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Re-searching for hidden costs: Evidence from the adoption of fuel-saving technologies in light-duty vehicles

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ABSTRACT

A variety of fuel-saving technologies have been implemented in light-duty vehicles since 2012 under the U.S. Environmental Protection Agency's (EPA) and Department of Transportation (DOT)'s light-duty vehicle greenhouse gas emissions and fuel economy standards. Questions have arisen whether there are hidden costs that have not been included in the net benefit calculations as a result of adoption of the new technologies. In this paper, we replicate and expand results from Helfand et al. (2016). We define hidden costs of the new technologies as problems with operational characteristics such as acceleration, handling, ride comfort, noise, braking feel, and vibration, not all of which are easily measured by objective criteria. We overcome the empirical challenge by using data coded from online professional auto reviews that qualitatively evaluate fuel-saving technologies and operational characteristics for model years 2014 and 2015 vehicles. We estimate relationships of fuel-saving technologies and operational characteristics, including an overall vehicle assessment, and find little correlation of hidden costs with the technologies themselves. Variable quality of implementation of technologies across automakers may better explain negatively evaluated operational characteristics. The results imply that automakers have typically been able to implement fuel-saving technologies without harm to vehicle operational characteristics.

1. Introduction

Fossil fuel combustion in transportation has contributed approximately one-fourth of greenhouse gas (GHG) emissions in the United States in recent years (U.S. Environmental Protection Agency (EPA), 2016a). In an effort to reduce GHG emissions and improve energy security, the U.S. Environmental Protection Agency (EPA) and the Department of Transportation (DOT) established vehicle GHG and fuel economy standards for light-duty vehicles for model years (MYs) 2012 through 2025. In the presence of the standards, vehicle manufacturers have implemented a wide range of fuel-saving technologies (EPA, 2016b; EPA, DOT and California

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Air Resources Board (CARB) 2016, Chapter 5).[1] Assessments of the standards have found enormous net benefits to society, including significant net benefits from fuel savings for new vehicle buyers (e.g., EPA and DOT, 2010, 2012; EPA, DOT, and CARB, 2016). However, questions have been raised about whether there are hidden costs that have not been included in the net benefit calculations as a result of adoption of the new technologies (Allcott and Greenstone, 2012; Gillingham and Palmer, 2014; Helfand et al., 2016). In particular, hidden costs that exceed the net positive financial benefits from fuel reduction for new vehicle buyers might explain why markets had been slow to adopt fuel-saving technologies on light-duty vehicles in the absence of the standards. Given the wide range of fuel-saving technologies developed and adopted in recent years, it is important to understand whether any of the new technologies impose hidden costs.

We consider hidden costs to be negative impacts of the technologies on performance, drivability, ride comfort, and other characteristics that would cause losses to consumer welfare and are difficult to measure. For instance, if six-speed automatic transmissions were clunky or otherwise worse to drive than traditional four-speed automatic transmissions, buyers of vehicles with six-speed transmissions would suffer welfare losses from the hidden costs and thus would be less interested in buying them. As the effects of the GHG standards depend critically on consumers buying vehicles with fuel-saving technologies, an evaluation of the new technologies should consider potential hidden costs.

One set of literature relevant to hidden costs as a result of adoption of fuel-saving technology has focused on estimating the tradeoffs between fuel economy and horsepower and weight (e.g., Knittel, 2011; Klier and Linn, 2012, 2016; MacKenzie and Heywood, 2015). This literature has focused on estimating this relationship as technological, not involving consumer response; see EPA, DOT, and CARB (2016), Chapter 4.1.3, for further discussion.

This paper is closely related to Helfand et al. (2016), which investigated whether there are hidden costs in a range of operational characteristics. Though operational characteristics that consumers may care about are not well measured by quantified vehicle attributes, they are usually evaluated qualitatively by professional auto reviewers. Helfand et al. (2016) gathered data on both operational characteristics and fuel-saving technologies for MY 2014 by conducting a content analysis of online auto reviews of MY 2014 vehicles. Content analysis involves systematic coding of text; it can be used to convert qualitative information to quantitative (Krippendorff, 2013). They did not find systematic evidence of negative operational characteristics associated with adoption of a variety of fuel-saving technologies, suggesting that it is possible to use the technologies on light-duty vehicles without imposing hidden costs on consumers.

This paper builds on Helfand et al. (2016) in several ways. First, this paper adds evaluations from professional auto reviews for MY 2015 vehicles to the dataset. These additional data provide an opportunity for validation of the results of the original study.

Second, instead of only using cross-sectional variation in technology adoption, the use of year fixed effects allows for control of more unobserved factors that may be correlated with changes in technology adoption and evaluation results, such as changes in consumer preferences. The larger dataset also helps avoid small sample size for some technologies. The estimation results of this paper, using the pooled data and adjusted standard errors dealing with potential small sample bias, are consistent with Helfand et al. (2016)'s conclusion that fuel-saving technologies generally appear not to be associated with negative operational impacts.

Third, to further explore the role of variable implementation quality for fuel-saving technologies, proposed by Helfand et al. (2016), we estimate whether negative evaluations of operational characteristics are correlated with negatively reviewed technologies, conditional on the presence of the technologies. We find evidence of positive relationships between negatively evaluated technologies and negatively evaluated operational characteristics, suggesting that poorly implemented technologies, instead of the presence of the technologies themselves, may be correlated with hidden costs.

Lastly, we examine whether fuel-saving technologies are associated with the overall assessment of the reviewed vehicles concluded by each reviewer. An overall rating, advising whether to purchase the vehicle, may be explicit, or it may be inferred from the evaluation of vehicle characteristics and comparison with vehicles in the same segment. The overall rating is expected to include any factors that the reviewer may consider, even if they are not specifically evaluated. We do not find evidence of associations between negative overall ratings of vehicles and the presence of fuel-saving technologies. Instead, we find negatively rated technologies and negatively rated operational characteristics are highly associated with the overall rating, further suggesting that lower quality technologies, with their adverse effects on operational characteristics, play key roles in getting a negative overall assessment.

These results suggest that, to date, automakers generally have been able to implement fuel-saving technologies without imposing hidden costs on consumers. This finding implies that net benefits from fuel savings suggested in the literature are higher than potential hidden costs of adoption of fuel-saving technology.

The remainder of this paper is structured as follows. The next section describes our data. Section 3 covers our estimation approach. Section 4 presents our results for the relationship of fuel-saving technologies and operational impacts. Section 5 presents our results for the relationship of the technologies with the overall assessment. Section 6 concludes.

2. Data and content analysis

The data for this study come from online professional auto reviews of MY 2014 and MY 2015 new vehicles. Professional auto reviews provide qualitative evaluation of both technologies and operational characteristics. For both of these categories, quality may be difficult to quantify but is very important to consumers. Hidden costs emerge if negative impacts on these operational

[1] For instance, gasoline direct injection was widely used on nearly half of all vehicles in model year 2016, while it was used in less than 3% of vehicles in model year 2008 (EPA, 2016b).