NATURE OF COOKING FUEL TRANSITION: ESTIMATES FROM INDIAN HOUSEHOLDS

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Overview

For addressing issues such as poverty elimination, health hazards and environmental as well as energy security; analysing the nature of a household's choice and demand for fuel is important. One of the major elements of economic development is signalled by the household sector's shift from traditional fuels such as plant and animal residue burning to usage of modern sources of energy such as Liquid Petroleum Gas (LPG) stoves and electricity for cooking and lighting purposes. This shift is also a parameter to explain economic development and growth related to urbanization and industrialisation processes occurring within an economy. About 30 percent of end-user fuel consumption in India constitutes the household sector, making it one of the largest sectors that is dependent on energy. The process that goes into making of decisions by households comes from a "household decision environment" which is vital to study the process of energy consumption. But information asymmetry on the decision-making process is quite an obstacle to forecast responses from households and make robust energy policy for the household economy (Stern et al., 1986). Much of the traditional literature has paid particular attention to the "energy ladder" approach but a study on rural Mexican households revealed evidence that households do not completely travel up the "energy ladder" with rising income, but follow a "fuel stacking" procedure in which traditional fuels are combined with modern fuels according to individual preferences (Masera et al.,2000). It is,therefore,worthwhile to study the unambiguousness surrounding how households in emerging economies such as India,decide their fuel basket for cooking. The heterogeneity in a household's cooking fuel basket is determined by a host of conditions, but our study has broadly classified these determinants under four categories of influencing factors, namely: affordability, availability, accessibility, and social and behavioural conditioning.
The contribution of this research are as follows:
• Use of multiple-choice model for three categories of fuels for household's cooking fuel selection,
• Going beyond the typical economic determinants such as income of the households, we investigate four different categories of factors,and
• We consider not just economic but socio-demographic, regional and climatic factors to have significant impact on household fuel choices in a multiple choice framework for the Indian households

Methods

The present study is sourced from the latest available secondary data on household consumption in India collected in the 68th round of the National Sample Survey (NSS) between 2011-12 and published in 2014. It takes into account the responses of 97298 households (post-cleaning the dataset). We have also used the Human Development Index Data (statewise) from the "HDI Database" of the Global Data Lab as well as Gross State Domestic Product (GSDP) data for each Indian state, at constant 2011-12 prices, which is collected by The Central Statistical Organization, New Delhi, India and is available online. In our multiple-choice fuel model, the dependent variables (xi) are cooking fuels classified into the following 3 categories: Primitive Fuels (e.g., coke, coal, plant and animal residue, firewood abbreviated as "P"), Transition Fuels (e.g., kerosene, abbreviated as "T"), and Advanced Fuels (e.g., LPG, Electricity denoted as "A"). There are fifteen explanatory variables broadly grouped into four overheads, mentioned earlier. When the dependent variable is a category variable like in our current study, it is unfitting to use the Ordinary Least Square (OLS) method to predict the dependent variable's behavior. In such a case, Logistic Regression is applied. However, here, the traditional logistic regression model is inappropriate because it can address only binomial dependent variables. Between ordered logistic regression and multinomial logistic regression, we choose the latter because, in reality, households do not necessarily sort available energy sources based on their cleanliness to choose their cooking fuel. Their choice set is built based on a complex interaction of preferences to maximize their utility where they can resort to fuelstacking or exhibit unidirectional fuel transition or oscillate between both. Consequently, this study proposes that households choose their fuel requirements based on socio-economic, demographic, and geo-ecological characteristics. Using these variables, the following MNLM specification was estimated:

$$\ln \Omega_{T|P}(x_i) = \beta_{0,T|P} + \beta_{1,T|P}\mathrm{Y}_1 + \beta_{2,\mathrm{T|P}}\mathrm{Y}_2 + \beta_{3,T|P}Y_3 + \beta_{4,T|P}Y_4 + \beta_{5,T|P}Y_5 + \beta_{6,T|P}Y_6 + \beta_{7,T|P}Y_7 + \beta_{8,T|P}Y_8 + \beta_{9,T|P}Y_9 + \beta_{10,T|P}Y_{10} + \beta_{11,T|P}Y_{11} + \beta_{12,T|P}Y_{12} + \beta_{13,T|P}Y_{13} + \beta_{14,T|P}Y_{14} + \beta_{15,T|P}Y_{15} + \beta_{16,T|P}Y_{16} + \beta_{17,T|P}Y_{17} + \beta_{18,T|P}Y_{18}$$

