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Modeling the demand for electric mobility in the Canadian rental vehicle market

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ABSTRACT

In recent years, numerous studies have been conducted to evaluate the demand for acquiring electric vehicles (EVs) by household with little attention given to the commercial fleet sector. Within the latter, rental vehicles account for the majority of fleets in Canada. Eventually, the acquisition of rental vehicles by their respective companies is driven by consumers' demand for these vehicles in the market. This research provides a pioneering effort to evaluate Canadian consumers' preferences towards renting EVs. A nationwide stated preference (SP) survey was conducted to collect information from over 1000 respondents. Each respondent was presented with six choice scenarios, and each scenario featured the following vehicle powertrains: internal combustion engine vehicle (ICEV), hybrid electric vehicle (HEV), plug-in hybrid electric vehicle (PHEV) and battery electric vehicle (BEV). The collected SP responses, along with socio-demographic and attitudinal characteristics of the respondents, were analyzed using a latent class discrete choice model to identify the potential segments with unique features present in the sample population. The model identified the following four distinct latent classes: ICEV-oriented (22%), EV-curious (34%), Cost-sensitive (24%), and EV-oriented (20%). Based on the empirical analysis, the potential for renting electric vehicles among the EV-curious and the EV-oriented classes could increase with improvements in vehicle driving range and battery recharging time. Further, provision of monetary incentives (e.g., free vehicle upgrades, rental discounts and no rental taxes) could also increase the probability of renting HEVs by the Cost-sensitive consumers.

1. Introduction

Increase in daily travel activities coupled with reliance on petroleum-powered automobiles (i.e., conventional vehicles), places a significant pressure on the environment. In 2014, the transportation sector was the second-largest contributor of greenhouse gasses (GHG) in Canada, representing 23% (approximately 171 MtCO2eq) of the total GHG emissions (Environment and Climate Change Canada, 2016). Certain transportation policies have been geared towards reducing automobile dependency, although shifts to non-motorized modes of transportation (e.g., walking and cycling) have been marginally effective, given the sprawled nature of many metropolitan areas and societal stigmas towards the said modes (Bernardo and Bhat, 2014). Along with current advancements in battery technology, the introduction of electric vehicles (EVs) is considered by many as one of the more viable solutions in combating climate change and promoting sustainable energy. However, the success of EVs is highly dependent on the source of electricity used

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to charge their batteries.

EVs powered by coal-based electricity significantly increase environmental impact compared to conventional vehicles, while EVs running on electricity generated by renewable energy reduce environmental impact by at least 50% (Tessum et al., 2014). In the Canadian context, national electricity generation emission level (about 167tCO2eq/GWh) is considerably below the accepted 600tCO2eq/GWh threshold, placing the country as one of the cleanest electric power producer in the world (Kennedy, 2015). This implies that the scarcity of EV ownership in Canada[1] is due to barriers not related to the source of electricity needed to charge these vehicles. Egbue and Long (2012), and Browne et al. (2012) suggest that aside from high capital cost and some functional limitations like driving range and battery life, factors related to social cost and personal perceptions curtail the adoption of EVs. To date, numerous studies have been conducted to understand the factors affecting the adoption of alternative fuel vehicles among households (Potoglou and Kanaroglou, 2008; Rezvani et al., 2015). In contrast, the current knowledge on the process of acquiring such vehicle technologies by commercial fleets is lacking due to scarcity of studies on the topic, especially in the Canadian context. Public and private organizations typically have high vehicle purchase rates (Dijk et al., 2013) and high annual fleet mileage (Gnann et al., 2015), making them ideal EV adopters; thus, it is important to understand the factors that affect vehicle acquisition decisions of these organizations.

The objective of this study is to identify the significant factors influencing consumers' rental vehicle preferences, and to evaluate the importance of certain vehicle attributes when it comes to renting electric vehicles. Rental companies own the largest commercial fleet in Canada, which accounted for 69% and 50% of all the registered cars and light truck fleets in 2016, respectively (Canadian Automotive Fleet, 2017). Similar to the private vehicle market, EVs among rental fleets are fairly scarce. According to the Canadian Automotive Fleet (2017), the shares of hybrid and full-electric cars, and light trucks in Canada in 2016 were 4.4% and 0.7%, respectively.

