



Edwin Muchapondwa, Ph.D
Professor

Private Bag, Rondebosch 7701, Cape Town, South Africa
School of Economics Building, Middle Campus, Rondebosch
Tel: +27 (0) 21 650 5242 Fax: +27 (0) 21 650 2854
E-mail: edwin.muchapondwa@uct.ac.za
Internet: <http://www.commerce.uct.ac.za/Economics/>

Examiner's Report on Tarekegn Mamo Legamo's PhD Thesis entitled "Household Energy and Water use in Hawassa, Ethiopia"

The thesis seeks to explore issues in household energy and water use in Ethiopia. The research objectives are summarized as:

- To estimate the drivers of energy source choice and consumption at household level
- To investigate household preferences and the main drivers of investment decisions on biogas technology
- To examine household water savings and consumption behaviour along with the driving factors of the behaviour

These are dealt with in three substantive papers entitled:

1. Household energy sources, driving factors and use patterns
2. Determinants of investment decision on biogas energy technology conditioned on flexible financing options
3. Residential water saving behaviour and water use: Evidence from Hawassa, Ethiopia

OVERALL COMMENT

The thesis has satisfactorily addressed previous comments. I would like to congratulate the candidate for producing a good thesis.

Paper 1: Energy expenditure and fuel choices among households in the Sidama region, Southern Ethiopia

Using the data from an original survey (N=376), this paper examined access to different energy sources, choice and use, the key drivers and fuel expenditure among households in Hawassa City, Ethiopia. The analysis of household energy source decision and use patterns shows that demand for clean energy sources is growing very fast in the study area.

There are large differences in energy use between urban and suburban areas:

- Fuelwood and charcoal are the main sources for cooking among the poorest households
- Fuelwood is the dominant source for cooking in suburban locations

Electricity is the energy source used mainly in urban areas and especially among richer households. Among cooking energy sources, electricity and charcoal took up the highest budget share of high income households in urban areas while fuelwood for cooking took up a low energy budget share in both urban and peri urban areas.

The primary cooking energy choice modelled empirically using a discrete choice framework. Following this, the energy choice model used the multinomial logit

The main drivers of cooking energy source decision were income, budget share on fuel expenditure, alternative wood sources, education level, family size, gender and age of respondent head. Large families are more likely to prefer fuelwood and less likely to choose charcoal. Female-headed households are more likely to choose charcoal for cooking. Formal education increases the likelihood of using cleaner electricity and decreases the usage of fuelwood. Formal education, alongside income, seems to be the key factor in moving from traditional health-damaging energy sources towards modern and clean energy sources.

Income is one of the key drivers of consumption at income elasticity +0.246 for electricity, for fuelwood at +0.278, and charcoal at +0.124 respectively. Increased energy budget share, increasing ownership of electric appliances, and knowing energy saving cook method drive electricity consumption while charcoal use is significantly associated with age, geographic location, and charcoal budget share.

The drivers of fuelwood use are age of household head, marital status of household head, income, and budget share on fuel expenditure.

The paper makes an important contribution and draws the policy implications appropriately. The paper indicates that results suggest that access to clean energy source can play a significant role in suburban areas of low-income countries. When households start using modern energy sources for cooking, this reduces environmental pollution and improves the quality of life. Meanwhile increased household energy consumption will depend on future approaches to energy efficiency improvement achieved via increasing access to clean sources and changes in household behaviour. Moreover, energy policy interventions need to consider the main demand factors; affordability, market access for cooking stoves by removing bottlenecks for wide distributions and increasing innovative and clean fuel sources along with sustainable consumption behaviour.

Paper 2: Flexible Financing and Investment in Renewable Energy Sources: The Case of Biogas Energy in Sidama Region, Ethiopia

Even though, biogas and other renewable energy sources are abundantly available in Africa, the utilization of these resources is minimal because of various limiting factors. An important issue in promoting and implementation of biogas technology in low-income householders are equity issues, financing and marketing factors. Accordingly, this paper focused on testing new covariates such as flexible credit financing (i.e. three loan repayment options) as drivers for the demand of biogas particularly by households in suburban areas.

