Disruptive Transportation:
The Adoption, Utilization, and Impacts of Ride-Hailing in the United States

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Executive Summary

Ride-hailing services have experienced significant growth in adoption since the introduction of Uber, in 2009. Although business models to support the sharing of vehicles (e.g., carsharing) have been present in the United States for more than 15 years, their adoption has been somewhat limited to niche markets in dense, urban cities or college campuses. To date, carsharing has attracted over 2 million members in North America and close to 5 million globally.[1] Conversely, this new model of "shared mobility" is estimated to have grown to more than 250 million users within its first five years.[2]

The rapid adoption of ride-hailing poses significant challenges for transportation researchers, policymakers, and planners, as there is limited information and data about how these services affect transportation decisions and travel patterns. Given the long-range business, policy, and planning decisions that are required to support transportation infrastructure (including public transit, roads, bike lanes, and sidewalks), there is an urgent need to collect data on the adoption of these new services, and in particular their potential impacts on travel choices.

This paper presents findings from a comprehensive travel and residential survey deployed in seven major U.S. cities, in two phases from 2014 to 2016, with a targeted, representative sample of their urban and suburban populations. The purpose of this report is to provide early insight on the adoption of, use, and travel behavior impacts of ride-hailing. The report is structured around three primary topics, key findings of which are highlighted below.

Adoption of Ride-Hailing

- In major cities, 21% of adults personally use ride-hailing services; an additional 9% use ride-hailing with friends, but have not installed the app themselves.
- Nearly a quarter (24%) of ride-hailing adopters in metropolitan areas use ride-hailing on a weekly or daily basis.
- Parking represents the top reason that urban ride-hailing users substitute a ride-hailing service in place of driving themselves (37%).
- Avoiding driving when drinking is another top reason that those who own vehicles opt to use ride-hailing versus drive themselves (33%).
- Only 4% of those aged 65 and older have used ride-hailing services, as compared with 36% of those 18 to 29.
- College-educated, affluent Americans have adopted ride-hailing services at double the rate of less educated, lower income populations.
- 29% of those who live in more urban neighborhoods of cities have adopted ride-hailing and use them more regularly, while only 7% of suburban Americans in major cities use them to travel in and around their home region.

- Among adopters of prior carsharing services, 65% have also used ride-hailing. More than half of them have dropped their membership, and 23% cite their use of ride-hailing services as the top reason they have dropped carsharing.

Vehicle Ownership and Driving

- Ride-hailing users who also use transit have higher personal vehicle ownership rates than those who only use transit: 52% versus 46%.
- A larger portion of "transit only" travelers have no household vehicle (41%) as compared with "transit and ride-hail" travelers (30%).
- At the household level, ride-hailing users have slightly more vehicles than those who only use transit: 1.07 cars per household versus 1.02.
- Among non-transit users, there are no differences in vehicle ownership rates between ride-hailing users and traditionally car-centric households.
- The majority of ride-hailing users (91%) have not made any changes with regards to whether or not they own a vehicle.
- Those who have reduced the number of cars they own and the average number of miles they drive personally have substituted those trips with increased ride-hailing use. Net vehicle miles traveled (VMT) changes are unknown.

Ride-hailing and Public Transit Use

- After using ride-hailing, the average net change in transit use is a 6% reduction among Americans in major cities.
- As compared with previous studies that have suggested shared mobility services complement transit services, we find that the substitutive versus complementary nature of ride-hailing varies greatly based on the type of transit service in question.
- Ride-hailing attracts Americans away from bus services (a 6% reduction) and light rail services (a 3% reduction).
- Ride-hailing serves as a complementary mode for commuter rail services (a 3% net increase in use).
- We find that 49% to 61% of ride-hailing trips would have not been made at all, or by walking, biking, or transit.
- Directionally, based on mode substitution and ride-hailing frequency of use data, we conclude that ride-hailing is currently likely to contribute to growth in vehicle miles traveled (VMT) in the major cities represented in this study.

