Asymmetric rebound effects across different household income groups

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1. Introduction

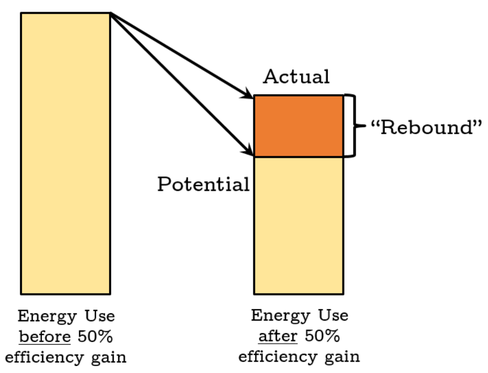
Increasing energy efficiency in household energy consumption can lead to **rebound effects**.

Microeconomic studies have used **partial equilibrium** economic models to show that low income households are generally associated with higher rebound effects (direct and indirect) (e.g. Chitnis et al. 2014).

This study uses a Computable General Equilibrium (CGE) model to assess the **household general equilibrium rebound** effect from a 10% increase in energy efficiency in **a)** refined fuels consumption and **b)** gas consumption across **five household income groups** in Scotland.

2. What is the rebound effect?

The **rebound effect** occurs when the actual energy savings (AES) from an increase in energy efficiency partially offset the potential energy savings (PES) due to responses of different economic agents.



Partial equilibrium Assumes fixed market prices and nominal incomes (Lecca et al. 2014).

- **Direct rebound** Improving energy efficiency of a certain energy service may encourage households to consume more of that good.
- **Indirect rebound** Costs savings from more efficient energy services may be spent on other goods and services that require energy at different points in their production and supply chain.

General equilibrium rebound Allows for market prices and income variations.

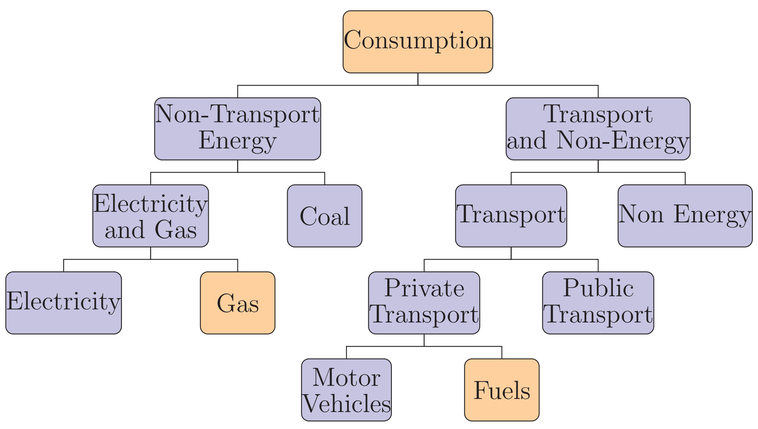
- **Household rebound** Households further respond to an increase in energy efficiency taking into account prices and income variations as the wider economy adjusts. It can be derived in a specific energy use, e.g. household rebound in gas use.
- **Economy-wide rebound** The responses to an energy efficiency improvement are considered both in consumption and production as prices adjust towards a new macroeconomic equilibrium.

3. The CGE model

The general equilibrium rebound effects are derived using the AMOS-ENVI CGE modelling framework for Scotland.

In this version of the model, consumption decisions are made by 5 representative utility maximising households, identified in 5 income bands.

The CES Nesting Structure



4. DATA

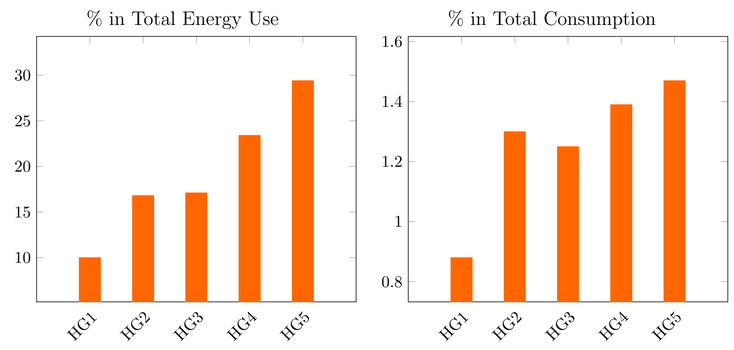
The core dataset of the model is the 2010 Scottish Social Accounting Matrix, which reports information about transactions between 30 Scottish industries, including refined fuels, gas, electricity and coal, and 5 household income groups.

Table 1: Income groups disaggregation in the 2010 Scottish SAM

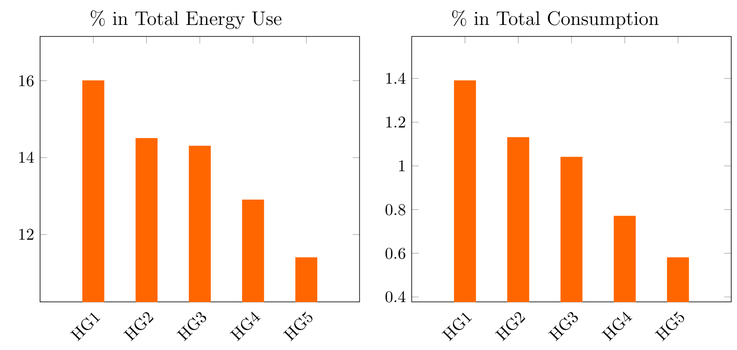
HG1	HG2	HG3	HG4	HG5
up to £32.0K	£32.1K - £41.0K	£41.1K - £52.0K	£52.1K - £69.0K	£69.1K and over

Consumption pattern differ across the five groups depending on the particular good. This study takes as illustrative examples the case of **gas** and **refined fuel** because they are consumed with different intensities by each group.

