Environment for Development

POLICY BRIEF

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Income alone doesn't determine adoption and choice of fuel types

Evidence from households in Tigrai and major cities in Ethiopia

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APRIL, 2009

It is estimated that approximately 2.5 billion people in developing countries rely on biomass fuels to meet their cooking needs. Biomass fuels are derived from living, or recently living organisms, such as wood and leaves, animal waste and other types of waste. Urban centers have long been dependent on the rural hinterlands for about 90% of their biomass fuel needs in Ethiopia. This is one of the causes of deforestation and has resulted in growing fuel scarcity and higher firewood prices.

One response to reducing the pressure on rural hinterlands could be for urban households to switch from biomass fuels to another type of fuel such as electricity. This swiching of fuel types is known as energy transition. Without new policies, the number of people globally that rely on biomass fuels is expected to increase to 2.6 billion by 2015, and 2.7 million by 2030 (about one-third of the world's population) due to population growth.

It has been argued that households with low income levels rely on biomass fuels, such as wood and dung, while those with higher incomes consume energy that is cleaner and more expensive, such as electricity. Those households in transition consume what are called transition fuels, such as kerosene and charcoal. This fuel choice and demand behaviour of households is known as the "energy ladder hypothesis".

More recently, it has also been argued that households in developing countries do not switch to modern energy sources but instead tend to consume a combination of fuels. This means households choose different fuels as from a menu, rather than completely switching from one form or fuel to another. This method of fuel usage is known as fuel stacking (multiple fuel use).

Fuel stacking could be important in urban Ethiopia because urban households have limited options for fuel, as well as stoves to bake *injera*[1], although there are more options for cooking other foods. Careful examination of fuel stacking could lead to a different set of conclusions and recommendations and thereby policy implications, than what might result from the assumption that households will shift to modern and cleaner fuels, such as electricity as their incomes rise.

Key Points

- Households generally used more fuel types as their incomes increased, instead of (completely) switching to another fuel type.
- In designing policy, for households in poor developing countries, such as those in Ethiopia, more attention should be paid to other factors besides income alone.
- Household income (expenditure), family size, age and education are significant and matter more in determining whether or not household adopts the electric *mitad*.

[1] *Injera* is a pancake-like bread made from *Teff* and is the staple food in the northern half of Ethiopia. Typically, either wood or electricity is used to bake *injera,* given existing technologies.

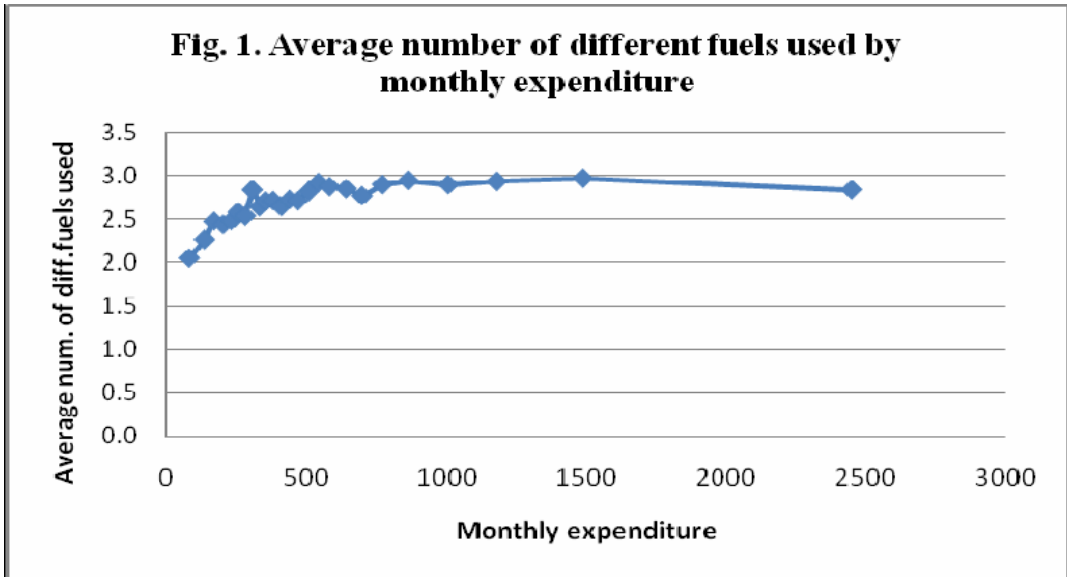
In one of two similar studies we examine the determinants of household fuel choice and demand in major Ethiopian cities. The other study tries to investigate urban energy transition and technology adoption as the possible means of reducing the pressure of urban centers on the rural hinterlands by particularly assessing the electric (*mitad)* cooking appliance holding or adoption rate and how it conditions urban energy transition.

