UNDERSTANDING LATENT DEMAND FOR HYBRID AND PLUG-IN ELECTRIC VEHICLES USING LARGE-SCALE LONGITUDINAL SURVEY DATA OF U.S. NEW VEHICLE BUYERS

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Overview

Federal and state-level policy programs in the U.S. encourage automakers to sell fuel-efficient and alternative-fuel vehicles. Emissions reduction, air quality improvement and energy security drive such programs to achieve these intended goals. The federal-level GHG/CAFE program, requires automakers to achieve a specific sales-weighted average of GHG emissions per mile/fuel economy each year up to Model Year (MY) 2025. The state-level ZEV mandate in California and nine other states, promotes the adoption of ZEVs by requiring automakers to achieve a set target ZEV credits each year. Both programs are examples of supply-side policies with specific targets that rise year after year. To promote ZEV adoption, states have also implemented demand-side policies such as offering rebates, up to about $2,500, as well as incentives such as HOV lane permits. In the past, similar support incentives were also offered to promote HEV adoption. States, primarily California, are also investing in charging station infrastructure. For these policies to achieve their intended goals, it is critical to understand consumer demand for fuel-efficient and alternative fuel vehicles.

In this study, we measure the changes in consumers' purchase motivations and estimate latent demand for hybrid and plug-in electric vehicles in the wake of such programs by analyzing the past 11 years of new vehicle buyer survey data in the United States with more than 1 million respondents. We also try to understand the relationship between observable macro factors and consumer motivation to adopt fuel-efficient vehicles.

Methods

We used a new data mining approach, *ex-post counterfactual inference*, which we had previously developed [1] to examine the survey data of new vehicle buyers. This approach aims to identify: current adopter types, their reasons for adoption, potential adopters, size of the potential market and factors that could induce potential buyers to adopt more fuel-efficient vehicles.

Results & Conclusions

The hybrid-electric vehicles (HEVs), plug-in hybrid-electric vehicles (PHEVs) and battery-electric vehicles (BEVs), are collectively termed as "xEVs." In a counterfactual scenario assuming optimistic growth, we find that the xEV fuel types had the potential to secure about 11 percent of the U.S. new vehicle sales in model year 2015. In reality, the xEVs achieved only one-third of this. Realization of the full potential would depend on the public and private sector's ability to encourage fuel economy conscious conventional gasoline vehicle buyers to adopt even more fuel-efficient xEVs.

The estimated potential market share for xEVs increases with narrowing of *valuation gap* between buyers of non xEVs and xEVs for purchase motivations of fuel economy, technical innovation, environmental friendliness and price (Figure 1). This is because the potential market share is estimated by identifying non-xEV buyers that have very similar purchase motivations and demographics as xEV buyers. Thus, as non-xEV and xEV consumers come close in terms of their valuation of these purchase motivations, a higher potential market share for xEVs is estimated.

The narrowing of the valuation gap in turn is strongly correlated with CAFE target and moderately correlated with gasoline price (Figure 2), two important macro factors exogenous to our model. We notice the valuation gap for these purchase motivations reduces over time because the non-xEV consumers' valuation is increasing, while that of xEV buyers is decreasing. Non-xEV consumers may derive higher utility from the innovative fuel-efficient technologies added to non-xEVs to meet CAFE target, thus leading to their rising valuation. On the other hand, demand-side policies have made xEVs more affordable and accessible for a bigger portion of mainstream consumers, thus leading to their decreasing valuation. A combination of such supply-side and demand-side policies, therefore, represents a viable tool to nudge non-xEV buyers' purchase motivations closer to xEV buyers.

The moderate effect of gasoline price on the valuation gap for purchase motivations may be due to mandated targets for automakers to sell increasingly fuel-efficient vehicles irrespective of the gasoline price.

Different xEV fuel types compete indirectly over similar segments of fuel economy conscious conventional gasoline vehicle buyers. Despite that, the different xEV fuel types have the potential to grow up to three times their MY 2015 market size. Because of GHG/CAFE, however, conventional gasoline vehicles are becoming increasingly more fuel efficient. In the short term, consumers have more fuel-efficient options. Encouraging them to choose the most fuel-efficient xEVs under current low gasoline prices remains a challenge. In the long term, as CAFE targets become more stringent, conventional vehicle costs would keep rising following the addition of fuel-efficiency technologies. Moreover, as battery costs shrink, through learning-by-doing, supply chain integration and economies of scale, xEVs could become an economically feasible option for automakers to meet the mandated standards, and for consumers when choosing among different fuel-efficient vehicles.

