerns linked with the use of dirty fuels. (Kennedy et al., 2011; Gould & Urpelainen, 2018). However, there is no clear distinction has been observed in this study.

Education is strongly connected with higher adoption of health-promoting environmental measures, such as cleaner cookstoves, in low- and middle-income countries. Multiple lines of

research have shown that global health and economic growth have improved due to increased education. Our regression results show a significant effect of education on cooking fear expenditure. In the case of rural regions, it is evident that a lower level of education is related to less expenditure on cooking fuel. It signifies that education plays a critical role in adopting clean cooking fuel by enhancing the willingness to pay. For all samples, the sign of the coefficient is consistently negative. Hence, it indicates that compared to better education levels (graduation or above education), less educated households spend less on cooking fuel. However, education is not statistically significant for the urban sample.

Larger household size is associated with lower per capita expenses on cooking fuel. It means there is economies of scale for using cooking fuel as more member require less than the proportional increment in cooking fuel expense. Locking at the effect of electrification, it has a positive effect on cooking fuel expenses. It is significant for all three models. So it means modern energy service has a spillover effect on increasing per capita cooking fuel expense as higher expenditure indicates a higher willingness to pay and use cleaner fuel. Improved access to electricity should be used to nudge households to adopt cleaner fuels. The introduction of an electric connection may impact households in different ways. Electricity is a fundamental input for utilizing a large variety of appliances and, therefore, opens up many new consumption possibilities. The size of the choice set of a recently electrified household increases significantly. How a household decides to use the electricity will determine the impact that electricity has on its budget and cooking fuel expenditure level. The traditional energy ladder theory and vast research results show that households can use electricity to do productive economic activities (Bridge et al., 2016; Chakravorty et al., 2014; Khandker et al., 2012). We would then argue that the increase in income from electrification should push households to spend more on cooking fuel and use cleaner fuel (normal goods) and replace fuel wood, dung, and crop waste as it is inferior good. If people use electric appliances, it will also help realize the benefits of modern energy services, so households may increase cooking fuel expenditure by moving toward cleaner fuel. Therefore, the government need to improve the accessibility of electricity to have better penetration of cleaner cooking fuel.

5. Conclusion

This article has investigated the role of income, caste, education and improved access to electricity in explaining household cooking fuel expenditures. Given the complex structure of the society across India and the state-wise institutional differences, data only from the state of Uttar Pradesh, India, are taken for the analysis. While variation in household total expenditure

(excluding cooking fuel) is not influenced by the difference in household cooking fuel expenditures, the regression results show that higher income leads to more cooking fuel expenses and is more responsive to increased household income in the rural regions than in the urban regions. Income is considered as the most influential factor bearing a non-linear relationship with cooking fuel expenditure. The effect of income is stronger to increase cooking fuel expenditure for poorer households. Therefore, the transition toward cleaner cooking fuel requires an increase in income or affordability for the lower-income group. Expenditure on cooking fuel and willingness to pay for clean cooking fuel (like LPG) is strongly affected by household income. This is consistent with the findings that poorer households have less willingness to pay for high-quality modern energy as they do not drive great value from it. Moreover, it means that the poorer people bear a greater cost of cooking fuel due to low income levels.

The effect of caste structure is inevitable for any socio-economic outcome in India as it represents the social institution. Urban upper caste group spends a higher amount on cooking fuel. Since they enjoy the highest social status and have better access to energy and other resources, they are more likely to adopt cleaner cooking fuel than OBCs. On the contrary, in the rural regions, household from one part of the lower social strata (SCs) incur a higher magnitude of spending than OBCs, while the STs spend less on cooking fuel. It reveals that STs merely have access to clean cooking fuel and predominantly rely on abundant free biomass. Higher spending on cocking fuel by SCs may be due to use of clean cooking fuel or higher spending on biomass (including implicit cost of freely collected biomass). While the SCs usually reside in the periphery of main residential areas and relatively deprived of access to clean cooking fuel and modern household services (Saxena & Bhattacharya, 2018) . It is expected that their higher spending on cooking fuel than OBCs reflect more use of biomass. When we look at the gender dimension, it is revealed that female-dominated families spend the same amount on cooking fuel as male-dominated ones. Furthermore, it is evident that the lower level of education is related to less expenditure on cooking fuel. Therefore, this study acknowledges the crucial role of education in adopting clean cooking fuel as it enhances awareness and benefits of clean fuel. It has larger slipover effects in the rural areas, enabling people to recognize the importance of modern energy services. On the same line, improved electricity access also leads to higher expenditure on cooking fuel and hence transition to clean cooking fuel. There is also scope for economizing the cooking fuel expenses as larger household size is associated with lower per capita cooking fuel expenses.

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