PEAK CAR AND PEAK REBOUND? A CLOSER LOOK AT RECENT TRENDS IN CAR TRAVEL IN GREAT BRITAIN

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Overview

Direct rebound effects result from increased consumption of energy services that have become cheaper as a consequence of energy efficiency improvements. For example, more fuel-efficient cars may encourage more driving that may erode some of the potential fuel savings. But the size and nature of this response may change over time. These changes are particularly important for car travel, since the relationship between income and distance travelled has changed over the last 15 years. This study investigates how the direct rebound effect for car travel has changed in Great Britain since 1970. We employ aggregate time-series data on distance travelled, fuel costs, income and other relevant variables. We estimate the direct rebound effect from the elasticity of distance travelled with respect to the fuel cost of driving (£/km). Distance travelled has approximately doubled since 1970 but the rate of growth slowed around 2000 and is now on a declining trend. This pattern ('peak car') has been observed in several developed countries and predates the falls in income that followed the 2008 financial crisis. Our results suggest that the factors contributing to peak car may have also reduced the direct rebound effect. However, the results are sensitive to the inclusion of urbanisation in the specification and the stationarity properties of the data, so there remains considerable uncertainty over the drivers of recent trends.

Methods

This study builds upon Stapleton *et al* (2016) who used a range of models and measures to estimate the average direct rebound effect for personal automotive transport in Great Britain since 1970. This study follows a similar approach, in that we test a number of models and evaluate and compare their statistical robustness using 13 different diagnostic tests in most cases. We take the best performing model forward at each stage according to their aggregate 'robustness scores'. The additional contribution of the present study is to test the effect of additional variables relevant to 'peak car'and to explore whether and how the direct rebound effect has changed over time.

We use aggregate time-series data for Great Britain over the period 1970 to 2012. The explained variable across all models is vehicle kilometres per adult. The primary explanatory variables are equivalised household income (£/week) and the fuel cost of driving (£/km) – with the latter being constructed from aggregate data on fuel consumption, distance travelled and fuel prices. Our measure of fuel consumption combines both petrol and diesel, with aggregate fuel prices being estimated by weighting by the relative share of each. In addition, we include a binary dummy variable for the 1974 and 1979 oil price shocks and compare the use of *mean* and *median* equivalised household income to investigate the effect of increasing inequality. For some of the models, we include variables indicating the proportion of licensed drivers, the proportion of households with internet access and the proportion of adults living in urban areas. The last two reflect common explanations of the 'peak car' phenomenon - namely substitution of car travel by virtual communication and growing urbanisation (reversing the trend of the 1970s and 80s). While a range of other factors may also contribute to 'peak car', our aggregate time series specification constrains the number of variables that can be tested.

We test two groups of models, with the Group 2 models containing variables for urbanisation and the number of licensed drivers while the Group 1 models do not. Both groups include both 'static' and 'dynamic' specifications, where the latter includes a one year lag of the explained variable. In total, we estimate 11 models in Group 1 and 17 models in Group 2. Since theory does not suggest a single optimal specification, we adopt a sequential approach to model development. In each Group, we begin by estimating 'base' static and dynamic models that include the fuel cost of driving (£/km), mean equivalised household income (£/week) and a binary dummy variable for the 1974 and 1979 oil price shocks. We then investigate the effect of: a) using median rather than mean household income; b) adding a quadratic income term that permits a saturating relationship between income and distance travelled; c) adding an interaction term which allows the rebound effect to vary with income; d) adding a variable indicating the proportion of households with internet access; and e) excluding jointly insignificant coefficients. Additionally, in Group 2, we investigate including variables for: a) the proportion of adults living in major urban areas; and b) the proportion of adults who are licensed drivers. The reason for only including these variables within Group 2 is that unit root tests suggest that they are integrated of a different order compared to the remainder – so in principle they should be excluded from our analysis. On the other hand, unit roots tests have low power in small samples and there are plausible theoretical grounds for including these variables. We therefore estimate models with (Group 2) and without (Group 1) these variables and compare the results.

We take the best performing model forward at each stage according to their 'aggregate robustness scores' (0-100%), described in Stapleton et al (2016). This ultimately leads to the 'best' static and dynamic specifications in each Group. We also re-estimate the best performing static model in each set with a specialised technique suitable for co-integrated time series.

Results

Eight of the Group 1 models provided significant estimates of the long run direct rebound effect, with a mean of 22.1% (range 6.1% - 38.4%). The static models gave lower estimates (mean 22.1%) than the dynamic models (mean 27.4%) but the small sample size precludes testing for the statistical significance of this difference. The overall 'robustness scores' of the Group 1 models were good (mean 66.1%), with the dynamic models scoring higher than the static models (73.2% versus 54.2%). Models with mean income performed better than those with median income, while the addition of quadratic income term improved model diagnostics - with the results suggesting that distance travelled starts to decline when income exceeds ~£510 per week. Household internet usage was not found to be statistically significant in any model, while the interaction term which permits rebound to vary with income was only found to be significant for the dynamic models. Here, the results suggest that rebound decreases as income increases, falling from ~30% in 1971 to ~25% in 2009..

The Group 2 models gave rather different results, but the unit root tests suggest these are less robust. The urban population variable was found to be statistically significant in all of the models tested, but (in contrast to the Group 1 models) the addition of a quadratic income term was *not* found to improve model performance. In other words, these models explain the saturation in distance travelled by the re-urbanisation trends rather than by increasing incomes. Moreover, all of the Group 2 specifications suggest that the rebound effect *increases* with income – which contradicts both our theoretical expectations and the results of studies in other regions (e.g. Greene, 2012). Overall, these results demonstrate that the role of urbanisation relative to other factors in explaining recent GB mobility trends requires much closer investigation.

Conclusions

The results from our preferred set of models suggest that the direct rebound effect for car travel in GB has decreased over time as incomes have increased. The results also suggest that car travel begins to decline once equivalised income exceeds a particular level - approximately £510/week. Put another way, the GB appears to have passed both 'peak car' and 'peak rebound' for car travel. These findings agree with the results of recent US studies (e.g. Greeme 2012; Small and van Dender, 2005). However, the role of urbanisation in explaining these trends remains unclear –as does the role of other variables that are difficult to incorporate within an econometric model such as this. Hence, more detailed scrutiny of the drivers of peak car is required – using different datasets and a broader range of methodologies.

References

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