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U.S. State Data, 1966-2001”**

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The Effect of Improved Fuel Economy on Vehicle Miles Traveled: Estimating the Rebound Effect Using U.S. State Data, 1966-2001

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Abstract:

We estimate the rebound effect for motor vehicles, by which improved fuel efficiency causes additional travel, using a panel of US states for 1966-2001. Our model accounts for endogenous changes in fuel efficiency, distinguishes between autocorrelation and lagged effects, includes a measure of the stringency of fuel-economy standards, and interacts the rebound effect with income. At sample averages of variables, our 3SLS estimates of the short- and long-run rebound effect are 4.7% and 22.0%. But they decline substantially with income: with variables at 1997-2001 levels they become 2.6% and 12.1%, considerably smaller than typically assumed for policy analysis.

JEL-codes: Q0, D5, R4, C2

Keywords: carbon dioxide, fuel economy, travel demand, motor vehicle use, rebound effect

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1. Introduction

It has long been realized that improving energy efficiency releases an economic reaction that partially offsets the original energy saving. As the energy efficiency of some process improves, the process becomes cheaper, thereby providing an incentive to increase its use. Thus total energy consumption changes less than proportionally to changes in physical energy efficiency. This "rebound effect" is typically quantified as the extent of the deviation from proportionality. It has been studied in many contexts, including residential space heating and cooling, appliances, and transportation (Greening, Greene, and Difiglio, 2000).

For motor vehicles, the energy input is fuel and the associated service is travel, typically measured as vehicle-miles traveled (VMT). When vehicles are made more fuel-efficient, it costs less to drive a mile, so VMT increases if demand for it is downward-sloping. That in turn causes more fuel to be used than would be the case if VMT were constant; the difference is the rebound effect. Obtaining reliable measures of it is important because it affects the effectiveness of measures intended to reduce fuel consumption and because increased driving exacerbates congestion and air pollution. For example, the rebound effect was an issue in the evaluation of recently adopted greenhouse-gas regulations for California (CARB, 2004, Sect. 12.3-12.4). It has played a prominent role in analyses of the Corporate Average Fuel Economy (CAFE) regulations in the US and of proposals to strengthen them. The rebound effect is also relevant to the problem of instrument choice: if it is large, then price instruments become relatively more effective compared to technology standards because higher energy prices counteract the rebound effect.

This paper presents estimates of the rebound effect for passenger-vehicle use that are based on cross-sectional time series data at the U.S. State level. It adds to a sizeable econometric literature, contributing four main improvements. First, we use a longer time series (1966-2001) than was possible in earlier studies. This increases the precision of our estimates, enabling us (among other things) to determine short- and long-run rebound effects and their dependence on income. Second, the econometric specifications rest on an explicit model of simultaneous aggregate demand for VMT, vehicle stock, and fuel efficiency. The model is estimated directly using two- and three-stage least squares (2SLS and 3SLS); thus we can treat consistently the fact that the rebound effect is defined starting with a given change in fuel efficiency, yet fuel efficiency itself is endogenous. Third, we measure the stringency of CAFE regulation, which was in effect during part of our sample period, in a theoretically motivated way: as the gap

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