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Patterns and determinants of household use of fuels for cooking: Empirical evidence from sub-Saharan Africa

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ABSTRACT

The use of clean sources of energy for cooking is critical for securing better health for women and children and improving the overall standard of living of people in developing countries. Despite increasing awareness and the revolution in energy sources, a vast majority of households in developing countries continue to use solid fuels for cooking, which are considered to be harmful to both the environment and human health. This paper uses the World Bank's comprehensive living standard survey measurement data from Ethiopia, Malawi and Tanzania to analyze cooking fuel use patterns and their determinants. The descriptive analysis shows that a significant number of households use solid fuels for cooking and only a small fraction of households use clean fuels such as electricity, liquid petroleum gas. Rural households and those situated far from markets are more dependent on dirty fuels. Multinomial logit and ordered probit model estimation results show that female-headed households, household heads with a higher level of education, urban and wealthy households are more likely to use modern energy sources such as electricity and liquid petroleum gas (LPG), and are less likely to use solid fuels.

1. Introduction

About 1.4 billion people worldwide lack access to electricity and 2.7 billion people rely on the traditional use of biomass for cooking [1,2]. Heavy use of firewood as a cooking fuel has greatly contributed to aggregate carbon emissions [3,4]. Use of solid fuels and kerosene (so called dirty fuels) has a severe negative impact on human health and global warming; therefore, access to and use of clean fuels is critical for improved human health, environmental protection and overall socioeconomic development. Sustainable development is directly linked to the quality of household energy consumption [5].

Despite the revolution in energy sources, households in developing countries particularly in East and Southern Africa continue to use traditional sources of energy which has adverse effects on human health and the environment [6–8]. Although countries in East and Southern Africa have abundant renewable energy resources such as solar, wind power, geothermal and hydropower, these countries have been unable to harness these renewable energy resources to influence growth and development.

Households in sub-Saharan Africa, as in many developing countries, rely heavily on fuelwood and other solid fuels for their daily domestic uses [6,8]. Lack of access to clean and reliable energy sources and their affordability are the main reasons for the rampant use of solid fuels in developing countries in general and in South Asia and Bhutan in particular [2,9].

A gradient of quality, convenience and cost can be observed, rising from solid fuels such as firewood and charcoal at the bottom, to liquid fuels such as gas and oil, and, finally, electricity at the top [10]. As a result, the use of fuelwood, dung and crop waste is prevalent among poor households, while households with a higher income move to the use of electricity and LPG [9]. This so-called energy transition ladder [10,11]elucidates the relationship between income and types of energy used. It postulates that in response to higher income and other factors, households will shift from traditional biomass and other solid fuels, to more efficient cooking fuels such as LPG, natural gas, or even electricity. The main driver affecting the movement up the energy ladder is hypothesized to be income and relative fuel prices [2,10,12,13]. Apart from the quantity, the type of energy used also changes with income [14], with a shift towards modern fuels [15], in particular, the use of

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electricity [16]. The poor tend to use solid fuels domestically which is damaging the environment as well as human health [17–19]; when income increases, they generally, but not always, switch to cleaner fuels [20,21].

Several empirical studies have documented the existence of the energy ladder and the factors influencing household decisions to switch to cleaner fuels with an increase in household income [22]. In addition, household demographic features, consumption habits and gender play a significant role in energy-choice decisions of households. Hence, identifying the relative importance of the above factors that influence a household's choice of fuels for cooking is critical for policy making in the context of sub-Saharan Africa.

A significant proportion of the households in sub-Saharan Africa still use dirty fuels such as firewood, straw, manure, and kerosene as sources of energy for cooking and only a small fraction of these households use electricity for cooking.

The contributions of this paper to the existing body of knowledge are fivefold. First, no such energy study has been carried out using large household datasets from three sub-Saharan African countries covering over 17,000 households. Second, this is the first attempt to study the cooking-fuel use patterns and determinants at a regional level in Africa. Third, it uses a multinomial logit and ordered probit models which analyzes the determinant according to their sequence in the energy ladder. Fourth, it uses several different and observable measure of wealth to establish the casual relationship between wealth and fuel choice behaviours. Fifth, it also employs alternative measure of education, accessibility to establish the casual linkage of the awareness and accessibility on choice of clean energy for cooking.