$$\ln \Omega_{A|P}(x_i) = \beta_{0,A|P} + \beta_{1,A|P}\mathrm{Y}_1 + \beta_{2,\mathrm{A|P}}\mathrm{Y}_2 + \beta_{3,A|P}Y_3 + \beta_{4,A|P}Y_4 + \beta_{5,A|P}Y_5 + \beta_{6,A|P}Y_6 + \beta_{7,A|P}Y_7 + \beta_{8,A|P}Y_8 + \beta_{9,A|P}Y_9 + \beta_{10,A|P}Y_{10} + \beta_{11,A|P}Y_{11} + \beta_{12,A|P}Y_{12} + \beta_{13,A|P}Y_{13} + \beta_{14,A|P}Y_{14} + \beta_{15,A|P}Y_{15} + \beta_{16,A|P}Y_{16} + \beta_{17,A|P}Y_{17} + \beta_{18,A|P}Y_{18}$$

We are restricted to making pairwise interpretations only using this method, contingent upon a baseline category of outcome from multiple alternatives.Despite this limitation, MNL regression is appealing because the probability function takes a simple form and is strictly concave; therefore, the vector has a unique solution which is easily estimable using standard maximum likelihood methods.

Results

• On observing the sampled households' total monthly expenditure quartiles, it is seen that the transition from the lowest to the highest monthly expenditure quartile also marks a shift of the majority of households from mainly consuming primitive fuels towards using more advanced fuels like LPG and electricity. However, a significant proportion of households (= 6360) are observed in the highest expenditure quartile who would still prefer using primitive fuels to cook and that contradiction is observed in the lowest expenditure quartile also with preferences for advanced cooking fuels (= 4635). Hence there is a contradiction in following the Energy Ladder Model.
• Looking at the percentage of households under each rural and urban sector using the three types of cooking fuel, we can see that rural households across all the quintiles of GSDP of Indian states tend to be majorly primitive fuel users. Only about 10-20% of the surveyed urban households report using primitive fuels for cooking.
• Barring few variables, all our other explanatory variables significantly influence the choice of household fuels for cooking according to our multinomial logit model. This indicates that a "household decision environment" for choosing cooking-fuel depends upon not only economic but also demographic, social and geographical/ regional characteristics.
• Probability of using advanced fuels (LPG, Electricity etc.) for cooking increases by 7% when monthly expenditure on food items is lower than fuel expenses, as per the data analysis
• Ownership of land increases the odds of consuming primitive fuels by 2.4% while having dependent children lowers probability of using advanced cleaner fuels by 3%. This implies that bigger households that possess their own land often prefer primitive fuels because they habitually domesticate animals and grow their own produce whose residues could be better utilised by burning them as fuels, and also it assures an outdoor space needed to burn such fuels for cooking. An additional household member especially children could spare a few extra hands in collecting firewood, etc. with lesser opportunity costs thus reducing the need for arranging advanced cooking stoves for LPG/Electricity.
• Female-headed households and households with educated heads, show a significant positive preference for advanced fuels(2% and 15% respectively). An educated woman heading a household is likely to have scarcity of time and more health awareness to gather firewood for her family because of the higher opportunity cost of her time hence they have higher odds of choosing advanced fuels over primitive fuels than a male headed-household.
• Belonging to religious minority sections lowers probability of use of primitive fuels such as charcoal or firewood to prepare food, contrary to our expected sign. This result is consistent with the study in Kolkata, India by Gupta et al. (2006). But belonging to backward caste increases the probability of the same fuel-consumption behaviour by 8%.

Conclusions

- It is important to study not only economic factors, but also the cultural aspects involved in cooking fuel choices for a culturally complex nation as India as these could infuence households to use charcoal, firewood etc.for particular styles of cooking despite their high overall monthly expenditure(which is a proxy to monthly income)
- The study finds rural households to be the major consumers of primitive dirty fuels for cooking, across every states from low, medium and high quantiles of GSDP, signifying major policy bottle-necks in implementing access to cleaner fuels in rural areas irrespective of the state's Gross State Domestic Product numbers. What causes rural households to not consume cleaner fuels to cook? Are the bottlenecks due to affordability or accessibility or availability?And why are they prominent to rural sector?This aspect needs to be studied further.
- In designing policies for reducing the use and effects of primary fuels, women's role in a household decision-environment must not be ignored. Compared to men, women may have more substantial reasons to use efficient fuels for cooking because of their prolonged involvement with the process.Hence policy makers should give due importance to women's say while designing surveys etc. for formulating the list of policy levers meant for assisting the fuel transition amongst households towards greater efficiency.