The Adoption of Ridehailing and Its Impacts on Travel Demand

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This document discusses the adoption of ridehailing services such as Uber and Lyft in California, and the changes that the adoption of these services is causing in travel demand and the use of other travel modes.

Introduction

Transportation is changing at an unprecedented pace. The increased availability of locational data and smartphone applications, together with other information and communication technologies, are transforming transportation supply and demand in many ways. Among these technology-enabled options, modern shared-mobility services merge the advantages of mobile communications and instant reservations with the principles of the sharing economy. In doing so, they separate access to transportation services from the fixed costs of auto ownership and provide cheaper options compared to driving one's own car for large groups of travelers (Davidson and Webber, 2017). These technology-enabled services can affect travel behavior in multiple ways, such as by increasing the number of available options for a trip, reducing travel uncertainty, increasing the attractiveness of living in zero-/low-vehicle households, and potentially increasing the efficiency of the transportation system.

Shared-mobility services range from *car-sharing*, including *fleet-based round-trip* and *one-way services* such as Zipcar and Car2Go or *peer-to-peer* services such as Turo, to *ride-sharing* services, including *dynamic carpooling* such as Carma and *on-demand ride services* such as Uber and Lyft, as well as *bike-sharing* services. The availability of each of these services varies across different cities and regions (Shaheen et al. 2016; Hallock and Inglis 2015). One of the most rapidly growing – and controversial – forms of shared-mobility services is on-demand ride services, also known as ride-sourcing, ridehailing, or transportation network companies (TNCs), such as Uber and Lyft in the U.S. market. On-demand ride services are similar to taxi services in that they connect travelers requesting a ride with the network of available drivers through a smartphone application. They are different from dynamic ride-sharing services such as Carma in the U.S. or BlaBlaCar in Europe, because drivers who participate in the latter only offer rides to other travelers (with similar destinations) along the route of a trip the driver would be taking anyway. Instead, drivers of on-demand ride services "chauffeur" passengers to their destination, independently from the drivers' own travel needs.

Even though ridehailing is expanding quickly in many developed and developing countries, information about the adoption rate, frequency of use and the potential effects of these services on the use of other modes is still limited. The availability and popularity of these services are quickly growing. So do their impacts on transportation demand and traffic congestion in cities. For example, a recent study of ridehailing services in the City of San Francisco showed that the share of total trips made with these services (approximately 170,000 trips per day) exceeds 15% of all trips inside the city of San Francisco on a typical weekday (SFCTA 2017), which is equivalent to 20% of total vehicle miles traveled (VMT) inside the city of San Francisco, and 6.5% of total VMT including both intra- and inter-city trips. The rapid growth in the adoption and frequency of use of ridehailing poses significant challenges for transportation planners and policy makers. However, to date, the factors affecting the use of new shared-mobility services and the potential impacts that they have on the other components of travel behavior and vehicle ownership are still largely unexplored. The main reasons that limit transportation researchers in their ability to answer these questions are (1) the lack of data on users, the nature of their use, and the changes in travel behavior it causes; (2) the uncertainty over the evolution and eventual maturation of shared-mobility services and their impacts, and (3) the heterogeneity in the potential impacts owing to differences in the local context and the characteristics of the users. Policy makers and transportation planners face a significant challenge in their efforts to regulate transportation and lead it towards goals of sustainability, equity, and safety.

Overall the behavioral studies that have focused on ridehailing services to date address one of these two main research questions: (1) What factors affect the adoption and/or frequency of use of ridehailing; and (2) How the adoption of ridehailing affects individuals' vehicle ownership and various components of travel behavior, including mode choice and vehicle miles traveled.

In this brief document, we first present the results of our current research on the adoption and frequency of use of ridehailing and then discuss how these services may reshape the future of transportation.

