A Stated Preference Analysis of Personal Vehicle Transaction Choice: Abstract

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The transportation sector in US accounted for 72 percent of US oil consumption\(^1\) and 28 percent of the US greenhouse gas emission in 2012\(^2\). Even in the European union, transportation, particularly road transport is the largest consumer of oil products and second largest emitter of carbon dioxide (Achtnicht et al. 2012). While state agencies and policymakers are trying to promote the energy efficient and sustainable technology like the electric vehicle (EV) to reduce air pollution caused by vehicle emission, manufacturers are also trying to design vehicles that meet the stringent emission standards set by the federal and state governments and are attractive to consumers. There are attempts to produce environment-friendly cars across the range of models: from compacts, to sport utility vehicles (SUV), pickup-trucks and minivans.

As alternate fuel vehicles currently arriving in the market offer much better driving performance compared to their predecessors in the 1990s their potential market penetration is higher than before. Also, in terms of the infrastructure required to support the alternative fuel vehicles like charging station for EVs or refueling station for CNG vehicles, there has been considerable improvement over the last 10 years. However, most people still do not consider these alternate fuel vehicles as a real alternative to the traditional gasoline car (Jensen et al. 2013). To promote adoption of low or zero emission vehicles both the manufacturers and the state agencies need to understand how consumer demand is affected by different attributes of these vehicles. How and when does policy incentives matter? Does experience with a technology have an effect on attitude and preference for alternate fuel vehicles?

In this paper, a discrete choice model is used to study the vehicle transaction decision of 2647 survey respondents located throughout the state of California. The model is based on responses to customized stated preference questions involving hypothetical vehicle options and their attributes. The transaction model in the current version of this paper is a conditional logit model of choice of the hypothetical vehicles.

\(^1\)U.S. Energy Information Administration

\(^2\)U.S. Environment Protection Agency
similar to the set up in Brownstone et al. (1996). The model is conditioned on the current vehicle stock of the household, as the characteristics of the current holding like vehicle body or fuel type can be an important determinant of the stated preference choice. Secondly, experience with a new technology reduces the uncertainty factor associated with it. In other words, presence of a hybrid or a battery vehicle in the holding should reduce the skepticism observed in adopting a new technology. This effect of real experience is observed in the preliminary results of the paper. The results are potentially useful to energy agencies interested in promoting alternative fuel vehicles and to manufactures faced with designing and marketing these vehicles.

In this paper, I analyze data obtained from a California-wide survey of potential car buyers administered by the California Department of Transportation along with the California Energy Commission between 2010 and 2012. Households were selected for the survey by a random selection process that considered all residential addresses in the study area. The sample, comprising of individuals from 58 counties of California and various demographic and socio-economic groups (age, gender, education, income etc.), should represent the population residing in the state of California. It is a comprehensive dataset collected in three rounds. The first round of data came from the California Highway Transportation Survey (CHTS) with information on travel behavior and vehicle holdings of 109,113 individuals and 43,431 households of California. The second round of survey collected data on demographic characteristics, future vehicle purchase intentions, and preferences for different vehicle attributes from a random sample of 4341 households selected from the pool of the CHTS survey respondents. This information was used to customize the third round of survey consisting of the eight choice experiments. The SP choice experiments described four hypothetical vehicles from which households were asked to choose their preferred vehicle. The hypothetical vehicle alternatives were characterized by: body type, fuel type, number of models available, model year, vehicle price, purchase incentives, MPG/Fuel Economy, cost per 100 miles, fuel availability given by time taken to get to the refueling station, time to refuel, vehicle range, cargo space, maintenance cost and acceleration rate. A comprehensive dataset of this nature with information on household characteristics, travel behavior, purchase intentions, holding details, and stated choice is not common in the U.S. context. Also, California as a state has usually been a leader in the diffusion process of any energy efficient technology. This makes the dataset and the sample studied even more relevant for the problem that is being analyzed here. In comparison to the survey data used in the Brownstone et.al,1996 paper (the model used in the current paper is similar to the Brownstone et al., 1996 paper), the current dataset is based on choice experiments where the attribute values of the vehicle options can be expected to reflect better the current level of technology. Also, as consumers are more aware of low emission vehicles and have been exposed to different fuel types, we can expect to obtain more informed choice decisions from stated preference surveys. The larger sample size and newness of the dataset
can be expected to help me get more representative choice decisions and precise estimates (lower standard errors).

Several papers have studied the characteristics of alternate fuel vehicles, adoption decision of consumers and the role of policy to encourage diffusion of the technology (for example Bunch et al. 1993; Brownstone et al. 1996; Achtenicht et al. 2012). In all these studies, stated preference (SP) experiments were presented to respondents who usually had no experience with the new technology and were unaware of the benefits and costs of its usage. One of the major criticisms of the SP approach is that the consumer in reality may not do what they state in the survey data. In order to overcome the limitations of SP data in representing demand for EVs and other alternate fuel vehicles there has been attempts to link the SP data with revealed preference or market transaction data (Brownstone et al. 2000). Also, as mentioned in the paper by Brownstone et al. (1996), the majority of the early papers on alternate fuel vehicle demand based on SP data concentrated on electric vehicles and modeled choice neglecting the current holding of the household. One of the first choice models to consider household vehicle holding was developed by Train (1986). It is a hierarchical model of auto ownership and use, designed to forecast future vehicle demand. Based on this work, Brownstone et al. (1996) developed a micro simulation model using both stated and revealed preference data to forecast demand for alternate fuel vehicles conditioned on the current holding of the household. Vehicle holding can be expected to influence the future purchase intentions of households looking to add to or replace their current vehicle. In a two vehicle household if there is already two SUVs, it is unlikely that the household will go for a third SUV. More importantly, considering the problem in hand, if a household have a hybrid or electric vehicle in their holding they can be expected to be less skeptical of the new technology and instead have more positive attitude and preference for it. Jensen et al. (2013) found a significant change in preferences for driving range, top speed, fuel cost, charging options, and battery life after real experience with an electric vehicle. Hence, in my analysis of vehicle choice, I account for the size of the household vehicle holding (one vehicle or two vehicle households) and the type of vehicles both in terms of car type and fuel types (gasoline or electric or hybrid).

Currently, I have the first round of results from the conditional logit model. From the current analysis I observe that the usual vehicle attributes like purchase price, gallon per miles, refueling time, time to refuel station, maintenance costs and vehicle range primarily drive transaction choice. Purchase incentives do not help a lot in pushing preferences towards alternative fuel vehicles that are still costlier than their gasoline counterparts. Individuals do care about gallon per mile suggesting that they are concerned about gas prices and would want higher fuel cost savings. Finally, the role of experience in the diffusion of a new technology is captured in the first round of results. Households with a hybrid or battery vehicle in their holding are more likely to adopt a new technology compared to the ones who do not have the experience. With experience
the skepticism associated with a new technology can be expected to reduce. This is an important result for manufacturers as well as policymakers trying to promote diffusion of battery vehicles or EVs.

I am currently working on a random coefficient model to analyze potential heterogeneity in taste with respect to vehicle range, fuel cost or refueling time. Also, the data from the second round of survey on future purchase intentions can be used to test non response bias as well as build a two stage model modeling individual attitude towards alternate fuel vehicles and the influence of their attitude on the vehicle choice.

References


