Analyzing the adoption and usage frequency of shared E-scooters: a zero-inflated ordered probit modelling approach

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Introduction

Research indicates the promotion of micro-mobility as a key to reducing the share of car-based trips. Empirical evidence shows that most of the car-based trips in the U.S. are short enough that can be alternatively performed using micro-mobility options, if the barriers hindering the way of switching from a mode of transportation as comfort as private cars are resolved (Zarif et al., 2019). The literature suggests as a practical solution the integration of the various micro-mobility options, including ducked bike-sharing programs such as Divvy bikes in the city of Chicago, Illinois, or the duck-less service offered by HOPE for the greater Chicago land, Illinois (Fu and Farber, 2017; Gu et al., 2019; Li et al., 2019).

Walking and biking, as the two most active micro-mobility options, provide noticeable health benefits as well; yet, their share remains understandably low due partially to the various physical limitations of people. As new forms of micro-mobility services, on the other hand, the Shared electric scooter (shared E-scooter) service helps their users benefit from many of the active modes' advantages at the same time with ease of use to perform short- to medium-distance trips. Unlike services like ducked shared bikes, shared E-scooters are also of the benefit of offering their riders opportunities to perform their trips with flexibility in their pick-up and drop-off locations.

Although this new micro-mobility option shows potential, it is not clear yet whether or not it will be adopted by individuals for everyday use. The City of Chicago launched a shared E-scooter pilot program starting Jun 15, 2019, and permitted ten companies to operate around 2000 E-scooters across the pilot area encompassing the University of Illinois at Chicago (UIC) campus; the pilot program ended Oct 15, 2019. The present study is to analyze the usage pattern of shared E-scooters during the pilot program. Based on an online survey of potential users of shared E-scooters among the UIC students, faculties, and employees, we estimated a zero-inflated hierarchical ordered probit (ZIHOPC) model (Greene and Hensher, 2010) to analyze .

Data

The online survey was designed through the platform of Qualtrics and the data was collected in three waives: (1) the users of shared E-scooters on the UIC campuses were intercepted and handed the survey card which included the survey link , (2) individuals on the UIC campuses were intercepted and asked if they used shared E-scooters before, and if they did, they were handed the survey card, and 3) an email was sent to the UIC students, faculties, and employees containing the survey link. The dependent variables used in the present study are derived from three questions in the survey:

1- Have you ever used shared E-scooter in Chicago?
2- How frequent did you use shared E-scooter in the past month?
3- Do you have a plan to use shared E-scooter in future?

Methodology

Due to the ordinal nature of the frequency of use of shared E-scooters, this study applies a version of ordered probit model. In a typical situation, an individual decides whether or not to adopt shared E-scooter, then, if so, decides how much (Greene and Hensher, 2010). The first decision is a binary choice, while the intercity outcome would be ordinal. Besides, the spike at zeros (i.e., either did not use shared e-scooters) shows the excessive number of non-users and suggests a type of latent class arrangement in the population. The excessive number of do not use observations can be associated with the fact that many individuals either did not have enough time/access (due to short pilot program in Chicago) to adopt this new micro-mobility option (i.e., potential users) or they prefer not to use even when it is a feasible option for them (Greene and Hensher, 2010). To address this issue, we adopt Zero-inflated hierarchical ordered probit (ZIHOPC) model (Greene and Hensher, 2010) to simultaneously estimate individuals' shared E-scooter adoption decision as well as frequency of use.

This model splits the population into two regimes that their decision outcomes relate to potentially two different sets of explanatory variables. Therefore, this model consists of two stage. The first stage (known as participation equation) deals with a binary choice of whether an individual is a "potential user" or not. The second stage (known as activity equation) corresponds to the frequency of use of shared E-scooters that is estimated with an ordered probit model as follows (Washington et al., 2010). This model also allows for systematic variations in the thresholds across decision-makers (Greene and Hensher, 2010).

Results

Our results show that sociodemographic variables, travel lifestyle, individuals attitudes, and built environment are good predictors for adoption and frequency of use of shared E-Scooters in Chicago. More specifically, individuals who have active mobility style (i.e., walk and bike more frequently) are more likely to adopt and use shared E-Scooters. Besides, our findings indicate a positive correlation between the use of public transit and the use of shared E-Scooter, suggesting that shared E-Scooters might be a preferred mode for the first mile-last mile part of transit trips.

Also, we found that individuals who have access to smartphone with data and those who believe that they know more than others about latest technologies are more likely to adopt these technology-based services and to use them more frequently, which is consistent with expectations. However, the interaction with the phone application was turned out to negatively affect the adoption of shared E-scooters.

Moreover, our results revealed that subjective well-being is associated with the adoption and frequency of use of shared E-scooters. More specifically, individuals who perceive that the trip by shared E-Scooters was either mentally or physically activating and pleasant to them use shared E-Scooters more frequently. Thus, the results further support the idea of positive utility of travel through subjective well-being.

Conclusion

This study helps us not only simulate the behavior of micro-mobility transport users in the transportation network, but also provide policy implications to increase the positive benefits of the system such as vehicle emissions reduction, physical activity increases, and subjective well-being enhancement in the community.

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