Assessing the Impact of Direct Experience on Individual Preferences and Attitudes for Electric Vehicles

Over the last decades, several studies have focused on understanding what drives the demand for electric vehicles (EVs). However, EVs still face large difficulties in developing into a mass market product. It is now recognised that individuals make choices based on a mixture of strategies that involve trade-offs between current characteristics of the alternatives (as in typical neoclassical economic theory) and several effects of bounded rationality. In this connection, some studies have shown that, in addition to the objective characteristics of the vehicles, individuals’ attitudes toward the environment have an impact on the choice of EVs. However, all these studies assume that individuals have pre-defined preferences. EVs are emerging products that few people have experienced and preferences and attitudes might change as the market for new products expands and individuals acquire experience with the new technology and better understand how it affects their lives.

The objective of the Ph.D. thesis is to investigate the extent to which direct experience with an EV affects individual preferences for specific EV characteristics and attitudes towards relevant topics and how this impacts market elasticity and the diffusion of the EV into the car market. In particular the thesis (1) proposes a methodology to collect adequate data on choices before and after respondents obtain experience with EVs; (2) uses advanced hybrid choice models estimated jointly on the before and the after data to model changes in preferences and attitudes as a results of the direct experience and (3) tests a method to improve the forecasts of the demand for EVs by combining the disaggregate choice model with a diffusion model, taking into account the time dependent adoption process.

The methodology used to collect the data consists of a long panel survey where individuals are interviewed before (wave 1) and after (wave 2) they have had experience with an EV for the duration of three months in a demonstration project. Considering the very small share of actual EV owners, Stated choices (SC) were used to elicit potential consumer’s preferences. The survey includes (i) information about current vehicle stock and plans for future purchase; (ii) a SC experiment between an EV and a conventional internal combustion engine vehicle (ICV); (iii) background information about the respondent and family, and (iv) a number of statements to measure the attitudes of environmental concern, appreciation of car features, interest in technology, general opinions towards EVs and scepticism. The same survey was then repeated in wave 2. First, a SC experiment was built with orthogonal design and tested with a sample of 369 individuals. The experience obtained from this data collection and prior estimates were then used to build the final survey with a SC experiment based on efficient design. The two datasets are very similar, with a few differences in some SC attributes and the inclusion of the no-choice alternative only in the SC experiment of the final survey. In both surveys the scenarios presented in the experiment are customized based on a relevant car purchase as indicated by each respondent.

An in-depth descriptive analysis of the data clearly indicates that preferences for several attributes changed between the two waves. In general the EV is chosen fewer times in wave 2 than in wave 1. In both waves, the EV is chosen more often if the car purchase used as reference is not the only car in the family or if it is a small car. Analyses of the answers to the attitude statements indicate that respondents only change attitude if the statements are EV related. For example, with experience, respondents indicate a more positive view towards the driving performance of EVs and this change is significantly higher for women than men. Furthermore, respondents indicate less concern about having to charge the EV. On the other hand, they indicate a higher concern for being able to maintain their current mobility if they use an EV.

Several hybrid discrete choice models were estimated, using jointly the data from wave 1 and wave 2. The joint estimation allows us to compare individual preferences and attitudes between the two waves directly, after controlling for scale differences between the two datasets. A detailed factorial analysis was first performed to define the latent variables and the relevant indicators. Several discrete choice models and latent variable models were first estimated separately to identify the best utility specification. Then joint hybrid choice models were estimated to investigate whether real-life experience with an EV changes individual preferences for specific attributes, attitudes toward several topics and the effect that these changes have on the choice. We investigated these effects using the data collected with the orthogonal design and the data collected with the efficient design. With slight differences, results were confirmed with both datasets. Estimation of the joint hybrid choice model shows that preferences for several attributes indeed do change with experience. Especially, the preference for driving range, which is a critical attribute for EVs, changes and becomes twice as important in wave 2 compared to wave 1. As in previous studies, results show that environmental concern has a positive effect on the choice for EVs, but results indicate that this effect does not change with experience. Using the dataset collected in the final survey (i.e. with the efficient design), the Ph.D. thesis explores more in detail different sources of individual preference variation and to what extent preferences changes as a result of real-life experience with an EV. In particular the thesis investigates (1) the effect of the scale coefficient parameterisation; (2) the effect of respondents’ knowledge about being selected; (3) the effect of the latent variable, scepticism and (4) differences in the results obtained with orthogonal and efficient design. We did not find any effect of the scale coefficient parameterisation, but results show that there are differences in preferences if individuals know that they have been selected. Finally, the results indicate that being sceptic reduces the preference for EVs compared to ICVs, but we only found this effect for individuals without EV experience.

The last part of the thesis discusses the problem of predicting the market share of new products. As most studies for new technologies rely on stated preference data, prediction with choice models requires at least recalibrating the alternative specific constants (ASCs) and the scale to reflect that the unobserved factors in the design year can be different than in the base situation. However, this method gives a quite restrictive calibration of the ASC’s, since the current market share for EVs is extremely low. This means that the models become unresponsive, even to major improvements of the EV alternative. The results indicate that there are some time-dependent factors which are not taken into account in the choice models. The effect of diffusion is a time-dependent factor crucial in case of new products that often need time to obtain a significant market share. The Ph.D. presents and applies an integrated choice and diffusion model to forecast future scenarios of the EV market. Results show that accounting for the diffusion effect allows us to predict a low market share in...
the initial years and a rapid increase in the market share as the diffusion effect kicks in.

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