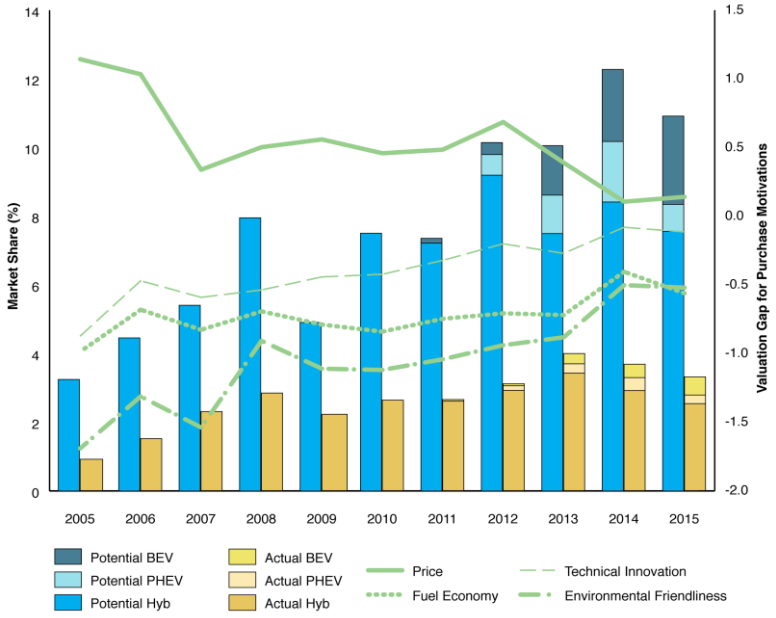

Figure 1. Variation of (i) actual and potential market share for xEVs on primary axis, (ii) difference between non-xEV and xEV consumers' valuation of purchase motivations on secondary axis.

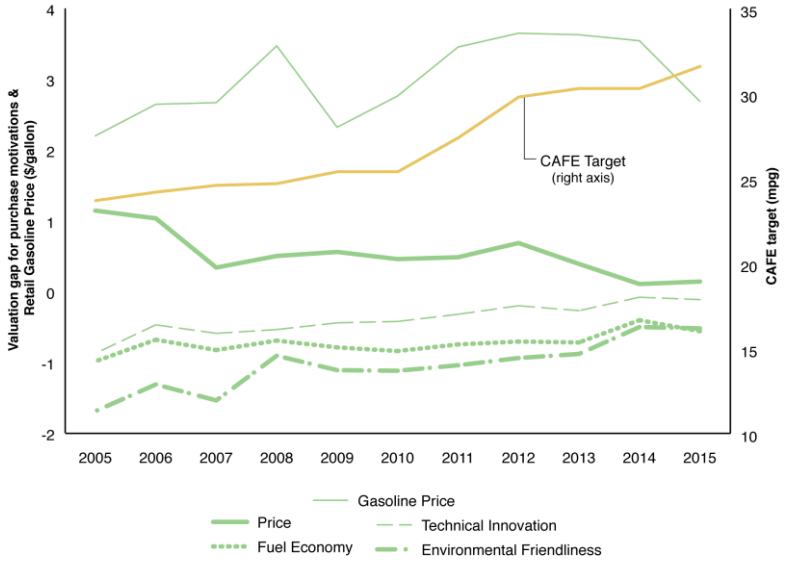

Figure 2. Variation of (i) valuation gap for fuel economy, technical innovation, environmental friendliness and price (ii) retail gasoline price, and (iii) CAFE target. The retail gasoline price is obtained from U.S. EIA and CAFE target is obtained from NHTSA.

References

1. Dua, R., K. White, and R. Lindland (2017), "Understanding Potential for Battery Electric Vehicle Adoption Using Large-Scale Consumer Profile Data," Transportation Research Board: 2017 TRB Annual Meeting Compendium of Papers, 2017.