Contrary to targeting rental fleet managers as in Golob et al. (1997), the focus of this research is on consumers and their rental vehicle preferences. The rationale for this is two-fold: first, rental companies are primarily driven by profit maximization, and as such, would normally invest in acquiring vehicles that are in high demand. Therefore, understanding the rental choice behavior (i.e., demand) could provide insights about the potential for adopting EVs by Canadian rental vehicle companies. Second, the decision to acquire new vehicles by rental companies is done at the corporate level and not by the local branches. This will make the stated preference (SP) experiment impractical, since there are only a handful of prominent rental companies across the country.

The remainder of this paper is organized into four sections. Section two provides an overview of the existing literature on new vehicle technology adoption. This is followed by section three, which presents the development of the SP survey. The section also provides descriptive statistics that characterize the collected data. Section four presents the econometric demand model used to study the rental vehicle choice process. Section five then discusses the results obtained from estimating the demand model with the collected SP data. Finally, the last section provides a conclusion to our study.

2. Literature review

Understanding the factors affecting the decision to adopt alternative fuel vehicles (AFVs) is timely and crucial for their immediate success. A mainstream approach towards studying the demand for AFVs has been to collect and analyze SP data along with estimating different forms of econometric models. Potoglou and Kanaroglou (2008) provided a comprehensive literature review on various research methods for modeling AFV demand based on SP data. More recently, Rezvani et al. (2015) focused primarily on empirical studies evaluating consumer choice behavior towards plug-in electric vehicle adoptions.

Findings from the existing literature on AFV adoption suggest that the significant factors affecting consumers' vehicle preferences could be classified into three main categories: (a) costs; (b) incentives; and (c) reliability. Table 1 provides an overview of the various attributes that have been used in the literature. Vehicle costs, such as capital cost and operating cost (i.e., fuel and/or maintenance costs), are considered as key factors in vehicle ownership studies. Moreover, most studies did not consider maintenance cost, but rather focused on fuel cost as part of their experimental design. On the other hand, those that considered both operational costs either used them separately (e.g., Ahn et al., 2008; Ewing and Sarigöllü, 2000; Hess et al., 2012; Potoglou and Kanaroglou, 2007; Shin et al., 2012) or combined them into one attribute (e.g., Hoen and Koetse, 2014; Mabit and Fosgerau, 2011).

In addition to reduced operating costs, policies focused on incentives were considered in past studies. For instance, monetary incentives are usually introduced in some form of tax rebate like vehicle registration tax (e.g., Beck et al., 2013; Caulfield et al., 2010). The effects of reduced toll values have also been tested (e.g., Hess et al., 2012; Maness and Cirillo, 2012). Alongside monetary incentives, non-monetary incentives, such as free parking and free access to exclusive lanes (e.g., HOV or bus lanes) were considered (e.g., Hackbarth and Madlener, 2016, 2013; Hess et al., 2012; Hoen and Koetse, 2014; Potoglou and Kanaroglou, 2007; Qian and Soopramanien, 2011). Reliability of new vehicle technology is often compared to conventional vehicles in terms of its maximum driving range and refueling and/or recharging time (e.g., Axsen et al., 2015; Ewing and Sarigöllü, 2000; Hackbarth and Madlener, 2016, 2013; Hess et al., 2012; Hidrue et al., 2011; Hoen and Koetse, 2014; Ito et al., 2013; Parsons et al., 2014).

In a similar fashion, past efforts used the accessibility of AFVs to their respective refueling and/or recharging stations, instead of identifying how refueling/recharging would potentially impact consumers' preferences for such vehicle type (e.g., Achtnicht et al., 2008; Potoglou and Kanaroglou, 2007; Shin et al., 2012; Ziegler, 2012). AFVs' performance is another criterion typically introduced,

[1] Total number of registered EVs in Canada in 2016 was 29,270 (FleetCarma, 2017). This is compared to a total number of 22,410,030 registered cars during the same year (Statistics Canada, 2017a).