Adoption of Ridehailing

This research builds on a large research effort undertaken to investigate the relationships among millennials' residential location, individual attitudes, lifestyles, travel behavior and vehicle ownership, the adoption of shared mobility services, and the aspiration to purchase and use a vehicle vs. use other means of transportation in California, which was designed to overcome some of the limitations from previous studies. We collected a rich dataset in fall 2015 with a comprehensive online survey administered to a sample of 2400 California residents, including millennials (i.e. young adults, 18-34) and members of the preceding Generation X (i.e. middle-age adults, 35-50). The data collection is part of a longitudinal study of emerging transportation trends in California, designed with a rotating panel structure, with additional waves of data collection planned in spring 2018. We used a quota sampling approach to recruit respondents from each of the six major regions of California and three dominant neighborhood types (urban, suburban and rural), while controlling for sociodemographic targets including household income, gender, race and ethnicity, and presence of children in the household. For additional information on the survey content and data collection, see Circella et al. (2016).

In order to investigate the way the adoption of on-demand ride services varies among different segments of the population, we estimated a model of the adoption of Uber/Lyft (Alemi et al., 2017), finding that better-educated and higher income older millennials are more likely to adopt ridehailing, in line with the findings from previous studies based on descriptive statistics (e.g. Rayle et al. 2014; Taylor et al. 2015; Shared-Use Mobility Center 2016). This seems also consistent with the other travel choices of the members of the millennial generation, who tend to more often live in zero-/lower vehicle household, drive less and use non-motorized means of transportation more often compared to the previous cohorts at the same age (Blumenberg et al. 2016; Kuhnimhof et al. 2012; Frändberg and Vilhelmson 2011), likely due to a combination of (a) generational differences in lifestyles and individual attitudes, (b) period effects and economic conditions and (c) stage in life cycle and residential location. We also found that individuals who do not work nor study and those of Hispanic origin are less likely to use ridehailing (Alemi et al., 2017). Further, we have employed a latent class choice model to better understand the factors affecting the use of on-demand ride services, thorough controlling for individuals taste heterogeneity and variations (Alemi et al. *under review*): Three latent classes were identified based on individuals' lifestyles and their stage in life, and showed that the class that is largely composed of higher educated independent millennials (i.e. millennials who have already established their own households) has the highest adoption rate, while the adoption of ridehailing is the lowest among the members of a class that is largely composed of less affluent individuals with lower education.

The majority of studies about ridehailing services confirmed the role of built environmental variables on the adoption of ridehailing. In our analyses (Alemi et al. 2017; Alemi et al. *under review*), we found that living in urban neighborhood is associated with higher likelihood of being an Uber/Lyft user. Among various built environment characteristics, the degree of land use mix, regional auto accessibility, and public transit availability and quality have the strongest impacts on the adoption of ridehailing. Individuals with higher familiarity with modern technologies (e.g. use of smartphone to access information on transportation services, and users of carsharing), and frequent long-distance travelers (in particular those that travel often by plane) more likely use ridehailing. This is also true for individuals with stronger attitudes towards pro-environmental policies, technology embracing, and variety seeking in life (Alemi et al., 2017).

Frequency of Use of Ridehailing

Few studies have investigated the factors affecting the frequency of use of ridehailing services. A recent study from the Pew Research Center (2016) showed that out of the 15% respondents in their sample who reported that they have used ridehailing services (N=4,787), only 3% and 12% reported that they have used ridehailing services on a daily and weekly basis, respectively. The research confirmed that younger adults tend to use Uber/Lyft more frequently. Similarly, Feigon et al. (2016) showed that the most frequent ridehailing users live in middle-income households (annual income of $50 to 75K). Both studies showed that the frequent users of Uber/Lyft are more likely to live in households with lower-than-average numbers of vehicles per driver and to rely on other means of transportation, including public transit or active modes.

Using the information in the California Millennials Dataset, we estimated (a) an ordered probit model with sample selection and (b) a zero-inflated ordered probit model to understand the factors affecting the frequency of use of ridehailing services (Alemi et al., 2018). The results of both models indicate that sociodemographic variables are only good predictors for the adoption of on-demand ride services, and not for the frequency of use of these services. Among the various built environment variables, we find that land use mix and activity density can impact the frequency of use of these services. The impact of other built environment variables, including geographic region and public transit quality and connectivity were only significant in the adoption model. However, the impacts of some of these built environment attributes might have been masked by to the coarse classification of the frequency of use on-demand ride services that was used for this study or, more importantly, by the confounding effects of variables such as mobility/modality styles and other factors affecting individuals' residential location, with which they are correlated.

