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Modeling the propensity to join carsharing using hybrid choice models and mixed survey data

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ABSTRACT

Carsharing combines the positive elements of both private and public transportation. This feature renders it attractive to a significant percentage of the population, especially younger people who do not own a car. To maximize the effectiveness of such systems, the characteristics of potential users have been investigated in this research.

The propensity of people to join a carsharing scheme is being modeled using mixed data collected from Internet and paper surveys. An ordered logit model is developed to model the willingness of young Greeks to join carsharing. Several types of explanatory variables are used, including demographic characteristics and travel attributes, but also the satisfaction of the commuters about their current travel patterns, which is included as latent attitude in the modeling framework. The combination of the two datasets aims to measure the difference of the variance of the error term, generated from the paper and Internet respondents; the latter are prone to be more positive in their responses, possibly in order to satisfy the interviewer. This is verified in the current research by the positive sign of the scale parameter applied at the utility function of the Internet-based data. The use of latent classes enhances the model estimation, by measuring the parameters that determine the respondents' unobserved, underlying behaviors.

The results demonstrate that people who use taxi for social activities, those with medium to low income, and the environmentally conscious, are more willing to join a hypothetical carsharing scheme. The results are compared with a 2013 study, in order to identify the advantages of using this advanced modeling framework.

1. Introduction

The always increasing generalized travel cost and the current economic difficulties that many households are experiencing, due to the crisis, has rendered car ownership a luxury good that many people cannot afford. Carsharing users enjoy the privacy of the car without incurring the cost of purchase. Moreover, the exact cost of their trip is known at the same time, avoiding the possible miscalculations that occur in private transport. The users pay a combination of a registration fee, a monthly amount and a cost per distance unit driven or time spent using the service.

In this paper, the research that begun by Efthymiou et al. (2013), where the authors analyzed the factors that affect the willingness to join car -or bike-sharing systems in Greece, is being extended. In Efthymiou et al. (2013), the authors, based on an extensive literature review of the available car and bike-sharing systems over the world, analyze the factors that affect car and bike ownership, and conclude in quantifying the factors that affect the potential to join car and bike sharing. The satisfaction of the respondents to their current travel patterns is, first, separately estimated, using the traditional framework of the ordered logit model. Then, the potential to join these schemes in three different time frames (immediately, within the first few years and eventually) is modeled.

The objective of this paper is to model the propensity of people to join carsharing, using mixed Internet/paper survey data and hybrid choice and latent variable model. In order to measure the difference of the variance of the error term between the Internet and paper surveys, every coefficient in the utility function of the ordered logit model for the Internet data is multiplied by the same scale parameter. Moreover, the satisfaction of the respondents about their current travel patterns has been included as a latent

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behavioral construct in the main utility function. The motivation behind this structure is to reveal and quantify the characteristics that determine the latent behavior, leading to a more detailed and accurate joined model. The estimation of all the utility functions is performed simultaneously, and therefore more efficiently.

The remainder of this paper is structured as follows. The next section describes carsharing schemes around the world focusing on studies that aim to identify the characteristics of carsharing users. The following Section describes the hybrid choice and latent variable model, and the mixed Internet/paper based survey data. The next Section analyzes the methodology that was followed, beginning with the data collection and then describing the model specification and the estimated coefficients. Finally, in the last Section, conclusions and recommendations for further research are presented.

2. Carsharing systems around the world

The basic idea of this scheme is that the users are members of a system, where they can utilize vehicles provided by a fleet, by paying an amount of money per time or distance of usage. The user can book a vehicle on-line, or via a smartphone application, and can then gain access to it through a personal identification infrastructure (e.g., a reservation password). In its conventional form, the service requires the return of the vehicle to the parking lot from where it was hired (two-way carsharing), while in its more flexible form, the user can leave the car to any parking lot reserved for the company, which can be different from the one that the trip begun (one-way carsharing). These two systems usually complement each other. Shaheen et al. (2015) found that in the Americas, 70% of two-way carsharing operators view one-way as complementary to their service, 19% perceive it as a competitor, and 12% as both a competitor and complement.

While carsharing usage is currently mainly addressed to the general public, it is believed than in the future the majority of users will be enterprises (Rydén and Morin, 2005). The companies would provide their staff with the opportunity to use the service, in order to stop using their private cars for business trips. As a result, carsharing could complement or substitute part of the leasing usage on the business domain (Ciari et al., 2009). Other innovative approaches have also been tested. For example, Steininger and Bachner (2014) report on a two-year field study where car-sharing vehicles were used for commuting purposes (from home to rail station and back). The problem with such applications is that the car then remains idle for most of the day. In this case, the rail company arranged for the vehicles to be used during the day by businesses, such as postal services and mobile health care.

