REBOUND EFFECT FOR UK RESIDENTIAL SECTOR

Mona Chitnis, Surrey Energy Economics Centre (SEEC), School of Economics, Faculty of Arts and Social Sciences, University of Surrey, Guildford, GU2 7XH, UK, Tel. +44 (0) 1483 689923, Email: m.chitnis@surrey.ac.uk
Roger Fouquet, London School of Economics and Political Science, Tel. +44 (0) 207 1075027, Email : r.fouquet@lse.ac.uk
Steve Sorrell, University of Sussex, Tel. +44 (0) 1273 877067, Email: s.r.sorrell@sussex.ac.uk

Overview

Improved energy efficiency is widely expected to play a key role in reducing energy consumption and GHG emissions. However, the energy and emissions 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 and GHG emissions. 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 and emissions, which offset the original energy and emission savings.

This study estimates the direct and indirect rebound effects following residential energy efficiency improvements for UK equivalised person. Using a unique dataset, the study separately investigates the effect of efficiency improvements for lighting, heating (water and heating combined), electrical appliances and cooking. This is the first study to investigate rebound effect at this level of disaggregation. The study includes the indirect rebound effects that result from increased consumption of other energy services (e.g. cheaper heating leading to more lighting), but excludes embodied energy.

Methods

This study estimates a linear Almost Ideal Demand System (AIDS) of Deaton & Muellbauer (1980) incorporating *'efficiency'* of energy services mentioned above through the price of these energy services:

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + \beta_i \ln(x_t / P_t) + \sum_j \lambda_{ij} w_{jt-1} + \varepsilon_{it}$$

Where w_i is the budget share of energy service *i*, p_i is the price of energy service *i*, x_t is the total equivalised expenditure for energy services and P_t is the Stone price index. α_i is the constant term, γ_{ij}, β_i and λ_{ij} are unknown parameters and ε_{it} is an error term. Our model departs from standard applications of LAIDS by including lagged expenditure shares w_{jt-1} to capture the inertia in price responses e.g. as a result of habit formation. The inclusion of lags also reduces problems of serial correlation (Edgerton 1997). The following restrictions are imposed to the model:

Adding up: $\sum_i \alpha_i = 1$; $\sum_i \beta_i = 0$; $\sum_i \gamma_{ij} = 0$; and $\sum_i \lambda_{ij} = 0$

Homogeneity: $\sum_i \gamma_{ij} = 0$ and Symmetry: $\gamma_{ij} = \gamma_{ji}$

The model is estimated by econometrics approach of Iterative Seemingly Unrelated Regressions (ISUR). The data are annual time series for 1964-2015, derived from a variety of sources with estimates of average energy efficiency being used to derive the price of the individual energy services. From this we obtain the own-price, cross-price and expenditure elasticities for each energy service. The direct rebound effect is estimated from the negative of the own-price elasticity of each energy service, while the indirect rebound effects are estimated from the cross-price elasticities and the relevant energy and GHG intensities. Rebound effects are therefore estimated in terms of both energy use and GHG emissions.

Results

The initial results suggest a *direct* rebound effect from energy efficiency improvement of 84% for lighting, 14% heating, 63% for appliances and 99% for cooking. Indirect rebound effects are -84% for lighting, -13% heating, -59% for appliances and -99% for cooking. This means that total rebound effects are negligible. We are further investigating the robustness of these results by re-formulating the model (e.g. disaggregating appliances to wet and cold; and other appliances) and additional tests. Moreover, we will add transport services demand to the model. The rebound effect for transport is still to be estimated.

Conclusions

The results indicate how the direct and indirect rebound effects vary with the type of energy efficiency improvement. Rebound effects appear to be relatively lower for measures that improve the efficiency for heating and appliances but significantly larger for measures that improve lighting and cooking efficiencies. We expect that adding transport will affect the estimated rebound effects significantly. These results are subject to a number of caveats, and further elaborations of the model (to be incorporated into this paper) may modify our estimates.

References

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