The availability of a wide range of variables and the quality of data that the Living Standard Measurement Survey (LSMS) provides enabled several detailed robustness tests on the significance and differential role of levels of household education and wealth on the household choice of electricity as the energy source for cooking.

The paper is organized as follows: Section 2 presents a comprehensive review of related literature on the determinants of household energy choice; Section 3 outlines the data sources and collection, and the specification of econometric models; in Section 4, trends and the transition of household energy consumption in sub-Saharan Africa are presented; empirical results and discussions on the determinants of electricity use by household are presented in Section 5; Section 6 concludes with policy implications.

2. Literature review

Much research on a household's choice of energy for domestic use has pointed to the importance of income, household size and composition, education and the gender of the household heads [23,24].

Households derive higher utility from the use of clean and convenient sources of energy subject to budget constraints; therefore, wealth/income of the household influences their ability to afford the high cost of a clean and convenient source of energy. Household wealth is one of the important parameters influencing a household's choice of energy sources [14,23]. Rich households have a higher ability, and consequently willingness to pay for a better quality of fuel. Hence, as the wealth and income of the household increases, it is more likely to switch from using dirty energy sources such as firewood to using clean energy sources. A study in India found that per capita total household expenditure has the largest positive effect on per capita total energy requirements [25].

Energy consumption generally increases with household wealth [14], which is often measured by farm size and livestock in rural households [26,27]. Therefore, an increase in farm size and income from agricultural production can result in a decrease in the collection of firewood from the forest when households consume more energy and consequently switch to higher-quality energy sources. Recent studies have measured wealth using the quality of housing and the ownership of durable assets [9].

The education level of household members affects household energy choices in two different ways: first, education improves income and, hence, affordability and the opportunity cost of time; second, income increases knowledge and affects cultural and consumer preferences. Households with an educated head tend to choose cleaner energy because of the convenience of use, health benefits and the opportunity cost of their labor. In India, the education level of the household head has been found to increase a household's interest in choosing a clean and efficient source of energy [14]. Furthermore, the number of educated females between ten and 50 years old in a household has been found to have a positive effect on the choice of a clean source of energy [28]. Households where the head and spouse have a higher level of education have a greater tendency to use modern energy sources as these offer a significant savings in time [29]. Education is a strong determinant of fuel switching [30,31]; increasing levels of education are associated with a higher probability of using modern energy sources, and a lower incidence of solid fuel use [32]. Education of the household head and spouse reduces the consumption of fuelwood and other conventional fuels because education prejudices households in favor of modern fuels, and improves decision-makers' understanding of the costs and benefits of modern energy sources and in particular their health benefits [33].

In rural households in India, the female members are more involved in collecting firewood from the forest than their male counterparts, who are more involved in agriculture, wage earning and in other non-farm employment activities [27]. The presence of a large number of women in the household increases the available labor for the collection of firewood and for cooking, thus the likelihood of the household moving to less time-consuming sources of energy is reduced [30]. However, having young children reduces available labor: the presence of a child below six-years old reduces a household's use of firewood, probably because the time available for wood collection is reduced by the time needed for child care [34].

When the income level increases in the household, or if a woman heads the household, women's preferences are more likely to be realized. Female household members concern themselves with the sourcing of energy in developing countries, and households are the main users of energy [35]. The role of female household members varies from collecting fuel at low income levels, to making decisions on the choice of fuel at high income levels [29]. With the use of clean sources of energy, female members have better health and more time for leisure and family, so when a female member is the principal decision-making agent, a high priority will be given to goods that are more useful to the female members of the household. In urban households, women have a stronger preference than men for a clean energy source, given their greater involvement in cooking [33]. The same study found that per capita fuelwood consumption in female-headed households is less than in male-headed households [33]. Ignoring gender roles and traditions in energy use has reduced the global potential for renewable energy [35].

Other demographic characteristics such as the age of the household head and the number of adult males and females play an important role in influencing a household's decision to choose an energy source. The size of the household has a negative impact on the probability of choosing clean cooking fuel [28], although the relationship can be non-linear [14]. Household size has a positive impact on the collection of wood for fuel, both because of an increased demand for energy, and an increased labor supply for