We found that individuals who use a smartphone in connection to their travel (in particular those who use smartphone to find new places and to navigate in real-time) are more likely to adopt and use these technology-based services more frequently. The results of this study indicate that there is a competition among different new shared-mobility services. Those who used carsharing services (e.g. Zipcar) before are also more likely to adopt ridehailing services. However, frequent users of carsharing tend to use ridehailing services less frequently. Among various travel-related behaviors and decisions, we found that frequent long-distance travelers (in particular those with higher shares of long-distance leisure trips made by plane) and individuals who live in a zero-vehicle household tend to use on-demand ride services more often. We also showed that the frequency of Uber/Lyft use decreases for the individuals who evaluated the preference to use (have) their own vehicle as strongly limiting factors in using these services (Alemi et al., 2018).

Impacts of Ridehailing on the Use of Other Travel Modes

In addition to understanding the factors affecting the adoption and frequency of use of ridehailing services, there is interest in understanding the degree to which current Uber/Lyft users will continue to use on-demand ride services as they transition to later stages of life and as they move to other residential location (Taylor et al. 2015). Further, the emergence of other technology-enabled transportation services such as pooled ridehailing services, and the future introduction of autonomous and connected vehicles raise questions about the eventual permanence of the observed travel patterns and of how shared mobility will continue to reshape transportation in future years. In this section, we briefly discuss how the use of on-demand ride services affect the use of other means of transportation using data collected in California as part of our research project.

Previous research on the impacts that ridehailing services have on other components of travel behavior is still limited, largely because of the lack of longitudinal data or robust analytical approaches that capture the causal relationship among the use of on-demand ride services and different components of travel behavior. Other important factors that pose significant challenges to understand the way Uber/Lyft impact travel behavior are the evolving nature of these services and the eventual maturation of their effects over time, which limits the availability to evaluate these effects in the short term. Most studies in this area, to date, are based on the analysis of descriptive statistics and self-reported behavioral changes, and are based on the analysis of convenience samples. Accordingly, it is often difficult to extrapolate the findings from these studies and apply them to the entire population

Recent studies indicate that the impact of shared-mobility services on other means of transportation may vary based on the type of services available, the local context, and the characteristics of the users (Taylor et al. 2015; Circella et al. 2016). For example, 40% of TNC users in San Francisco reported that they reduced their driving due to the adoption of on-demand ride services (Rayle et al. 2014). Further, depending on local circumstances, travelers may use on-demand ride services as a substitute for or as a complement to the use of public transit. For example, a survey of 4,500 users of shared-mobility services revealed that frequent users of shared mobility tend to use public transit more often and are more multimodal than non-users. Some of this relationship may be due to the correlation of both behaviors with other variables and various characteristics of the individuals and their households, such as low-car ownership or living in more accessible locations. A study carried out by Shared-Use Mobility Center (2016) found that the majority of trips made by on-demand ride services occurs between 10 pm and 4 am, when public transit either runs very infrequently or does not run at all. This finding suggests a complementarity effect. On the other hand, public transit may lose its riders as the share of ridehailing increases: A study of seven large U.S. metro areas showed that these services tend to substitute 6% and 3% of the trips that would have been otherwise made by bus and light rail, respectively (Clewlow and Mishra 2017). However, it is not yet clear the extent to which the adoption of shared-mobility services causes an increase (or decrease) in transit use, as opposed to both of those conditions being caused by other variables (such as residential location, age/stage in lifecycle, and vehicle ownership).

We further expanded our analysis of the self-reported behavioral changes in response to the use of ridehailing employing a latent classification approach. The latent-class analysis of self-reported behavioral changes provides more meaningful and scientifically interesting results against the noisy background compared to other approaches. The preliminary result of this analysis is presented in Figure 1.

