ENERGY EFFICIENCY FOR LOW INCOME HOUSEHOLDS: WHAT ABOUT REBOUND EFFECTS?

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Overview

Improved energy efficiency is widely expected to play a key role in reducing energy consumption. However, the energy savings from such improvements may be less than simple calculations suggest, owing to a variety of economic mechanisms that go under the heading of *rebound effects* (Sorrell 2010). *Direct* rebound effects result from increased consumption of relatively cheaper energy services: for example, an efficient boiler lowers the cost of space heating so households may choose to increase internal temperatures and/or leave the heating on for longer. *Indirect* rebound effects result from induced changes in consumption of other goods and services, the provision of which necessarily involves energy use. For example, the money saved on space heating may be spent instead on increased lighting, or on electronic appliances. Re-spending therefore may lead to additional energy use, which offsets the original energy savings. The range of estimated rebound effects differs widely among different studies, from very low to very high. However, Chitnis et al. (2014) find that the rebound effect for lower income households is larger than higher income households.

This study estimates the direct rebound effect from increased efficiency of heating and associated indirect rebound effect for electricity services for Greece mountain area of Metsovo where households have generally lower income. In other words, the study includes the indirect rebound effect that results from increased consumption of other energy services (e.g. cheaper heating leading to more lighting), but excludes embodied energy. The data used are collected by survey of 300 households.

Methods

Following Chitnis et al. 2020, this study estimates a heating service demand model incorporating *'efficiency'* of heating service through the price of heating service:

$$\ln h_i = \alpha + \beta \ln p_i + \gamma \ln x_i + \lambda \ln dsize_i + \theta \ln dage_i + \varphi \ln hrs_i + \tau \ln hsize_i + \omega \ln age_i + \rho Dd_i + \xi Df_i + \upsilon_i \quad (1)$$

Where *h* is expenditure for heating service, *p* is the price of heating service, *x* is the disposable income, *dsize* is dwelling size, *dage* is dwelling age , *hrs* is heating hours, *hsize* is household size, *age* is household reference person age, *Dd* is dummy for dwelling type, *Df* is dummy for household reference person gender, υ is an error term and *i* represents household. We also try adding other socio-demographic variables to the above model. In equation 1, $p = \frac{p_f}{\varepsilon}$ where p_f is the price of heating fuel and ε is the heating efficiency of the household heating system.

The electricity service demand model is as follow:

$$\ln el_i = \alpha' + \beta' \ln p_i + \gamma' \ln x_i + \lambda' \ln dsize_i + \tau' \ln hsize_i + \omega' \ln age_i + \xi' Df_i + \upsilon'_i - u_i \quad (2)$$

Where *el* is expenditure for electricity service, υ' is the error term, *u* is the inefficiency term, and the rest of the variables are as defined above. We also try adding other socio-demographic variables to the above model. The price of electricity is constant for all households during the survey period and efficiency data is missing for electricity services. Equation 2 is estimated using Stochastic Frontier Analysis (SFA) to count for technical efficiency.

The direct rebound effect is estimated from the negative of the own- price elasticity of heating service in equation 1, while the indirect rebound effect is estimated from the cross-price elasticity in equation 2. Rebound effects are estimated in terms of energy use.

Results

The initial results suggest that the *direct* rebound effect from heating efficiency improvement is 48%. *Indirect* rebound effect is 8%. This means that the total rebound effect is 56%. In addition, the mean estimated efficiency score for electricity services is 0.74 meaning that there is room for efficiency improvements.

Conclusions

Rebound effect appears to be significantly large for measures that improve heating efficiency for the residential sector in Metsovo. The households in Metsovo generally have lower income than average in Greece. Therefore, increase in heating efficiency helps these households to achieve better standards of living by improving their comfort level and adequately heating up their homes. This is confirmed by the large direct rebound effect.

References

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