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Do consumers recognize the value of fuel economy? Evidence from used car prices and gasoline price fluctuations☆

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ABSTRACT

Debate about the appropriate design of energy policy hinges critically on whether consumers might undervalue energy efficiency, due to myopia or some other manifestation of limited rationality. We contribute to this debate by measuring consumers' willingness to pay for fuel economy using a novel identification strategy and high quality microdata from wholesale used car auctions. We leverage differences in future fuel costs across otherwise identical vehicles that have different current mileage, and therefore different remaining lifetimes. By seeing how price differences across high and low mileage vehicles of different fuel economies change in response to shocks to the price of gasoline, we estimate the relationship between vehicle prices and future fuel costs. Our data suggest that used automobile prices move one for one with changes in present discounted future fuel costs, which implies that consumers fully value fuel economy.

1. Introduction

One of the great questions facing policy makers in the twenty-first century is whether and how to mitigate greenhouse gas emissions so as to limit climate change. Automobiles are a critical part of this policy problem—in the U.S., personal transportation accounts for 28% of greenhouse gas emissions (Environmental Protection Agency, 2014). Gasoline consumption maps neatly into greenhouse gas emissions. This means that a Pigouvian tax on emissions is feasible (in the form of a gasoline tax). Such a tax can fully restore market efficiency, and alternative policies, such as fuel economy standards, will have inferior welfare properties, provided that the environmental externality is the only market failure leading to inefficiencies.[1]

However, many have argued that another market failure does exist, which is that consumers undervalue energy efficiency in a variety of choice situations, including automobile markets. The root of this hypothesis is the observation that engineering estimates of the cost of deploying fuel saving technologies suggest that privately cost-effective technologies often go unadopted. Jaffe and Stavins (1994) call this the “energy paradox”. If markets substantially undervalue energy efficiency, then the dominance of a gasoline tax over regulatory approaches may be broken because alternative policies may be better able to correct for inefficiencies from mis-valuation.[2]

Motivated by these policy implications, researchers have sought to use revealed preference data to determine whether consumers do in fact undervalue fuel economy. In this paper, we add to this literature by developing a unique identification strategy that utilizes

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[1] For reviews of the design of policies to correct driving related externalities, see Parry et al. (2007), Anderson et al. (2011) and Sallee (2011). The efficiency property of a gasoline tax is more complicated for local pollutants, as is explored in several papers, including Fullerton and West (2002, 2010) and Knittel and Sandler (2012).

[2] Fischer et al. (2007), Allcott et al. (2014) and Heutel (2011) explore the implications of undervaluation for optimal policy design.

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fifteen years worth of microdata on used vehicle transactions to test whether used vehicle prices change by the amount predicted by a fully rational asset pricing model. We interpret our results as a test of whether or not consumers fully value fuel economy, and our results directly provide the parameters necessary for informed policymaking.

Intuitively, our approach is to first compare the prices of two used cars which are identical except in their current odometer readings—and therefore in remaining future operating costs—and second to repeat this comparison when different gasoline prices prevail. We repeat this comparison across many vehicle types and many months, during which changes in the price of gasoline drive changes in fuel costs, in order to estimate the relationship between vehicle prices and a measure of the present discounted fuel cost that we construct. For example, we calculate the price and fuel cost of a 2000 Ford Taurus SE six cylinder 3.0 L vehicle with automatic transmission and front-wheel drive that has 50,000 miles in July 2005 to a different 2000 Ford Taurus SE six cylinder 3.0 L vehicle with automatic transmission and front-wheel drive that has 60,000 miles in July 2005. We then calculate the price and fuel cost of two different cars with the exact same configuration and mileage in July 2006. Changes in the gasoline price between July 2005 and July 2006 will cause changes in the difference in expected fuel costs across the higher and lower mileage vehicles. We test whether the change in the price difference between the high and low mileage vehicle over time corresponds to the change in the cost difference.

This is conceptually similar to a difference-in-difference approach. The fact that our comparison is across vehicles of the same type that differ only in their current mileage allows us to provide an exceptionally rich set of controls, including time-period shocks and depreciation schedules that are unique for each vehicle type. Our preferred specification allows for a month-by-vehicle type fixed effect, and it controls for a unique depreciation schedule for each vehicle type, where a vehicle type is very finely defined. To execute this research design, we employ used vehicle price data that include actual transaction prices, dates of sale, vehicle identification numbers, and odometer readings for a large sample of vehicles sold at wholesale auctions between July 1993 and June 2008.