A survey of 298 households is used.

The paper examined determinants of investment decision on family size biogas energy technology, conditioned on credit access at flexible loan repayment options. It used a multinomial logit model of the three credit repayment options.

The key drivers of willingness to invest in short-term loan repayment options were the education and gender of household heads, access to fuelwood sources and wastewater systems, and, livestock ownership.

Households' willingness to invest in biogas energy funded via medium term financing varies with the level of formal education of household heads, wastewater system, and livestock ownership.

Willingness to fund biogas energy with long-term loans was positively correlated with the area of land in use.



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Notably, the results show that women are more likely to invest in biogas technology if given a short-term loan repayment option with a high credit rate (70 percent of investment cost). If women have autonomous decision making, they will benefit from biogas technology in terms of reduced health risks, time and energy saved, while the biogas technology use increase convenience and reduce hardships in fuelwood collection by women and children, which is common in the study area.

Landholding does not affect investment decision on biogas digester in short-term loan instalment while it does for medium and long-term loan instalment.

Regarding livestock ownership, the results indicated that as households possess a large number of cattle and other livestock they are willing to invest in biogas digester since they could have enough substrate for plant operation.

The relationship between formal education and investment decision on biogas digester is more likely in short and medium-term loan instalment than the long term, while informal education has a modest factor for biogas digester in medium-term instalment relative to long term.

The paper rightly concludes that credit provision and financial assistance policies should take into account gender balance in extended credit share with flexible loan repayment options. In addition, strong awareness creation regarding the benefits of biogas technology bio products (slurry for natural fertilizer) to address the gap in the demand of households with large land holdings and have alternative fuel sources.

Paper 3: Residential Water Saving Behaviour and Water Use. Evidence from Hawassa, Ethiopia

This paper analyses residential water use and water saving behaviour along with factors driving them among households in Hawassa, Ethiopia. It uses a cross-sectional survey of 200 households.

Three sorts of analyses are conducted:

First, the two-sample t-test for connected vs. non-connected respondents revealed that the non-connected households are characterized by lower income, lower level of education, family size, private business occupation, and less water use.

Second, the logistic regression procedures is used on the connected households (i.e. 85 percent of survey respondents) to analysed the key factors predicting water savings behaviour at home.

Third, the OLS regression model is used to capture the variation in water use controlling for income elasticity, number of water using devices, socio-demographic and environmental perception variables.

The results show a 4 percent increase in kitchen sink water savings with large family size. An extra income of \$0.03 will increase tap water saving by 1 percent and shower savings by 3 percent respectively. Higher education raises the tap water savings by 0.227 units compared to lower

education. The probability of indoor water savings in terms of tap water and shower savings rise by 0.18 units if there is a joint agreement between the households and the municipality on water source protection to sustain water supply. High education raises the tap water saving performance by 22.7% compared to low educated households.

Household's income is a key predictor of water consumption at an income elasticity +0.235, and both larger families and more water-using devices significantly increase water use. Age is negatively related to water use. Female household heads were negatively associated with water use suggesting more prudence amongst women in water conservation.

The study implies that use of policy instruments for water conservation should rely on quantified characteristics and driving factors of household water consumption and savings behaviour.

OVERALL ASSESSMENT

- a) Can you recognize an original contribution of the author? YES
- b) Is the thesis based on relevant references? YES
- c) Is the thesis defensible at your home institution or another respected institution where you gave lectures? YES
- d) Do the results of the thesis allow their publication in a respected economic journal? YES
- e) Are there any additional major comments on what should be improved? NO
- f) What is your overall assessment of the thesis? (A) I recommend the thesis for defense without substantial changes, (B) the thesis can be defended after revision indicated in my comments, (C) not-defensible in this form. A

*** END OF REPORT ***