As indicated in Figure 1, three rather well defined latent-classes were identified in this preliminary latent-class analysis:

(1) The first class (which accounts for 53% of individuals in our sample who used Uber/Lyft) predominantly comprise younger independent millennials who tend to live in urban neighborhood with high walk and transit access. The members of this class travel frequently using a combination of travel options (i.e. they are rather multimodal) and use ridehailing more often compared to the members of all other classes. The use of ridehailing affects their use of other modes of transportation. In particular the members of this class reported that they have reduced their amount of driving, use of public transportation and active modes.

(2) The members of the second class mainly include suburban dwellers who live in vehicle sufficient households (i.e. the ratio of car per household driver is the highest among the members of this class). The members of this class are highly car-dependent individuals who also reported the strongest attitudes towards vehicle use and ownership. The members of this class also tend to be among the most frequent air travelers, which leads to the speculation that their use of ridehailing is often adopted as a replacement for other modes as a way to travel to/from the airport. This class accounts for approximately 37% of the ridehailing users in our data: they used ridehailing as a perfect substitute to the use of personal vehicle.

(3) The last class also includes individuals who predominantly live in the suburbs with low public transportation and walk accessibility. This group largely comprises older Gen Xers that have more pro-environmental attitudes. However, the members of this class report that they like biking more than the other classes and they also tend to be surprisingly multimodal anytime they can, despite the low-accessibility location where they live. This tiny class of individuals (which only accounts for 10% of the individuals who reported that they have used ridehailing in our sample) reported that the use of ridehailing had a complementary effect on the use of public transportation: The members of this class reported that they reduced their driving and active modes but they significantly increased their use of public transportation through using Uber/Lyft as an access mode to public transportation stations and stops.