Findings

In the study attempting to determine urban household's fuel choice and demand, we find that the average number of fuels used by households in our data is between 2 and 3, with many households using 4 different fuel types at the same time. This shows that households generally used more fuel types as their incomes increased, instead of (completely) switching to another fuel type.

Such behaviour is associated with the fact that while households were more likely to afford to buy additional cooking stoves if new fuel types required them, there were also various other reasons to do so, including preferences for a particular fuel type used for a particular type of food, for a particular time or occasion, for convenience, or due to uncertainty about the supply of a fuel type. A very good example of this is the fuel type used for baking *injera*, which is either wood or electricity given the existing baking technologies.

This is supported by results from the similar study looking at energy transition to electricity to reduce pressure on rural hinterlands. The clay enclosed traditional *Tigrai* type stove was found to be the predominant stove used in urban areas for baking *injera*.



In the study examining the determinants of fuel type choices and demand, we find that although the share of expenditure on wood declined and the proportion of households using wood declined as expenditure rose, the total expenditure on wood increased as expenditure rose. What this suggests is that households generally increased their spending on all fuel types as their incomes rose, but they spent more on electricity and kerosene in relative terms, compared to wood, as their incomes rose. This indicates that fuel types such as wood are not inferior, which is contrary to the energy-ladder hypothesis.

Our results suggest that higher kerosene prices made households choose either solid fuels only or a mix of solid and non-solid fuels, moving away from non-solid fuels. Households were also more likely to choose a mix of solid and non-solid fuels with higher wood prices, with a similar result for choice of solid fuels. This suggests, perhaps, that one needs to look at other factors in addition to prices to explain fuel choice, such as the role of equipment cost, preferences, and habit. A positive association of the price of kerosene and the decision to consume charcoal also suggests that charcoal and kerosene are substitutes.

In addition to the price of fuel affecting the choice of fuel type, we also find that:

- Households with a more educated member were more likely to have non-solid fuels as their main fuel.
- Female-headed households were more likely to choose either solid fuels only or a mix of solid and non-solid fuels as their main fuel.

Older household heads were more likely to choose solid fuels only as their main fuel, perhaps from habit as non-solid fuels are relatively more recent and younger household heads are more likely to adopt them.

Despite most sample households, about 80 percent, in the study looking at energy transition in Tigrai, were using electricity, only about 20 percent were found to have adopted the electric *mitad* cooking appliance. The expensiveness of the stove was the main reason for non-adoption. For example, two-thirds of the non-adopters responded that the *mitad* cooking appliance is too expensive.

Characteristics of household such as household income (expenditure), family size, age and education are significant and matter more in determining whether or not household adopts the electric *mitad*. Our results reveal, an increase in the household income increases the likelihood of adopting electric *mitad*. One year of extra schooling of the household head increases the probability of adoption. Similarly, holding all others things constant, a unit change in family size and age also implied an increase in probability of adoption of the electric *mitad*.

Data and Method

In the study examining the determinants of fuel choice and demand, we used panel data collected in the years 2000 and 2004 from seven major cities in Ethiopia by Addis Ababa University's department of economics, in collaboration with the University of Gothenburg. We included 1,500 households in each survey, with about 60 percent of them from Addis Ababa, the capital city.

To analyse fuel choice and demand, we used both descriptive and more rigorous analyses. In the descriptive analysis, in addition to presenting the nature of fuel choice in general, we used graphs to examine unconditional correlation between the decision and intensity of fuel use (including fuel stacking behaviour), on one hand, and household expenditure on the other.

For the more rigorous analysis, we looked into the factors that determine choice of a particular fuel type and fuel-stacking behaviour of households. To do this we used a model by grouping consumers into three categories according to the main fuel used by the household: those whose main fuel was only solid fuel (fuel-wood and/or charcoal), only non-solid fuel (kerosene and/or electricity), and a mixture of solid and non-solid fuels.

