REDUCING REBOUND WITHOUT SACRIFICING MACROECONOMIC BENEFITS OF INCREASED ENERGY EFFICIENCY

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Overview

Previous research has shown that increased efficiency in the use of energy triggers price and income effects that result in cost- or demand-led economic expansion processes (depending on whether efficiency improves on the production or consumption side of the economy). However, this generates rebound in energy use at the economy-wide level that partially offsets expected energy savings in the more efficiency activity. The question we set out to address here is whether economy-wide rebound effects can be reduced without sacrificing macroeconomic benefits. We hypothesise that this may be possible if increased efficiency in production leads to a reduction in the relative price of something that is a substitute for an energy-intensive activity elsewhere in the economy. That is by changing the *composition* of consumption, for example favouring (low carbon) electricity over gas, or public over private transport. We consider the latter example here by simulating an increase in energy efficiency in the provision of public transport in the UK using a computable general equilibrium (CGE) model. 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. Our key finding is that by varying just one parameter in our CGE model – 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 latter – we get marked variation in the magnitude of the economy-wide rebound effect with negligible (if any) impact on key macroeconomic impacts. That is, we show that it is possible to maximise both macroeconomic benefits and energy savings the more UK households can be persuaded to switch their transportation needs in favour of more efficient and competitive public transport options.

Methods

The economy-wide impacts of improving energy efficiency in UK public transport are analysed using a recursive dynamic UK CGE model, UKENVI, calibrated on a 2010 Social Accounting Matrix (SAM). It includes 30 different productive sectors, including energy industries supplying coal, gas, electricity and refined petroleum. We identify final domestic public and private consumers (UK government and households), and income and trade flows with a single exogenous region, the rest of the World (ROW). UK and ROW products are imperfect substitutes (Armington assumption) and export demands respond to changes in relative prices. Wages are determined in an imperfect competition setting, using a wage curve where the real wage is negatively related to the unemployment rate. In our central simulation the total labour supply is fixed at national level. Investment responds to changes in the return to capital at the sectoral level, with a share of the gap between actual and desired capital stock filled in each period of adjustment. In the long-run capital stocks are fully adjusted to a new equilibrium level. We conduct sensitivity analysis allowing the labour supply to adjust through migration (to consider maximum macroeconomic expansion).

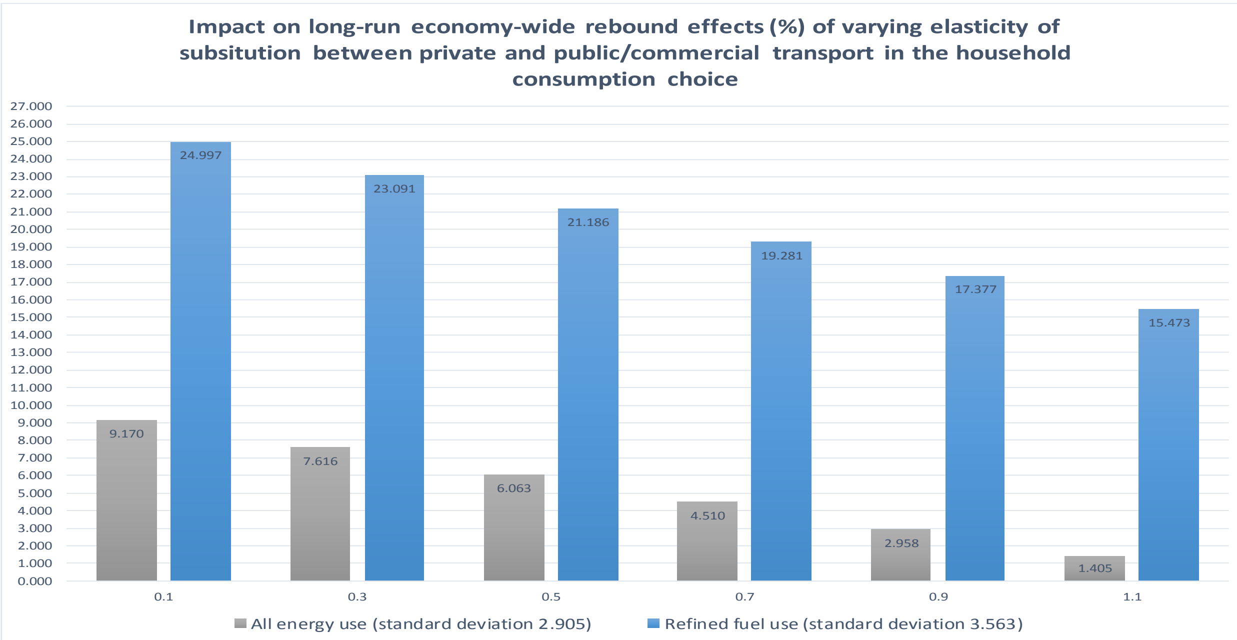
The key element of model specification for the scenario analysed here is the inclusion of a transport nest within the household consumption decision, where public and private transport are substitutes in a CES nest. Private transport involves a combination of refined fuel use and motor vehicles. The central focus of our analysis is to conduct sensitivity analysis of results in response to varying the elasticity of substitution between public and private transport options, when the price of the former falls as a result of increased energy efficiency in public transport provision (but the price of the latter is also affected due to decreased demand for refined fuels in the more efficient public provision).

