Reducing Rebound Without Sacrificing Macroeconomic Benefits of Increased Energy Efficiency?

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Introduction

Increased efficiency in the use of energy will trigger a series of price and income effects that result in cost-push or demand-led economic expansionary processes (depending on whether efficiency improves on the production or consumption side of the economy). However, the same set of processes will also generate rebound in energy use at the economy-wide level, acting to partially offset expected energy savings in the more efficient activity. The question then arises as to whether rebound is a necessary 'evil' that we must accept in order to enjoy economic gains of increased energy efficiency. Or, are the possibilities for expansion due to increased efficiency limited if we wish to maximise energy (and related emissions) savings? *Or,* can economy-wide rebound effects from increased energy efficiency be reduced without sacrificing macroeconomic benefits? We hypothesise that this may be possible if we focus on energy-using *service* needs and consider increased efficiency in the production/delivery of a less energy intensive competitor in the household consumption choice. That is, by changing the *composition of consumption* - here with focus on the demand of UK households for mobility and increasing the energy efficiency and attractiveness of less energy intensive (per person mile) public over private transport options - the net economic welfare gains of increased energy efficiency may preserved while reducing associated rebound effects.

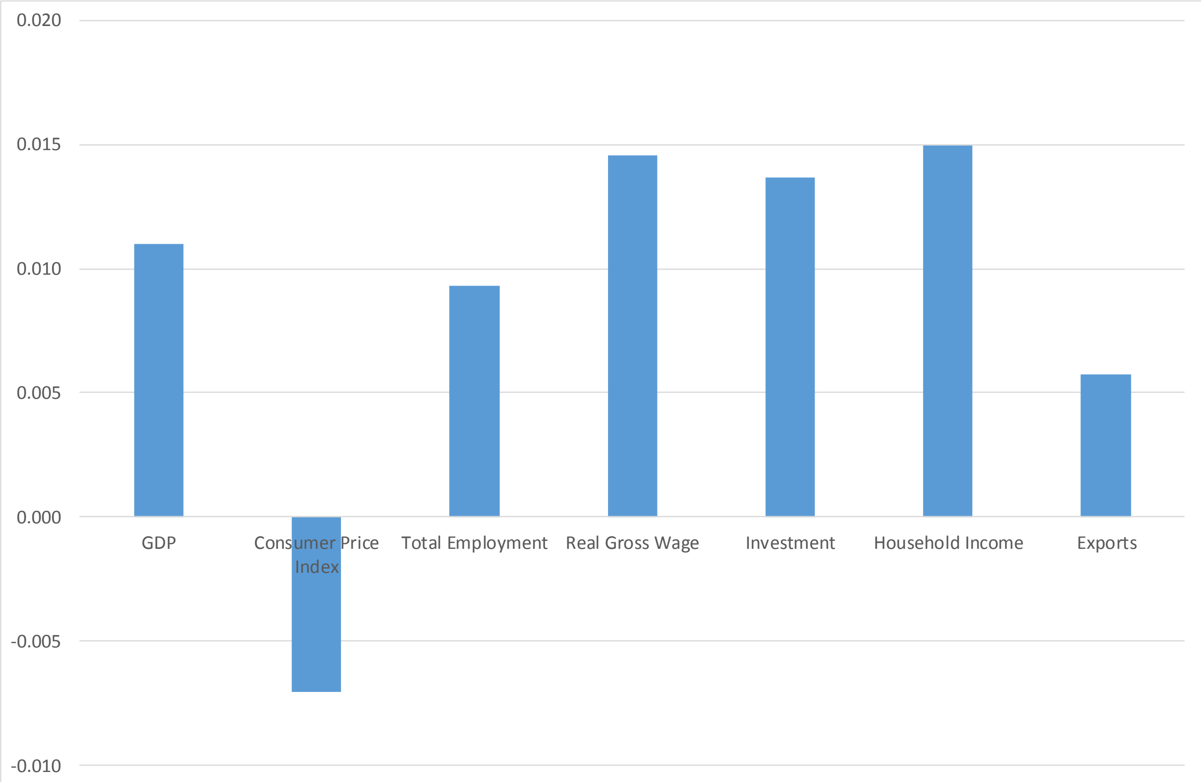
Modelling Approach

We use a multi-sector economy-wide computable general equilibrium (CGE) model of the UK economy, UKENVI, to simulate the impacts of a simple 10% increase in energy efficiency in the industry that supplies road and rail public and freight transport services, 'Road and Rail Transport'. We include four energy types (with both domestic and imported supply): refined fuels, electricity, gas and coal. The key assumption in our analysis is that private transport is a competing and relatively energy-intensive substitute for the more efficient public transport provision (particularly in refined fuel, petrol and diesel, use).[i] Our simulations involve examining the impacts on a range of economic variables and economy-wide rebound in different energy uses if we vary just one parameter in the model. This is the elasticity governing the extent to which households are prepared to substitute away from private in favour of public transport as the relative price changes in favour of the (more energy efficient) public option.

Cost-push expansion accompanied by economy-wide rebound effects

The improvement in energy use in the UK 'Road and Rail Transport sector triggers a cost-push or productivity-led expansion. The reduced cost of production is assumed to translate to a lower output price in the sector, which spills forward through sectors that use transport services as an input. Generally, the energy efficiency improvement translates to a small but positive supply-side shock to the UK economy. Over time, as the economy adjusts through accumulation of capital (we assume a fixed national labour supply[ii]) and there are positive impacts on all key macroeconomic indicators, as illustrated in Figure 1.