In our baseline specification, we find that vehicle prices do move one for one with future fuel costs. This conclusion is robust to a number of specification checks.[3] Given some simplifying assumptions about the structure of the used car market, this result implies that consumers do value fuel economy fully. This finding casts doubt on the idea that regulatory policies, such as fuel economy standards, might be more efficient than fuel taxation because they correct both the environmental externality and private mis-optimization due to limited rationality.

Our data come from wholesale auctions, but our interest is in what consumers pay in the retail market. Using an auxiliary data set from used car guide books, we demonstrate that price changes in the wholesale market appear to pass through one to one into retail prices. This is consistent with a competitive used car market, and it allows us to interpret our wholesale price results as directly reflecting consumer willingness to pay in the retail used car market.

We are not the first to ask whether or not consumers value fuel economy properly. The most similar existing papers are Allcott and Wozny (2014), Busse et al. (2013) and Grigolon et al. (2014). These papers use a panel identification strategy that leverages the fact that common gasoline price shocks translate into different fuel cost shocks for different vehicles based on their fuel economies.[4] Compared to these papers, we are able to relax a number of restrictive assumptions on the set of control variables. Specifically, because we utilize differences across vehicles of the same type in the same month by using variation in the odometer, we can control nonparametrically for time period shocks specific to each vehicle type, and we can control very flexibly for a depreciation schedule for each vehicle type.

The prior literature finds a range of estimates of consumer valuation across specifications that overlap with each other, where Allcott and Wozny (2014) emphasize estimates that find modest undervaluation, while Busse et al. (2013) and Grigolon et al. (2014) emphasize that their results cannot consistently reject full valuation. We interpret our estimates as consistent with their results. Moreover, we believe that our procedure presents a more stringent test of full valuation because we identify consumer valuation off of variation in odometers within a set of otherwise identical vehicles, which may not be very salient to consumers. If consumers have limited attention, in the sense of Sallee (2014), then we might expect them to ignore the type of within model variation in fuel costs that we leverage. That is, one could imagine consumers recognizing the fuel cost differences across categories of automobiles, but not "noticing" the difference in implied fuel costs across high and low mileage versions of the same model.

Our baseline model produces precise estimates consistent with full valuation. Our procedure yields statistical precision, and our results are robust across a number of dimensions. But, we emphasize that our procedure can be made to yield different results because it relies on a number of assumptions about underlying parameters that we use to construct our estimate of the future fuel cost of a vehicle, including consumer discount rates, expectations regarding future gasoline prices, perceived on road fuel economy, and typical patterns of vehicle utilization and scrappage. We have empirical support for each of the assumptions we use, but reasonable alternative parameter choices could shift our coefficient estimate in either direction. The same is true of other papers in the literature.

Thus, while the literature fails to consistently reject the null hypothesis of full valuation, the data cannot consistently rule out modest undervaluation, unless one takes a firm stand on underlying parameters that are themselves uncertain. What is clear from our results, in conjunction with the existing literature, is that a belief that consumers place a very low value on fuel economy is not supported by the data. Such a low valuation, however, would be required to rationalize the cost-benefit analysis employed in regulatory impact analyses of Corporate Average Fuel Economy (CAFE) standards. For example, the EPA estimates CAFE fuel savings from 2017–2025 that are about three times larger than the program costs (Environmental Protection Agency, 2012). For benefits to exceed costs in this way even when consumers fully value fuel economy, the regulatory analysis must not account for all program costs or it must implicitly assume that CAFE corrects some other market failure. Importantly, according to the analysis, fuel savings make up around 80% of the gross benefits, so if true program costs exceed fuel savings by even a modest fraction, it is possible that these costs could reverse the sign of the cost-benefit analysis.

Our empirical evidence, combined with the previous literature, implies that consumers at worst undervalue fuel economy modestly. If there are energy efficient technologies that are not being deployed, then researchers and regulators should perhaps shift their attention

[3] The main exception is that we find that for our highest mileage cars (those with over 100,000 miles when sold at auction), prices are significantly less responsive to fuel cost shocks. This may indicate that buyers of the oldest and least expensive used cars undervalue fuel economy, but it may also be due to a selection process by which only certain types of high mileage vehicles appear in wholesale auctions.

[4] Linn and Klier (2010) use the same strategy to study sales volumes, rather than prices. Li et al. (2009) and Jacobsen and van Benthem (2015) use it to study vehicle scrappage decisions.