HOUSEHOLD ENERGY DEMAND IN UGANDA: ESTIMATION AND POLICY RELEVANCE

Grace Alinaitwe
Department of Economics, Norwegian University of Life Sciences, Ås, Norway
+4792525180, gral@nmbu.no

Abstract
The generation capacity of electricity in Uganda is very high compared to its current demand Sekantsi & Okot (2016). Only a few households are connected on the electricity grid in the country. Usage of clean energy saves time and protects health the users. It also reduces environmental degradation. This paper aims at finding ways of increasing the demand of electricity, using the Uganda National Panel Survey (UNPS) data 2013/2014. We use the augmented QUAIDs model by Banks et al. (1997) and find that, electricity is a substitute of kerosene, charcoal and firewood, since its estimated Hicksian cross-price elasticities are positive. The policy implication of the results is that the government can use tax incentives to increase the demand of clean renewable energy.
Keywords: Energy types, Electricity Demand, QUAIDS, Uganda

1 Introduction

Many people in the world still lack access to electricity majority living in South Asia and Sub-Saharan Africa IEA, (2009). Many times, households are not connected to the electricity grid even when they have access due to affordability constraints in form of high tariffs. Electricity is important to households because it saves them time and since it is clean energy, it protects their health hence increasing their welfare. It also reduces environmental degradation and transportation costs as services and goods can easily be found within the locality. In addition to this, past studies have showed that electricity is a component in the production functions leading to development. The paper aims at finding incentives like subsidies to increase the demand of electricity since it is a clean renewable energy, and hence preferred over and above the other energy types. Without electricity households' resort to its alternatives like firewood, kerosene and charcoal to meet their daily energy needs. In fact, the past surveys in Uganda show that firewood is the most popular source of energy for cooking while kerosene dominates lighting hence exposing the users to dangers of open fire. Using the UNPS data 2013/2014 we find that 75.2% of the Ugandan households used kerosene for lighting while 86.5% used firewood and charcoal for cooking. Only 14.3% of the households used electricity for lighting and 0.8% used it for cooking.

On the other hand, we observe that in Uganda the generation capacity of electricity is higher than its demand. The Electricity Regulatory Authority (ERA), (2018) forecasted total demand for electricity equal to 560MW by 2025 while the installed generation capacity was 927.4MW at that time and much higher today. Clearly there is a mis-match between demand and supply of electricity in the country hence an urgent need to explore ways of increasing its uptake. It can be done but not limiting through; the expansion of the transmission lines hence connecting more households, expansion of the industrial sector, and the increase of household demand of electricity. The study aims at estimating the income and price elasticities of household demand for energy fuels with the aim of providing fiscal incentives to increase the demand and hence usage of electricity at household level. Policy analysis related to energy consumption and household welfare require this knowledge of households' demand responses to changes in price and income. For instance, a policy aiming at providing subsidies either directly or indirectly to vulnerable household consumers requires this knowledge. On the other hand, Energy utilities may also require the knowledge of price elasticities of the demand of energy in order to make dispatch decisions and to assess the impact of the subsidies on the welfare of households.

In Uganda, there is scanty literature existing on changes of energy consumption due to changes in income and prices. This may be due to lack of the extensive data required on consumer purchases and income flow in the analysis of the price and income elasticities. While this data may be forthcoming in the country via regular household expenditure surveys, it is not readily available. In fact, most studies on developing country rely on general household surveys, which often lack detailed information on household purchases, particularly, prices (Deaton, 1988, 1997 and 2000). This therefore limits the extent and quality of analysis required to influence policy in the respective countries.

This paper will therefore contribute to the debate of price and expenditure elasticities of energy fuels in Uganda. To do this, we analyze the household energy demand in the country and consequently, estimate the price and expenditure elasticities. We jointly estimate households' demand of the energy types using a Quadratic Almost Ideal Demand System (QUAIDS) by Banks et al. (1997). We find that, electricity is a substitute to the other energy types.

2 Methodological Framework

We assume a quasi-concave utility function of the sampled household and a choice behavior of each household to gain utility from any demand given limited household income. We also assume that the amount of energy consumed by each household is function of prices and household income. The prices of any of the four energy types of fuel affects the amount of quantities and the qualities the household can decide to consume (Deaton 1990).

