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The potential of electromobility in Austria: Evidence from hybrid choice models under the presence of unreported information

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ABSTRACT

This paper analyses the impact of the introduction of electromobility in Austria, focusing specifically on the potential demand for electric vehicles in the automotive market. We estimate discrete choice behavioral mixture models considering latent variables; these allows us to deal with this potential demand as well as to analyze the effect of different attributes of the alternatives over the potential market penetration. We find out that some usual assumptions regarding electromobility also hold for the Austrian market (e.g. proclivity of green-minded people and reluctance of older individuals), while others are only partially valid (e.g. the power of the engine is not relevant for purely electric vehicles). Along the same line, it is established that some policy incentives would have a positive effect for the demand for electrical cars, while others – such as an annual Park and Ride subscription or a one-year-ticket for public transportation – would not increase the willingness-to-pay for electromobility. Our work suggests the existence of reliability thresholds concerning the availability of charging stations.

Finally this paper enunciates and successfully tests an alternative approach to address unreported information regarding income in presence of endogeneity and multiple information sources. We find that, for our sample, the presence of endogeneity and correlation makes both classical imputation techniques unsuitable.

1. Introduction

Both the coming scarcity and the negative environmental impact of fossil fuel resources as well as governmental guidelines are driving the automobile industry to focus on alternative, more efficient and cleaner, propulsion technologies. In addition, an increasing number of restrictive CO_2 emission regulations (Fontaras and Dilara, 2012) accompanied with rising fuel prices (Macharis et al., 2010) have led to a significant change in the way that some characteristics of the automobiles are perceived. Consumers – and the public in general – are pushing for lower emission, more fuel efficient, and smaller engines (Fontaras and Samaras, 2010; Thiel et al., 2014).

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This attitudinal change has not only led to significant changes in market shares, favoring more efficient technologies (e.g. rise of diesel engines at the expense of less-efficient Otto-cycle engines; Fontaras and Samaras, 2007), but also to an increased interest in alternative fuel vehicles. The new millennium has seen the composition of the car fleet change, with hybrid electric vehicles (HEV) playing an increasingly important role (Jenn et al., 2013). The expansion of other alternative engines, such as plug-in hybrid electric vehicles (PHEV) or battery electric vehicles (BEV) has been slower; mainly due to technical issues (Lu et al., 2013), user concerns (Egbue and Long, 2012), and economic hurdles (Dimitropoulos et al., 2013). However, the market expects significant sales increases when these issues are overcome (Eppstein et al., 2011; Lebeau et al., 2012; Shafiei et al., 2012; Hackbarth and Madlener, 2013; among many others).

Along this line, numerous governments, including Japan (Åhman, 2006), the USA (Diamond, 2009) and members of the European Union (Kley et al., 2012) have introduced policies that promote electromobility, ranging from the development of the charging infrastructure to free or reduced price access to express lanes and parking.

However, the adoption of electric vehicles is not only driven by economic benefits but also by the environmental concern of individuals. While the effectiveness of electromobility in reducing CO_2 emissions is disputed by some (Sandy Thomas, 2012; Kasten and Hacker, 2014), several studies show that a positive attitude toward the environment tends to increase the willingness-to-pay for electromobility (Bolduc et al., 2008; Daziano and Bolduc, 2013; Jensen et al., 2013, 2014; Sexton and Sexton, 2014).

Although the perspectives of electric vehicles are extensively studied, to our knowledge only one attempt based on disaggregated data for Austria exists (Link et al., 2012). Pfaffenbichler et al. (2009) summarize other attempts to establish the acceptance of electromobility in Austria, but these studies rely either on plain attitudes toward alternative transportation modes (tns infratest, 2008; Auto Bild, 2006; Landmann et al., 2009) or on current aggregated data and hypothetical scenarios (Haas, 2009; Enerdata, 2009; Roland Berger Strategy Consultants, 2009). These approaches do not seem to be suitable for reliable prognoses, as the former make it impossible to derive functional models and the latter attempt to derive the demand for a certain transportation mode (whose attributes are unknown to the wider public, as the current market share of electric vehicles is very small; Link et al., 2012) based on the characteristics of other alternatives.

Deriving reliable estimates for the future demand for electric vehicles is crucial, not only for the automobile and battery industries, but also for the electricity market, as the energy consumption of electric vehicles impacts electricity networks (Pieltain Fernández et al., 2011; Schill and Gerbaulet, 2014).

This paper aims to analyze the acceptance of electric vehicles by the Austrian population as well as the perspectives of electromobility in the country, which, as previously mentioned, have only been cursorily studied in the past. This way, we provide functional models to analyze how different features of alternative powered vehicles may impact their adoption in Austria. Along this line, we analyze the impact that different incentive policies may have on the acceptance of electric vehicles, considering not only classical subsidies (as reported in the literature by Jenn et al., 2013; Zhang et al., 2014; among many others) but also policies encouraging the joint use of electrical vehicles and public transportation. Additionally, as we are forced to deal with unreported income under the presence of endogeneity and correlation with socio-economical characteristics of the individuals (making unsuitable the classic imputation techniques reported in the literature; Kim et al., 2007; Fosgerau and Bierlaire, 2009), we develop an alternative approach to address this problem, extending the method proposed by Sanko et al. (2014). The rest of the paper is organized as follows; Section 2 presents a brief description of our dataset as well as of the variables we are considering, while Section 3 offers a theoretical overview of the modeling background and enunciates our approach the deal with unreported income. Our results are discussed in Sections 4 and 5 summarizes our conclusions.

2. Description of the dataset

Data was collected through a web-based survey conducted by a German commercial subcontractor (GfK) in February 2013. The sample of 1449 respondents was drawn from an online panel and divided into two subgroups on the basis of screening questions and randomized selection. The first subgroup was assigned to a discrete choice experiment (DCE) on vehicle purchase. Participation in this experiment was restricted to individuals with a driver's license and an explicit intention to buy a new vehicle in the near future. In total 787 respondents were selected into this subgroup.[1] Individuals in the second subgroup did not receive the same DCE.

Each respondent received nine independent choice scenarios, which took about 20–30 min to complete; including the standard demographic questions. Although comparable studies sometimes restrict the number of choice scenarios to avoid a potential drop in attention, pre-testing of the questionnaire showed that respondents were generally comfortable with the load of information and the total duration. An important issue that emerged from this test was the relevance of the descriptions of (a) the propulsion technologies and (b) the availability of charging stations. While the choice scenarios were described within a simple table to facilitate comparison, additional pop-up boxes were used to convey more detailed information. This approach proved to be especially important to communicate e.g. the differences between hybrid-electric and conventional vehicles or improvements in the charging station network.

[1] To strengthen the link between the hypothetical choice scenarios and the real purchase decision, additional information on observed driving behavior and purchase preferences was used to individualize the choice sets.