Results

We simulate a 10% increase in energy-augmenting technological progress in the combined public and freight road and rail transport sector. This combination is driven by the identification of 'road transport' and 'rail transport' industries in the UK input-output data that inform the SAM, each incorporating both passenger and freight transport. However, household consumption will be mainly on the passenger side in both cases (improved efficiency on the freight side will have positive competitiveness effects downstream in UK industry).

The energy efficiency improvement triggers a productivity-led expansion. This is a small but positive supply-side shock to the UK economy. Over time there are positive impacts on all key macroeconomic indicators

(GDP, investment, employment and household spending all increase by around 0.01%). This expansion is accompanied by rebound in different types of energy use across the economy. However, when we repeat our central simulation varying elasticity on the household choice between private and public transport we find that all macro-level non-energy variables are not sensitive to changes in this parameter, including total household income and expenditure. Moreover, the impact on prices is largely invariant. On the other hand, the composition of household spending *is* sensitive, as is the share of household income spent on energy, specifically on the refined fuels used in private transport activity. As the elasticity rises, demand for refined fuels to use in cars in private transport falls in favour of the public transport option. This in turn impacts energy use on the production side of the economy (particularly due to contraction in refined fuel supply activity). Most of the variability in total energy rebound is found in the case of refined fuel use (see figure). The extent of variability in is not sensitive to allowing greater economic expansion through relaxation of the labour supply constraint, though the magnitude at each elasticity value is (particularly rebound in all energy use, given the reduction in 'crowding out' of other production sectors).



Conclusions

Previous research has shown that both macroeconomic impacts and rebound effects are sensitive to a number of key parameters and other elements of model specification. Here, we focus on how results are impacted when households respond in different ways to more energy efficient and competitive public transport provision. We focus in particular on the choice between this and reliance on private transport, which is a relatively energy intensive consumption choice. We find that varying just one model parameter – governing the substitution between public and private transport in response to changes in relative price - causes the economy-wide rebound effect to change with only negligible impact on the key macroeconomic variables. We find that most of the variability in economy-wide rebound is in terms of refined fuel use stemming from variation in private transport activity. More generally, we show that while macroeconomic impacts of increased energy efficiency in a single sector may not be that large, there can be important inter-sectoral effects. Moreover, these are effects that would not be picked up either by a micro-focussed or a very macro-focussed analysis

In terms of policy implications, the analysis suggests a key focus for attention may be to make public transport more efficient, ensure this translates through to price, and that it is a sufficiently attractive option to induce a greater response to changes in relative prices. Addressing these issues is likely to require insights and research from multiple disciplines. The key questions for future research, particularly by micro-economists, and for CGE modellers in developing more useful models may be (i) what is the current substitutability in terms of household response to changes in relative price between private and public transport in the UK and other regions/countries; (ii) what type of changes may policymakers make to increase it; (iii) just how much difference would different types of changes/actions make?

More generally, our hypothesis – that focussing energy efficiency actions in areas where consequent changes in relative prices shift consumption away from more energy, particularly hydrocarbon-intensive activities – would seem to be a key area for future research and policy attention. Following a dematerialisation agenda through actions to induce substitutions away from more and toward less carbon-intensive choices in serving a given energy service, particularly heat and transport – while minimising rebound - are likely to be key in shifting to low carbon development paths that involve changing the composition rather than level of economic activity.