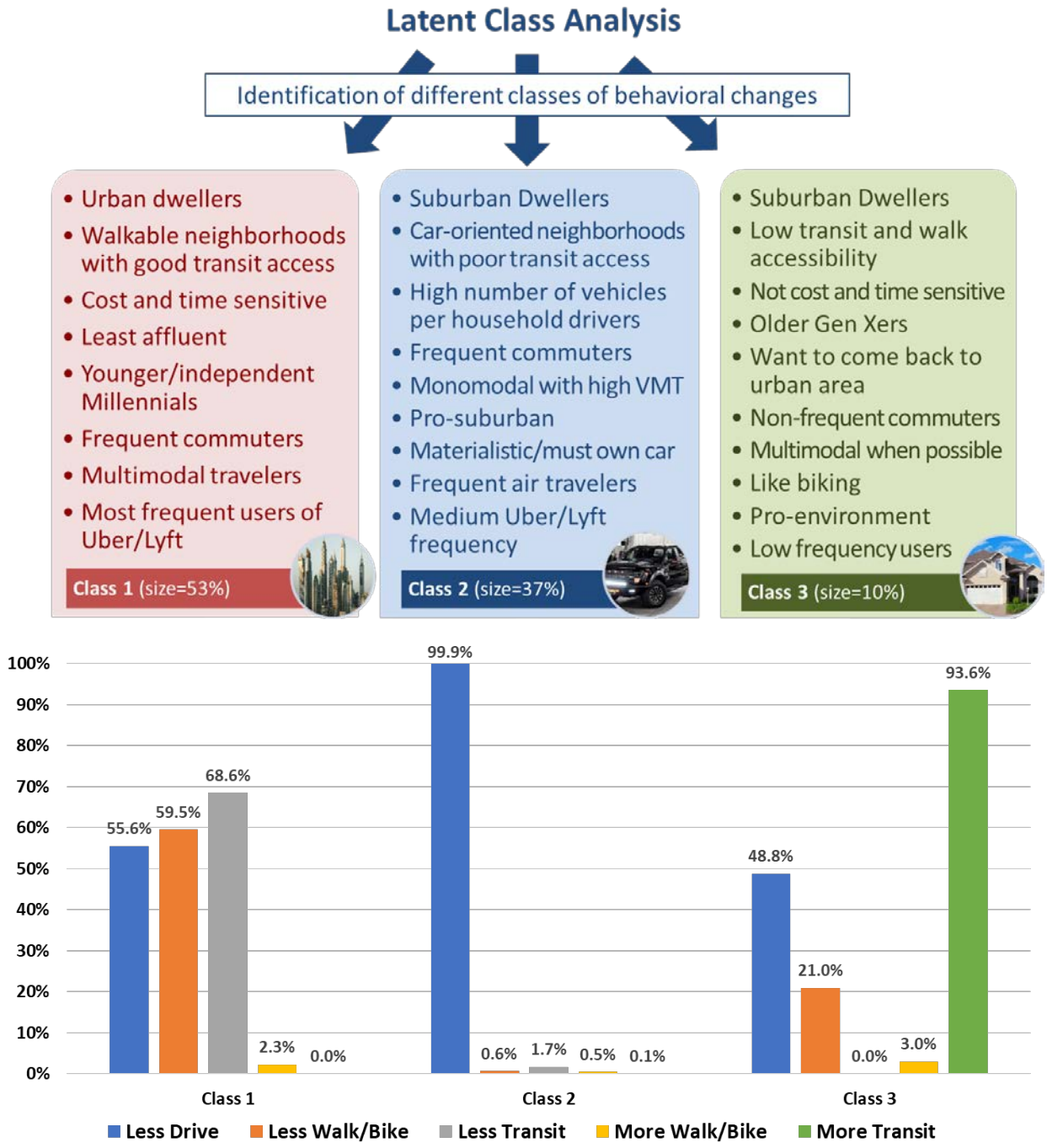

Figure 1: Latent classes of ridehailing users and impacts on the use of other travel modes.

Ridehailing and the Future of Transportation

The initial single-passenger ridehailing services tend to reduce the amount of driving among both frequent and non-frequent users, and substitute for some trips that would have otherwise been made by public transportation or active modes. The substitution effect is stronger among the frequent users of Uber/Lyft, who are more likely to live in zero-/lower vehicle household and are more multimodal. Thus, the net VMT impacts of single-passenger services are uncertain but probably positive, given that reduced trips by private vehicles are offset by the use of ridehailing cars, a reduction in public transportation use and some deadheading by Uber/Lyft drivers. Other studies also affirm that single-passenger services have non-trivial effects on VMT, possibly increasing it (Schaller 2017; Clewlow and Mishra 2017).

In terms of public benefits, we also found that frequent users of on-demand ride services are more willing to dispose of one or more of their household's vehicle(s). However, the direction of this relationship is not clear: in the next stage of this research we plan to better explore this topic by estimating joint models of the adoption of ridehailing services and other components of travel behavior, testing different causality structures, and comparing the magnitude of the marginal effects of each endogenous variable.

Moving forward, there will be increasing need to coordinate policy making and incentives in order to harvest the potential benefits of these services, while reducing the negative effects. The greatest public benefits would come from pooling – reduced traffic congestion, road infrastructure costs, greenhouse gas emissions, and parking demand – which suggests policymakers need better understanding of who might use pooling services and what incentives and policies would be most effective at encouraging them to do so. In our follow-up study we will be addressing these questions.

Perhaps more challenging is the issue of public transportation. Single-traveler services inevitably divert some passengers from public transportation, undermining an important public service. Our study and others provide some insights into this phenomenon, but the effects are still uncertain due to large variability across demographic groups, transit service levels, and limited data availability. More positively, though, shared mobility can be integrated with public transportation to provide better overall service, with lower overall economic and environmental costs (especially since public transportation is often called upon to offer services in lightly populated areas that could be served at much lower cost by a variety of shared demand-responsive services). Many U.S. public transportation operators began partnering during recent years with Uber, Lyft and others to reduce overall costs and improve accessibility (Polzin and Sperling, 2018). In some case they themselves are even offering demand-responsive services in vans and small buses (referred to as microtransit).

More studies are needed to help researchers and professionals understand the on-going transportation transformation and how to guide it to a better future. When driverless vehicles become available, the challenges of managing travel will become even more complex, enhancing the need for more research on travel behavior.

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