Assessing Consumer Valuation of Fuel Economy in Auto Markets

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Introduction

Oil Demand and Automobiles:

Improving vehicle efficiency could have dramatic effects on oil demand and Greenhouse Gas (GHG) emissions

- Transportation contributes 13% of global GHG emissions [IPCC]
- Gasoline accounts for 45% of U.S. oil consumption [EIA]

Legislating Efficiency - Carbon Tax vs. CAFE Standards:

Currently, Corporate Average Fuel Economy (CAFE) standards require a minimum average fuel efficiency for automobile manufacturers

Some argue that a tax on carbon emissions is more robust and cost-effective than CAFE [Fischer (2004)]

- CAFE fails to account for "rebound effect": Improved fuel economy spurs increased vehicle miles traveled (VMT) [Small and Van Dender (2006)]

- A carbon tax creates incentives for all energy sectors, while CAFE only affects transportation sector

Unlike CAFE, a carbon tax assumes that consumers rationally and correctly value fuel economy when making purchasing decisions [Gerard (2003)]

- Under a carbon tax, if consumers undervalue fuel efficiency, auto firms receive indirect (and thus better) signals, which decreases incentives for welfare-improving innovation. Thus, CAFE could provide a more effectively spur development in energy efficiency

- Past models yield mixed results in assessing consumer myopia [Kahn (1986); Kilian (2006); Sallee and West (2008), Espey (2004)]

Our Goal:

We use novel data to heterogeneously evaluate consumer rationality with respect to automobile fuel efficiency. These results have great implications about the need for and efficacy of fuel economy standards.

Theoretical Background

Consumer Cost Minimization Problem:

Consumers minimize the cost of their vehicle, which includes the price of the vehicle on the lot plus costs at the pump:

\[ C = Price \text{ of the Vehicle} + \text{Present Value of Gasoline Costs} \]

\[ C = P_V (F, X) + \sum_{t=1}^{T} P_f F_t M_d \]

\[ C \] - the present value cost of owning and operating the vehicle
\[ P_V \] - the price ($) of the vehicle
\[ F \] - efficiency (mpg)
\[ X \] - a vector of all vehicle attributes
\[ P_f \] - the expected fuel price ($/gal)
\[ M_d \] - the expected vehicle miles traveled (miles/ year)
\[ T \] - the expected vehicle lifetime (years)
\[ \Delta \] - the discount factor for year \( t \)

First Order Conditions: On the Margin,

- Cost of fuel economy = Value of fuel savings

\[ \frac{dP_f}{dF} = \sum_{t=1}^{T} P_f F_t M_d \]

- Rationality predicts that, all else equal, consumers choose fuel intensity such that the incremental cost of a more fuel-efficient vehicle (i.e. vehicle price) is equal to the incremental present value of expected cost savings from lower operating costs (i.e. fuel costs) over the life of the vehicle.

- Given independent information on the variables in equation (2), our project compares the left- and right-hand-side of the equation to ascertain the degree to which consumers do in fact minimize present value costs.

Model

Hedonic Price Analysis:

\[ \frac{dP_f}{dF} = \sum_{t=1}^{T} P_f F_t M_d \delta_t \]

- A hedonic price function isolates a consumer’s willingness to pay for a more fuel efficient vehicle:

\[ P_f = \beta + F \cdot \text{GenSegm} + \text{DetailSegm} \cdot \delta \cdot X + yeart + \delta \cdot F' + \epsilon \]

Data

- New Car Prices
- R.L. Polk and Co. Car Stock Guide
- Fuel Intensity (fuel economy or 1/MPG)
- Fuelseconomy.gov

Hedonic Regression

- Car and SUV buyers have low willingness to pay
- $87 for a .001 increase in fuel intensity (or a 1 MPG increase for a car with 30 MPG)
- Van and Truck buyers have high willingness to pay
- $468 and $549

References


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Results

19-27% of car and 12-18% of SUV buyers overpay for their investment in fuel economy (above red line)

94-97% of van and 95-98% of truck buyers overpay

Why?

- Truck and Van markets may not be "dense"
- Cars and trucks are assessed as functionality (e.g. large truck beds, extra seats) which may be at technological odds with greater fuel economy.
- Current technology does not allow the market to provide the greater fuel economy demanded.

- SUVs and Cars are not as often selected for specific functional requirements (other than transportation)
- Easily substitutable for greater fuel economy
- Cars & SUVs often built on same chassis: technology - cost relationships are similar

- Risk aversion under uncertainty (Greene, 2009)
- Car and SUV buyers are unwilling to pay a great upfront cost with so much uncertainty about the cost minimization problem

Conclusions

- Based on the price signals from consumer willingness to pay (WTP), manufacturers determine the fundamental relationship between efficiency technologies and cost.

- Low WTP for Cars and SUVs signals that consumers are not willing to take a bet on higher fuel economy

- CAFE standards are necessary for Car and SUV markets

- High WTP signals for Truck and Vans should cause increased fuel economy without CAFE standards

- Technological / cost barriers (not manufacturer decisions) prevent efficiency in Truck and Van markets

- CAFE not necessary for Trucks and Vans. A carbon tax could be more effective