Energy efficiency and road safety:
The effect of cars' size on risky driving behavior

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Introduction

The use of incentives to encourage consumers to purchase energy-efficient cars has become a popular instrument among policy makers in recent years, which effectively increased the share of these cars on the roads (IEA, 2016). However, energy-efficient cars tend to be small-sized and light-weighted, both of which were found to increase fatality rates (Campbell and Reinfurt, 1973; Evans, 1991; Joksch, Massie, and Pichler, 1998). Crandall and Graham (1989) studied the effect of the decrease in average car weight following the Corporate Average Fuel Economy (CAFE) regulation on road safety. Accounting for car weight alone, they predicted that following the CAFE regulation, fatality rate in the US would increase by 14%-28%. However, to understand the effect of energy efficiency – partially manifested by reduced weight and size – on road safety, one must also consider driving behavior. Previous studies reported that drivers modify their driving behavior according to the level of risk they perceive (Fuller, 2005; Näätänen and Heikki, 1974; Taylor, 1964; Wilde, 1982). Therefore, whereas energy-efficient cars are less safe due to their small size and light weight, their limited safety may sitmulate their drivers to drive more carefully. If drivers of energy-efficient cars remain more focused and avoid dangerous situations, they are likely to offset some of the increased hazard.

To measure the difference in driving behaviour between drivers of small versus large cars, we first examine whether drivers of small cars are more likely to be involved in a severe or fatal accident. To address the likelihood of selection bias (i.e., careful drivers own small cars), we use a national-scale policy promoting energy-efficiency in transportation in Israel as an instrumental variable.

Research contribution

Prior research has predicted that policies incentivizing energy-efficiency increase fatality rates. However, this body of knowledge accounted merely for objective car characteristics. Our research extend present theory by connecting the purely technical car characteristics to the behavior of drivers. We suggest that drivers of light-weight, small cars tend to drive more carefully and thereby offset the increased hazard inherent to the cars they own.

Methods

Study 1: We utilize Israeli Police records of all fatal and severe car accidents in Israel between 2007 and 2015. This database includes specific car characteristics (brand, model, engine-capacity, etc.), driver characteristics (age, gender, driving experience, etc.), and accident data (date, time of day, location, etc.). For each car model, we collected formal crash test results from

the European New Car Assessment (NCAP) institute. We filtered out accidents involving cars manufactured before 2000, as there are no crash test results for these cars, and accidents involving more than two cars, as the effects of each car are very complex to estimate. Consequently, our final database contains 1,733 single- and 1,204 two-car accidents. Following Jacobsen (2013), we estimate a model of severe and fatal accidents in five engine capacity categories (0-1300, 1301-1600, 1601-1800, 1801-2000, and 2000 and higher), divided into 6 bins. Each bin represents different driving conditions (time of day, urban or rural road). We use a Maximum Likelihood estimation of a negative binomial model to estimate the risk associated with drivers in each car category and the risk per kilometer of a fatality or a severe injury in a car from each category when colliding with a car from any other category. The latter is referred to as the objective risk – the risk that directly stems from the car's size and weight.

Study 2: Importantly, a critical question that stems from our preliminary results in Study 1 as well as from Jacobsen's (2013) results is whether the risk associated with drivers is linked with car choice, or whether drivers choose their car considering their habitual driving characteristics.

To examine this question, we evaluate the risk associated with drivers of cars of various sizes while controlling for the endogeneity of drivers' choice of the size of the car they own. To do so, we follow the methodology of Steren, Rubin, and Rosenzweig (2016), and use a policy that incentivized consumers to purchase energy-efficient cars (which tend to be small-sized) as an instrumental variable. To measure the risk associated with driving behavior, we use formal police records of the number of traffic violations commited by an individual driver.

Results

Controlling for the aforementioned driving conditions, our preliminary results indicate that drivers of cars with an engine-capacity of 0-1300cc are the most cautious drivers among all categories, with an accident risk level that is about two-thirds of the average across all categories. The riskiest category is 1801-2000cc, about 27 percent above the average (Figure 1). These findings are consistent with the prediction that drivers of small cars drive more carefully than drivers of large car do.

Conclusions

In this study we examine the risk associated with drivers of energy-efficient cars. In our onging work, we utilize Israeli Police records of all fatal and severe car accidents in Israel, 2007-2015. Using a Maximum Likelihood estimation of a negative binomial model we estimate the risk associated with drivers in each of five car categories. Next, we utilize the number of traffic violations commited by individual drivers in a two-step estimation, using a policy incentivizing the purchase of energy-efficient cars as an instrumental variable. Our results which will be presnted in the conference, imply that the risk associated with drivers of small cars is lower than that of drivers of large cars. We postulate that knowing their car is not very safe, drivers of small cars drive more carefully, thereby offsetting the increased hazard inherent to the cars they own. From a policy perspective, our findings connect two central policy goals: energy efficiency and road safety in private transportation. While prior research associates energy-efficiency policies with increased risk of fatalities, our studies provide policy makers with a better understanding of

the complex relationship between energy efficiency and road safety, so that better and more informed policies could be designed.
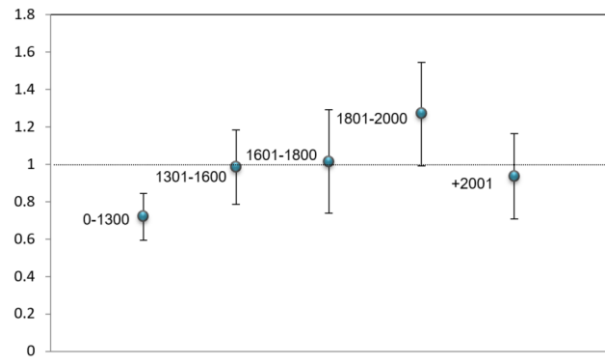

Figure 1: Estimates of the risk associated with drivers in each engine-size category (normalized to 1 at the average).

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