THE EFFECTS OF POLICY CHANGES ON HOUSEHOLDS' BEHAVIOR ABOUT ELECTRIC VEHICLES AND ENERGY RELATED APPLIANCES

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Overview

Industrialized countries are interested in encouraging the adoption of electric vehicle (EV) and energy-saving appliances. This is driven, in part, by concerns over climate change and energy security. In this paper, we develop a consumer preference model to assess households' behavior in terms of adopting EVs and energy-intensive household appliances. This model will be used as a sub-model for the Integrated Computational System for Energy Pricing and Policy (ICS-EPP), which is being developed by a multidisciplinary team to help assess the impacts of energy policy on energy use and technology adoption. This work develops two related models – the transportation technology adoption (TTA) and residential technology adoption (RTA) models. The TTA model simulates vehicle adoption decisions for individuals in the long-term based on different vehicle types and energy policies. The RTA model evaluates individual preferences for energy-intensive home appliances based on appliance attributes and characteristics of individuals. Both the TTA and RTA models help to understand which attributes of an EV or appliance have more effects on individuals' decisions, how policy choices affect those decisions, and provides insights into possible future market shares of consumer energy technologies.

Methods

The TTA model uses a mixed logit model (MLM), with some parameter estimates from the work of Hidrue et al. (2011), to simulate household vehicle-adoption decisions. This model can simulate the adoption of vehicles currently available on the market and vehicle models that may be available in the future. The TTA model can also be used to understand which EV characteristics (e.g., cost or driving range) have the greatest effect on household adoption decisions.

Additionally, we use net present value calculations for the RTA model. Inputs of the RTA model comes from various submodels constituting the ICS-EPP. Energy consumption amounts for each individual and appliance attributes come from the ICS-EPP. Discount rates, which depend on individuals' characteristics, and energy prices are other inputs of the model. As a result, the RTA compares different appliance types, and helps to understand which attributes of an energy-intensive home appliance are more important for individuals.

Results

A realistic case study is analysed for the RTA and TTA models, and sensitivity analyses are presented. We find that the price of an EV is the most important decision factor for individuals, but it does not provide significant changes in market shares of EVs without improvements of other EV attributes such as, range and recharging time. These two are also found to be important factors guiding vehicle-purchase decisions. On the other hand, pollution amounts, acceleration time, and miles per gallon are the attributes which have no significant effect on EV-adoption decisions. The RTA model provides what kind of appliances individuals would use in the long term, and specifies their characteristics. Detailed sensitivity analysis for the TTA and RTA models are presented as well.

Conclusions

From the view of a policy maker, focusing on some aspects of EV-technology improvements, such as increasing EV range and decreasing recharging times, are key factors to increase the market share of EVs. Our analysis presents new insights about how future EVs and appliances should be designed, and what would be their market shares in the long run. Another main contribution is using realistic appliance- and vehicle-use habits from the ICS-EPP model to have more robust behavioral assumptions underlying the techonology-adoption model.

References

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