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Accounting for attitudes on parking choice: An integrated choice and latent variable approach

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ABSTRACT

The well-differentiated impact that parking supply options produce on congestion, pollution and land consumption arouses the interest of policy makers for a better understanding of car user's behavior when choosing a parking option. Despite the evidence on the advantages of hybrid discrete choice models, most literature on parking choice only involves observable factors while leaving aside issues related to the latent variables. The behavioral hypothesis is that parking choice process depends not only on a set of observable factors but also has to do with individual-specific latent attributes. A hybrid discrete choice model with interactions among attitudes and observable factors, as well as among socioeconomic characteristics and observable factors, was estimated in order to consider individual heterogeneity. The results showed that, in addition to parking fee, search time and access time, a Risk-averse attitude and a Positive car care (maintenance) attitude are determinants for parking choice. The inclusion of these latent attributes and their interactions also resulted in a large improvement in the goodness-of-fit of the model and affected the time valuations.

1. Introduction

Making a trip by private car requires a parking space at the end destination of the trip or near it. When traveling to public areas, car users normally choose one of the available alternatives; for example, among free on-street parking, paid on-street parking, and paid public parking lots. Since vehicles spend the majority of the time parked, parking consumes a large amount of urban land (Manville and Shoup, 2005). Parking facility areas vary significantly, depending on planning practices. In a typical urban area, for example, about three times as much land is devoted to roads and parking as to residential structures (Litman, 2011). However, off-street parking requires about twice the amount of space consumed by on-street parking, so parking policies and practices can affect the amount of land devoted to parking facilities (Litman, 2016).

In addition to excessive land consumption, parking has other significant impacts on the environment (Caicedo et al., 2016). The more direct environmental impacts of parking include congestion and pollution, among others that are clearly significant (Merriman, 2016). Downtown parking produces traffic congestion because of cars entering and exiting parking spots (Arnott, 2006). Congestion and parking are also interrelated since looking for a parking space creates additional delays and impairs local circulation. However, the magnitude of the effect produced by this interrelationship depends on the parking alternative. For example, the process of

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searching for a free on-street parking space, which is not effective, wastes not only time but also fuel, increasing pollution levels (Shoup, 2006). Therefore, in city centers, especially in central business districts (CBD), increases in pollutant levels are largely associated with on-street parking (Gallagher et al., 2011).

A highly relevant aspect for decision makers is that parking farther plays an important role in mode choice and travel behavior (Christiansen et al., 2017). It is precisely for this reason that parking is a key element of any transportation program. Although the explanation of driver behavior concerning choice of parking alternatives is not simply due to the complexity and variety of interactions involved (Golias et al., 2002), to mitigate or avoid the problems related to parking, decision makers must come to defining parking policies, strategies or measures, which often rely on behavioral models. A lot of research in this field has depended on a wide range of discrete choice models (Hensher and King, 2001; Anderson et al., 2006; Kelly and Clinch, 2009; Márquez et al., 2011; Habib et al., 2012; Kobus et al., 2013; Ibeas et al., 2014; Chaniotakis and Pel, 2015). Typically, discrete choice models consider individual heterogeneity and involve observable factors such as walking time, searching time and parking fee, among the most important.

Although the transportation literature reflects a steady research interest in hybrid discrete choice models, none of the studies examined applied this modeling approach to investigate the parking choice behavior. However, some novel findings suggest moving the analysis of parking choice behavior into the terrain of the hybrid modeling approach. For example, Ibeas et al. (2014) found that owners of new vehicles prefer to leave them in safer conditions, which certainly refers to an unobservable attribute which could be evaluated through a latent variable. Consequently, owing to the abundant evidence on the advantages of hybrid discrete choice models (Bolduc et al., 2008; Yáñez et al., 2010; Bahamonde-Birke et al., 2015), this paper studies both the influence of a Risk-averse attitude and a Positive car care attitude on parking choice behavior.

Unlike other works, this paper includes not only observable factors but also individual attitudes influencing parking choice in order to contribute to a better understanding of this topic. To the best of our knowledge, ours is the first study to incorporate a Risk-averse attitude and a Positive car care attitude on parking choice models. The model specification allowed for capturing population heterogeneity through the latent variables and their interactions with observable factors. The findings from the case study in Cartagena, one of the most popular city destinations in Colombia, corroborate the hypothesis that individual attitudes are crucial for parking choice and allow for defining parking policies relying on the heterogeneity of people.

After the present introduction, Section 2 discusses the antecedents of modeling parking choice behavior. Section 3, which contains the methodology, explains the research context, describes the sample and profile of the respondents, the indicators used to form the individual attitudes, the stated preference experiment, and the model formulation. Section 4 shows the models estimated and discusses the results. Finally, Section 5 summarizes the significant findings from the study and concludes the paper.

2. Modeling parking choice behavior

Most literature on the subject tends to analyze the role of observable factors on parking choice behavior mainly based on revealed and stated preference survey data to establish discrete choice models. Some key features arise from the literature review. In the first place, it is evident the importance of parking fee in parking choice behavior. For example, Hensher and King (2001) specified a nested logit model in order to investigate the role of parking pricing and supply by the time of day in whether to drive and park in Sidney CBD. They defined parking alternatives by hours of operation, a tariff schedule, and access time to the end destination from the parking station. The most important result was that the change in CBD parking share attributable to parking prices was 97%, compared with less than 3% attributable to supply by the time of day.

Secondly, the studies that include parking duration acknowledge the endogeneity of this attribute. Habib et al. (2012), based on the idea that parking is a key policy element that captures land use and transportation interactions in urban areas, investigated the relationship between activity start-times and parking choices. They considered parking duration as an endogenous attribute and specified a generalized extreme value model structure for the joint start-time and parking type choice. They found that parking availability and parking type choice play a significant role in activity-travel schedule formation, especially for the auto drivers. Kobus et al. (2013) also acknowledged the endogeneity of parking duration on the estimation procedure in order to study the choice between street and garage parking, considering an on-street parking premium.

In the third place, the inclusion of heterogeneity provides much better predictive power. For example, Anderson et al. (2006), investigating parking preferences among tourists in Newport, Rhode Island, incorporated taste heterogeneity and found that tourists share many preferences with commuters. According to their findings, like any other traveler, parking fee, access time to the destination and traffic congestion were significant for tourists. Van der Waerden et al., (2006) studied parking policies for Eindhoven University Campus, finding that frequent travelers, students, and users younger than 25 years old would change mode if parking charges were applied on parking lots that used to be free. Other studies, such as Ibeas et al. (2014) or Chaniotakis and Pel (2015), which additionally included the search time to find a vacant parking spot, also found that the inclusion of heterogeneity and differences in preferences increased the predictive capabilities of the parking choice models.

With the aim of examining specific policies, a large part of the studies derives subjective values of time, i.e. the willingness to pay (WTP) in order to save time searching for a vacant parking spot and for reaching the end destination. Ibeas et al. (2014), for example, provided an in-depth discussion of values of time. They found that values of time are significantly different for residents and visitors, and for low and high-income individuals. An interesting insight derived from the modeling is that time spent finding a space to park and the time from the parking to the destination have similar importance, except when considering the variability of tastes on the access time, in which case the time seeking a parking space appears to be more important. In a similar context, Anderson et al. (2006) showed that tourists are more likely to continue searching for parking if the driving is scenic, and they are willing to pay more for parking if the journey from the lot to their destination is scenic.