Informing potential users about carsharing systems is of major importance for the promotion of the scheme. Clavel et al. (2009) found that, in France, 60% of the participants of a survey were not aware of the service, even in the Paris area, where carsharing is operating for more than 10 years. Moreover, 28% of the respondents was confounding the term carsharing with carpooling, considering that the first refers to the second.

Shaheen and Martin (2007) performed a survey in Beijing, when the carsharing scheme was still in early stages of operation, and found that 40% of the respondents were not familiar with the scheme. In a similar research in Greece (Efthymiou et al., 2013), where the system is still absent, 52.4% of the respondents declared ignorance. It is noted that there are successful and popular case studies of car-sharing in cities with similar characteristics, such as Rome (Musso et al., 2012).

Other initiatives like Getaround (www.getaround.com) offer peer-to-peer solutions through websites and smartphone applications. In these systems, car-owners can rent their vehicles for the time they don't use it.

The demographic characteristics of carsharing users have been investigated by a number of studies. In the recent literature, it is documented that the composition of the carsharing members differs from city to city. Carsharing combines the positive characteristics of public transport and car, but it also attracts bike users and people travelling on foot. The variability of carsharing users' travel patterns, and the need to understand the factors that determine their decision to join, maintains the research interest around this subject high. The number of carsharing members is estimated to be approximately 1.7 millions in 27 countries (Steinberg and Vlasic, 2013).

Burkhardt and Millard-Ball (2006) found that in North America the majority of the users are between 25 and 35 years old, while there are not many members below the age of 21, because of driving license restrictions. The members are usually highly educated and environmentally aware, while 50% of them have relatively high income ($>$ 60,000$). Finally, the great majority (72%) live in households without any available car. Carsharing system providers suggest the use to persons who drive between 10,000 to 16,000 km per year, while the service remains a choice of students and low-income households (Burkhardt and Millard-Ball, 2006). Zhou et al. (2011) concluded that car owners with high income are not interested in the service, and opposite to Burkhardt and Millard-Ball (2006), the education level is not a significant determinant of the willingness to join the scheme. Another study (TCRR, 2005) found that users are mainly male, members of low-size households, between 30 and 40 years old, of high education level. Stillwater et al. (2008) concluded that the users are members of households owning only one car, while solo drivers are not willing to join the scheme. Kopp et al. (2015) found that compared to non-members, free-floating carsharing members are of significantly higher educational and income level, and have lower car availability, while they did not find an impact of the household size.

Millard-Ball et al. (2006) found that many members of carsharing schemes either cancel the purchase of their car or sell it after joining the scheme. It has been estimated that in, North America, carsharing resulted to the removal of 90,000–130,000 cars from the streets (Millard-Ball et al., 2006), resulting to increasing the number of parking lots and reducing the air pollution and traffic congestion (Rodier and Shaheen, 2004). Muheim and Partner (1990) found that in Europe 15.6–31.6% of carsharing users sold their private car, and about 13–16.2% cancelled the purchase. Another study by Ryden and Morin (2005) that was conducted in Belgium and Bern, found that 21–34% of people sold their car after joining a carsharing scheme. Other studies in Northern America concluded that the equivalent percentage reaches 68%, which can be explained since car ownership plays more important role in daily transport there, and as a result it is expected that the margins of car usage reduction are higher (BoTS, 2001). According to the same research, only 8% of American households do not own car, which is the main travel mode for short and long trips. However, these findings are based on stated preference surveys, which are vulnerable to biases, either because of the difference between the stated and the final decision of the respondents, or because of the mis-execution of the experiment (Bonsall, 2002; Wardman, 1988).

Carsharing companies invest on the development of new user-interface technologies in order to increase the flexibility of the users and attract more members. The results of a study that was conducted by Nerenberg et al. (1999) in San Francisco between 1996 and 1998 show that women who are attracted by electric carsharing are mainly driven by environmental incentives, while men because they found the technical perspective of the service interesting, revealing that the system should not only be functional, but also have technological and environmental aspects.

As carsharing systems mature, researchers focus on optimizing their operations. For example, Boyaci et al. (2015) present an