Figure 1. Key long-run macroeconomic impacts (% change from base values) of a 10% increase in energy efficiency in the UK 'Road and Rail Transport' sector

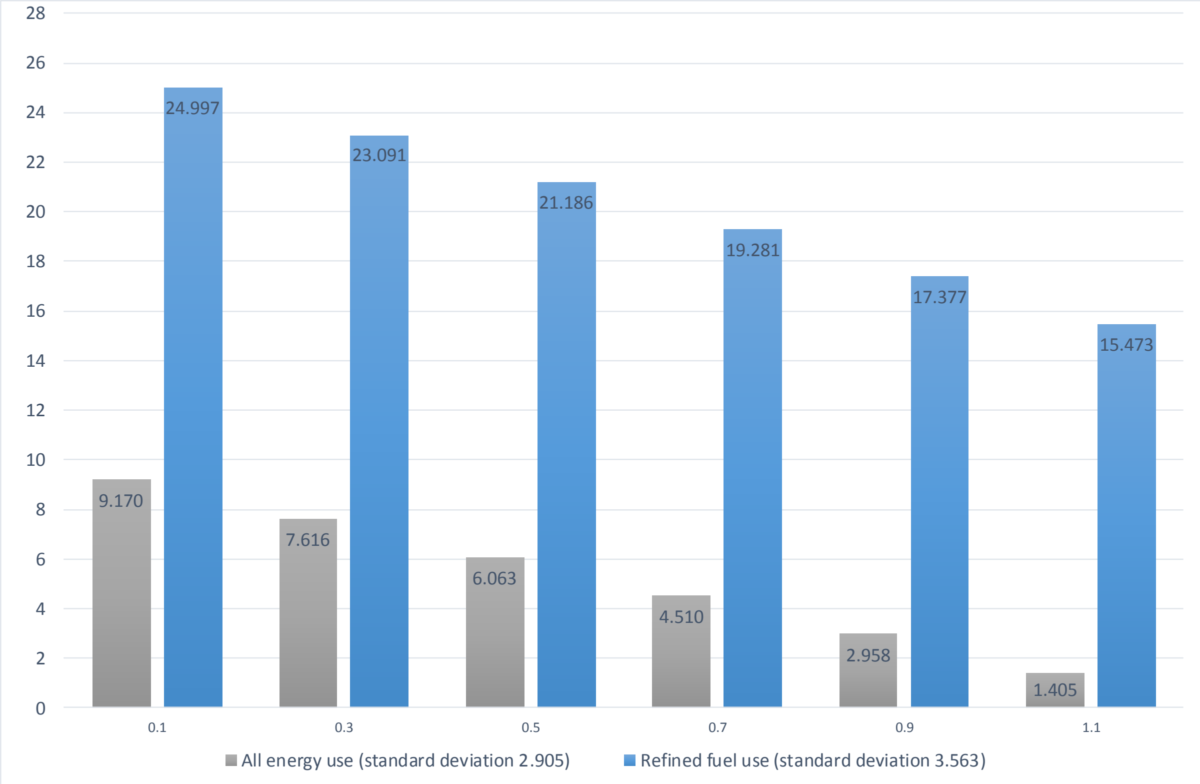


However, while we find a net decrease in energy use in the more efficient 'Road and Rail Transport' sector of 7.4%, this represents 36% rebound on the technical improvement of 10%. Our main focus of attention, however, is the full economy-wide rebound. That is, how energy use across the economy is impacted by the economic expansion. In particular, we are interested in whether and how this may vary if the more efficient public transport option becomes a more attractive competitor to private transport in the consumption choice of UK households.

De-coupling economic expansion and economy-wide rebound

We repeat our simulations varying just one element of model specification – the price elasticity of substitution between public and private transport options in the household consumption choice (varying from an inelastic value of 0.1 to an elastic value of 1.1). A crucial result emerges: all of the macroeconomic benefits (including but not limited to those in Figure 1) remain unchanged while the *composition* of household consumption, specifically the composition of transport activity, is variable. Crucially, the contribution to economy-wide rebound, particularly in refined fuel use, is reduced as we increase the extent to which households respond to the increased competitiveness of the public transport option. This is illustrated in Figure 2.

Figure 2. Impact on long-run rebound effects (%) of varying elasticity of substitution between public and private transport options in the household consumption choice



Policy implications?

The specific analysis presented here suggests that a key focus for policy attention may be to encourage public transport to become more energy efficient and more attractive as a substitute for personal transport. We acknowledge that pricing, and how people actually pay for public transport, may be a more complex issue in practice than reflected in the simple modelling analysis above. Then the key issue may be whether cost savings from increased efficiency in public transport provision can somehow be used to increase the attractiveness of public transport options. This is an issue worthy of further investigation.

However, our intention here is to consider a more general possibility. Research is required to assess whether the type of result reported above would occur in a wider set of cases. That is, can the proposition presented here be more widely applied to consider the role of improving efficiency (not just in energy use) and competitiveness of low carbon options in delivering a range of services? In particular, would such a policy approach permit low carbon expansion with limited, and less harmful (in terms of emissions), rebound in energy use?

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[i] Fuller explanation of the UKENVI CGE model and the simulations performed are reported in a discussion paper available to download at http://strathprints.strath.ac.uk/56448/.

[ii] The qualitative nature of the results reported below is not sensitive to this assumption. See the discussion paper in the previous endnote.