The study employs the Quadratic Almost Ideal Demand System (QUAIDS) developed by Banks et al., (1997), an extension of the Almost Ideal Demand System (AIDS) model developed by Deaton and Muellbauer (1980). It is more

flexible than the usual AIDS because it allows demand curves to be nonlinear in the logarithm of income. Many researchers including Khanal et al., (2015) and Abdulai, (2002) have applied the model. The model is:

$$S_{jk} = \alpha_{jk} + \sum_{i=1}^{4} \gamma_{ij} lnp_{ik} + \beta_j ln\left[\frac{y_k}{a(p)}\right] + \frac{\lambda_j}{b(p)}\left[ln\left(\frac{y_k}{a(p)}\right)\right]^2 \text{ for } j = 1,2,3,4 \quad (1)$$

where S_{jk} is the budget share for each energy type of the k[th] household in its total energy demand expenditures; k =1,.....N denotes for the sampled households; p_{ik} represents the energy prices for the k[th] household consumer; y_k represents the total energy expenditures of the k[th] household; a(p) and b(p) are the translog price aggregator and Cobb-Douglas aggregator respectively α_{jk}, γ_{ij}, β_j and λ_j are the parameters to be estimated.

Excluding the quadratic term in equation (1), makes an AIDS model. Theoretically, the above equation must satisfy the laws of demand which requires imposing the adding up condition, the homogeneity of degree zero in prices and income, and the symmetry conditions of the slustky parameters.

To account for heterogeneity among households, we include household demographic variables which have been considered in the relevant literature like Khanal et al., (2015) and found significant in influencing a household's purchase decisions. Specifically, our QUAIDS model includes: Age of household head, regional dummies, household population size and marital status of the household.

There are some energy types with zero household expenditure due to non-preference, non-affordability, and non-availability, leading to existence of corner solutions hence biased estimates Park et al., (1996). To solve the problem, we only consider enumeration areas with a probability of access to electricity greater than 0.1. We estimate the first stage using a probit model that describes the consumption selection decisions and we use the augmented QUAIDS in the second stage. Finally following Poi (2012), we derive expenditures and Marshallian price elasticities from which we derive the compensated (Hicksian) price elasticities.

3 Data

We use the UNPS 2013/2014 data which data is a national representative of households in the country. We use expenditure data to proxy income, specifically the expenditure on fuel types. Where unit price is not reported, it is calculated by dividing expenditure by the quantity consumed reported. Electricity price is not available in the survey, so the unit price is extracted from the website of Electricity Regulatoy Authority as reported by each distributor in their respective supply regions. For zero-consuming households, imputed prices based on the average fuel price for their enumeration area were assigned.

For all energy types, the constructed energy expenditure shares were used as the dependent variables and the independent variables included the logs of per unit prices of the energy types, logs of income, squared log of income and household control variables mentioned earlier. The households eliminated are mainly due to the lack of basic information on household energy expenditure or outside the access of electricity.

4 Results analysis and discussion

We find that all the parameters of the household demographic attributes exhibit statistically significant values, which shows that household energy demand depend greatly on household characteristics. The coefficients of log of income and log of income squared of fuel types are also significant. We find that in the short and medium term, income growth leads to an increased consumption of charcoal which is not the case in the remaining three fuel types.

All own-price elasticities for energy types showed are negative which implies the negativity condition is fulfilled hence consistent with economic theory.

We observe that, compared to uncompensated elasticities some of the Hicksian cross-price elasticities have different signs which further implies that household income effect plays a significant role on energy demand.

The results also indicate that electricity is a substitute to each of the other energy fuels since the cross elasticities are all positive. The cross elasticity between electricity and charcoal is the smallest, indicating that people are quite rigid to change from charcoal to electricity. This correlation with electricity consumption suggests that manipulating the price of electricity through tax incentives will influence shifting household's energy mix itself.

5 Conclusion and policy relevancy

The study aimed at finding ways to increase the demand for electricity since the installed capacity is greater than its current demand in Uganda. Therefore, using an augmented QUAIDs model that corrects for censored distribution of expenditure shares, we analyzed the household demand for energy types. The study reveals that the estimated the Marshallian and Hicksian own-price elasticities are all negative and thus consistent with economic theory. For policy purposes, results show that the consumption of electricity can be increased while that of charcoal and firewood decreased, using subsidy and tax incentives because electricity is a substitute to all the other fuel type. Increasing households' income may help to achieve the objective quickly because the income substitution effect is observed through the differences between Marshallian and Hicksian own-price elasticities, moreover electricity is found to be normal good. However, in conjunction to the above recommendations, the government should address the transmission constraints of electricity by expanding the grid and should ensure reliability of electricity.