ESTIMATION OF THE REBOUND EFFECT FOR TRAVEL DISTANCE USING MICRO-LEVEL DATA FOR FRANCE

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Overview

According to the IEA (2017), the share of global energy-related CO_2 emissions due to transportations is 23%. This sector plays a significant role in achieving the targets of reducing energy consumption and CO2 emissions worldwide. Rising vehicle fuel economy per passenger will dramatically reduce the cost of driving. However, the actual magnitude of the impact needs to be assessed by considering what literature call the "rebound effect". When the energy system becomes more efficient, the real cost of unit energy service might fall. This may stimulate people to enjoy more energy services, thus increasing the demand for energy. This increase in the demand for energy corresponds to the rebound effect (Sorrell & Dimitropoulos, 2008).

Most of the studies based in the United States (US) data find evidence that the rebound effect of increased fuel efficiency on vehicle travel is small, being from 5 to 25% (Greene, 1992; Greene, Kahn, & Gibson, 1999; Small & Van Dender, 2007). However, Linn, (2016) finds a rebound effect that erodes about one third of the fuel savings. He quantifies the implications of the principal sources of bias that has been pointed out for empirical estimates of the rebound effect (Linn, 2016; Sorrell & Dimitropoulos, 2008). As for evidence in European countries, rebound effects in transportation appear to be relatively stronger than those in the US. Estimates show rebound effects going from 9% to 80% (Frondel & Vance, 2013; Stapleton, Sorrell, & Schwanen, 2016; Weber & Farsi, 2014). Estimations made in developing economies, such as China, tend to show greater rebound effects and even in occasions a "backfire effect". It means that improving efficiency of traffic service can hardly realize energy conservation (Lin & Liu, 2013; Wang, Zhou, & Zhou, 2012; Zhang, Liu, Qin, & Tan, 2017).

The rebound effect is typically quantified as the extent of the deviation from proportionality. For motor vehicles, the fuel economy rebound effect corresponds to the percentage change in miles traveled caused by a 1% increase in fuel economy (Linn, 2016; Small & Van Dender, 2007). When data is limited, fuel cost elasticity of the demand for miles traveled or the own price elasticity of fuel demand can be used as a proxy for the efficiency elasticity of miles traveled. Such definitions of the rebound effect imply a symmetry argument, which may lead to biased estimates (Frondel & Vance, 2013; Linn, 2016; Sorrell & Dimitropoulos, 2008; Weber & Farsi, 2014).

The aim of this paper is to estimate the rebound effect for private transportation using micro-level data in France for 2008. This paper uses the primary definition of the rebound effect, which is the consumers' reaction to a change in energy efficiency, in other words, the efficiency elasticity of demand for energy services (definition (1), Sorrell & Dimitropoulos, 2008). To the best of our knowledge, this would be the first paper accessing this phenomenon using micro-level French data.

This paper would account for the main sources of bias presented in Steve Sorrell & Dimitropoulos (2008), namely, the correlation between energy efficiency and other input costs, the endogeneity of energy efficiency and the implied need for simultaneous equation estimation, and the symmetry assumption (the assumption that raising energy efficiency has the same effect as falling energy prices).

Because investigations on rebound effect in private transport, and more generally on fuel consumption, are traditionally conducted using aggregate data, our use of micro-level data constitute an important asset (Weber & Farsi, 2014). According to Small & Van Dender (2007), micro-level studies tend to produce a greater range of estimates; but those that exploit both cross-sectional and temporal variation are more consistent.

Methods

In order to estimate the rebound effect for private transportation in French households, in this study we follow the method used by Greene, Kahn, & Gibson (1999). We use Sorrell & Dimitropoulos (2008) standard definition of the rebound effect, which is formally measured as the efficiency elasticity of the demand for useful work.

A simultaneous equations model will be estimated using three stage least squares (3SLS). The simultaneous variables are: distance traveled, fuel intensity (in liters per 100 kilometers; i.e., the inverse of efficiency) of the vehicle, and its weight. We considered the fuel price to be similar for each individual and exogenous. This is because the data set is a single cross-section and prices are not collected at a regional level.

The data used for this paper comes from the 2007-2008 National Transport and Travel Survey (NTTS) for France. This survey is conducted every ten years by the National Institute of Statistics (Insee) and the Observation and Statistics Service (SOeS) of the Ministry of Ecology, Sustainable Development, Transport and Housing (MEDDTL).

NTTS gives detailed information for 20.200 households about vehicles stock and attributes (weight, age, horsepower, AC…), regular mobility, mobility during the week (distance as the crow flies), use of the personal vehicle during the week and the last 12 months, long distance and tourist trips and socio-demographic characteristics. The information about vehicle characteristics will allow us to account for unobserved household characteristics that otherwise would bias the estimates.

Results

In this particular study, we estimate the magnitude of the rebound effect of private transportation in France by using a simultaneous equations model. This method allows us to take into account the main bias associated with traditional estimations of the rebound effect.

We seek to verify the existence of a rebound effect of the use of the personal vehicles in French households. We expect the magnitude of the rebound effect to be consistent with the literature existent for European countries, which is relatively higher that it is in the US. The results of this study are in progress.

We use a rich database that allows to control for vehicle attributes and household characteristics which otherwise would bias the estimation. We can also take into account regional and income heterogeneity. Furthermore, we discuss the policy implication of the rebound effect in the French and European society.

Conclusions

Increasing the energy efficiency of personal vehicle can significantly reduce the cost of driving as well as carbon emissions. However, policy maker ought to take into account potential rebound effects that can limit the efficiency gains. This work would greatly contribute to understanding of the rebound effect, its mechanisms and implications into the French and European society. Hence, it could be used in the debate held by policy makers.

A future extension of this work could be the use of panel data can be, as it can add consistency to the estimates. Furthermore, one could access possible substitution effects or indirect rebound effect coming from touristic trips.

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