Percentage of Refined Fuels Consumed by Households



Percentage of Gas Consumed by Households

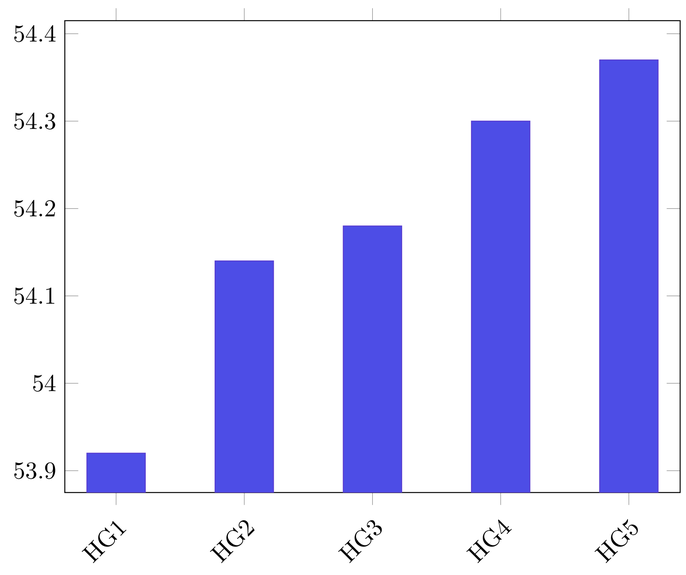


The data show that high income household groups use refined fuels more intensively than low income households.

Low income groups of households use domestic gas more intensively than high income groups.

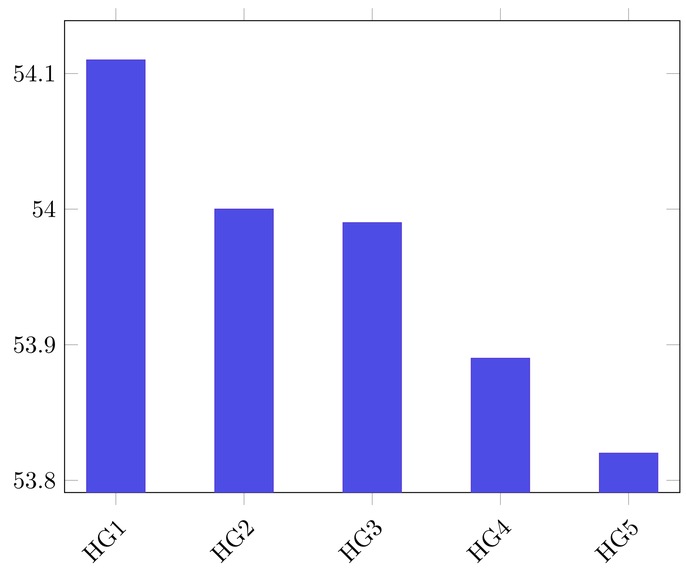
5. RESULTS

Household Rebound Effect in Refined Fuels Use from a 10% Increase in Fuels Efficiency



Households respond to a 10% increase in refined fuels efficiency by using more transport services. Higher income groups are associated with a higher calculated rebound effect, as their higher fuel intensity triggers larger income effects than in lower income households.

Household Rebound Effect in Gas Use from a 10% Increase in Gas Efficiency



The response to a 10% increase in gas efficiency is similar but opposite of the refined fuels case in terms of ranking of household income groups. The higher general equilibrium rebound effect in gas use is associated with lower income households.

6. conclusions

Results from simulations confirm that the size of the energy rebound effect varies across different types of energy use and different household income groups even in a general-equilibrium setting.

However, in contrast to previous findings in the microeconomic literature, lower income households are not always those who 'rebound' the most.

- Income groups consuming a certain energy good more intensively tend to rebound more in the use of the same good (preliminary results suggest the opposite may be true for other energy uses by the same households).
- A sufficiently disaggregated partial equilibrium study might pick up the same pattern, but it is not able to capture the full income effect.
- Energy should not be treated as a single homogeneous good and one should consider different energy types separately.

7. Next steps

The results are limited to the general equilibrium impact on household energy use only on the good whose efficiency has improved. This work will be extended to:

- Investigate the impacts on consumption of all the other energy and non-energy goods once the efficiency of one energy service has improved.
- Consider the impacts on total energy use in the whole economy, production and consumption, and calculate the full economy-wide rebound effect.

References

[1] M. Chitnis, S. Sorrell, A. Druckman Who rebounds most? Estimating direct and indirect rebound effects for different UK socioeconomic groups In *Ecological Economics, 106, 12-32*, 2014.

[2] P. Lecca, K. Swales, P. McGregor, K. Turner The added value from a general equilibrium analysis of increased efficiency in household energy use In *Energy Economics, 100, 51-62*, 2014.

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