In the second similar study investigating urban energy transition and technology adoption conditions a one period data (1994 CSA Census) was collected from a stratified sample of 350 urban households in Tigrai, Northern Ethiopia. Two stage sampling technique was applied in selecting the sample households. First sample towns were selected and then sample households were selected from the sample towns in such a way that every household had the same chance of

being included in the sample. To have an idea of the current population and base the sampling on the population size, the population of the focal towns was projected for 2000 and 2003.

In this second study theoretical utility maximization model and the demand for electricity consistent with discrete appliance choice, was used. In this model, emphasis is given to electricity demand and the use of electric *mitad* cooking appliance. The empirical framework specifies a discrete choice model: the adoption of fuel efficient cooking appliance in general and the electric *mitad* stove in particular and the behavioral factors that underline the adoption.

Policy Implication and Recommendation

The income level of households is not the only determinant for the choice and demand of fuel types. Our results suggest that households tend to switch to a multiple fuel-use strategy (fuel stacking) as their incomes rise, perhaps, because of a number of factors, including preferences, taste, dependability of supply, cost, cooking and consumption habits, and availability of technology. Because of the growing role of modern fuels such as electricity and kerosene and a declining role of dung and charcoal, particularly in urban areas, in our results, does not support the *energy ladder* hypothesis.

The results of these studies have important policy implications because they suggest the need to also focus on other factors besides household income in policy design. Improvement in income and education enhance the likelihood of the household to increase consumption of electricity and electric '*Mitad*' adoption and urban energy transition. This will thereby reduce consumption of wood, implying a reduction in the pressure on wood resources and contributing towards mitigating deforestation. At least for households in poor developing countries, such as those in Ethiopia, perhaps more attention should be paid to these factors and less to those implied by the energy ladder hypothesis, mainly income alone.

For example, these results are important for implementation of the United Nations Millennium Project, which recommends halving the number of households that use traditional biomass for cooking by 2015, which involves about 1.3 billion people switching to other fuels. We suggest that more studies be conducted to examine these issues to find out how important they are for smaller towns in Ethiopia and for other countries.

ABOUT THIS BRIEF

This brief is based on results from two similar studies. One is: Mekonnen, A., and Köhlin, G. 2008 "Determinants of Household Fuel Choice in Major Cities in Ethiopia" Discussion Paper Series EfD DP 08-18, Environment for Development (EfD), University of Gothenburg, Göteborg, Sweden. The other one is: Gebreegziabher, Z., Mekonnen, A., Kassie, M., and Köhlin, G. 2009 "Urban Energy Transition and Technology Adoption: the Case of Tigrai, Northern Ethiopia" Environmental Economics Policy Forum for Ethiopia (EEPFE), Ethiopian Development Research Institute (EDRI), Addis Ababa.

REFERENCES

Barnes, D.F., and W. Floor. 1999. "Biomass Energy and the Poor in the Developing World," *Journal of International Affairs* 53: 237–59.

Barnes, D.F., K. Krutilla, and W. Hyde, (2004). *The Urban Household Energy Transition: Energy, Poverty, and the Environment in the Developing World*. World Bank http://www.esmap.org/filez/pubs/8162007122407_UrbanEnergy_Transition.pdf (Accessed 19 September 2007)

CSA (Central Statistical Authority), (1995). '*The 1994 Population and Housing Census: Results for Tigrai Region*', Statistical Report Vol. I, , Addis Ababa.

Gebreegziabher, Z., (2004). '*Urban Domestic Energy Problems in Ethiopia: An Overview*'. Ethiopian Development Research Institute (EDRI), Addis Ababa.

Heltberg, R. 2005. "Factors Determining Household Fuel Choice in Guatemala," *Environment and Development Economics* 10: 337–61.

Hosier, R.H., and J. Dowd. 1987. "Household Fuel Choice in Zimbabwe: An Empirical Test of the Energy Ladder Hypothesis," *Resources and Energy* 9: 347–61.

IEA (International Energy Agency). 2006. *World Energy Outlook*. Paris: OECD.

Masera, O., B. Saatkamp, and D. Kammen. 2000. "From Linear Fuel Switching to Multiple Cooking Strategies: A Critique and Alternative to the Energy Ladder Model," *World Development* 28(12): 2083–2103.

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