1. Introduction

The emergence of shared mobility services, such as Uber, Lyft, and Zipcar, are disrupting established transportation business models. The notion of "shared mobility" is part of a broader concept often called the "sharing economy" through which information technology has enabled the shared use of assets and services, ranging from housing (Airbnb) to small jobs and tasks (TaskRabbit). In this report, we focus our discussion on the *sharing of vehicles* through carsharing (e.g., Zipcar, car2go) and ride-hailing (e.g., Uber, Lyft). Through the collection of a large, representative sample of survey respondents in seven major metropolitan areas, we explore the adoption, utilization, and early impacts on travel behavior of shared mobility services.
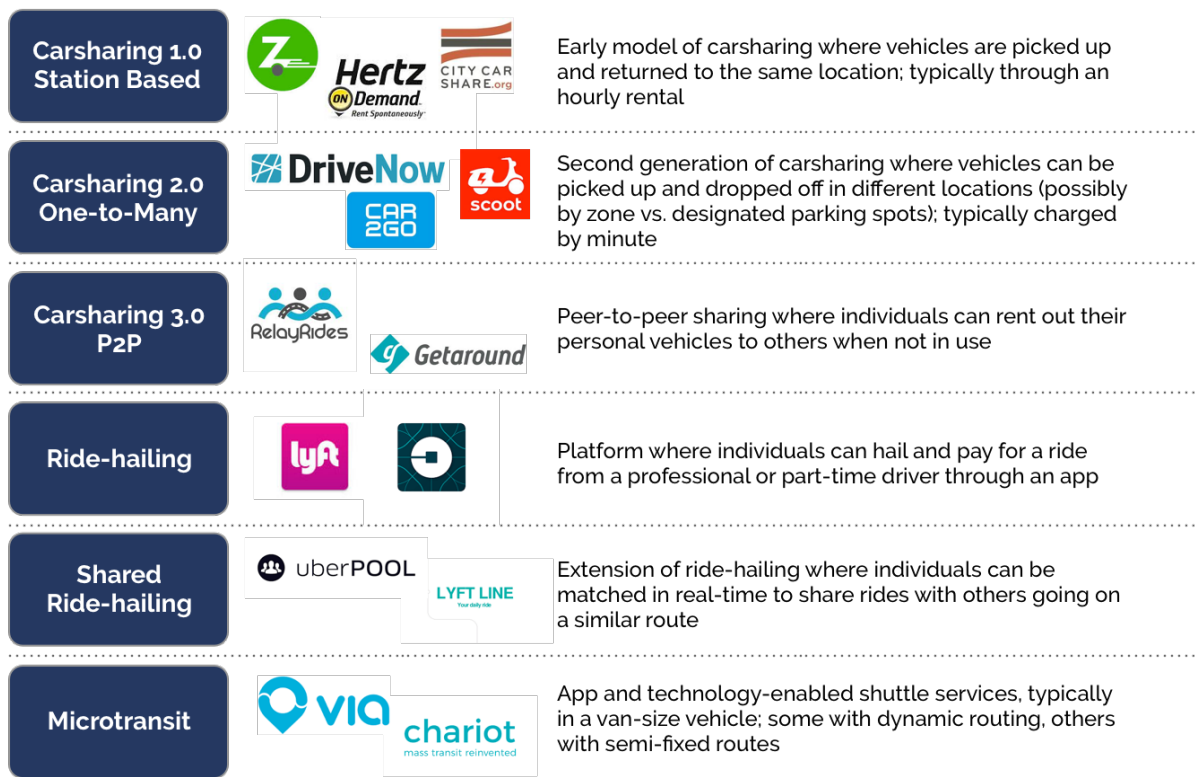
The rise of ride-hailing has sparked significant debate in cities around the world on a variety of issues including how they should be regulated, their safety implications, and how they influence travel behavior. Some suggest that shared services help reduce vehicle ownership and increase use of public transit, while other evidence suggests that they may lure riders away from transit and add to already congested streets.[3] The existing research on how ride-hailing influences travel behavior is somewhat limited due in large part to the recent, rapid growth of these services, and the lack of publicly available data for transportation planners and researchers to assess how, when, and why these services are utilized.

Shared Mobility: A Changing Landscape

First, we begin with a brief overview of the evolution from traditional carsharing programs to ride-hailing services, and the distinct features of these business models. In prior transportation literature and in the public sphere, it has been common to bundle these services and their associated impacts together. However, for reasons explained throughout this report, we believe it is important to distinguish between the different models and their impacts. Figure 1 presents the evolution of shared mobility services over the past two decades.

Traditional carsharing models, such as Zipcar, emerged in commercial form in the late 1990s in the United States. Through carsharing, individuals or households typically joined a member-based program through which they gained as-needed access to a vehicle that they then drove themselves. Two strategic advantages of early carsharing programs included the following: 1) carsharing vehicles were typically located in accessible locations throughout a dense, urban region; and 2) members were able to borrow the vehicles on a short-term hourly basis.[4]

Figure 1. The evolution of shared mobility services

Category	Providers	Description
Carsharing 1.0 Station Based	Zipcar, Hertz On Demand, City Car Share.org	Early model of carsharing where vehicles are picked up and returned to the same location; typically through an hourly rental
Carsharing 2.0 One-to-Many	DriveNow, CAR2GO, scoot	Second generation of carsharing where vehicles can be picked up and dropped off in different locations (possibly by zone vs. designated parking spots); typically charged by minute
Carsharing 3.0 P2P	RelayRides, Getaround	Peer-to-peer sharing where individuals can rent out their personal vehicles to others when not in use
Ride-hailing	lyft, Uber	Platform where individuals can hail and pay for a ride from a professional or part-time driver through an app
Shared Ride-hailing	uberPOOL, LYFT LINE	Extension of ride-hailing where individuals can be matched in real-time to share rides with others going on a similar route
Microtransit	VIA, chariot mass transit reinvented	App and technology-enabled shuttle services, typically in a van-size vehicle; some with dynamic routing, others with semi-fixed routes

Although traditional carsharing programs continue to be popular topics of transportation research and public discourse, total North American carsharing members in 2016 was estimated to be 2 million,[1] less than 0.7% of the current U.S. population. Based on these figures, we suggest that traditional carsharing services continue to serve a fairly niche market. However, the initial disruption of carsharing programs has spurred the development of similar programs by rental car companies (Hertz 24/7) and major automakers (Daimler's car2go in 2008, BMW's ReachNow – formerly DriveNow in 2011). An interesting new feature of the latter carsharing models is the ability to pick up a car at one location and drop it off at another spot or service area (one-way or free-floating carsharing).

The widespread adoption of smartphones embedded with GPS, combined with the availability of digital road maps through APIs, provided the necessary enabling technologies for ride-hailing services. Uber was one of the first services to emerge in 2009, however several similar companies have also entered (and some departed) this new market in subsequent years (Sidecar, Hailo, Lyft, Didi Kaudi). The common feature of ride-hailing services is the ability for a traveler to request a driver and vehicle through a smartphone app whereby the traveler's location is provided to the driver through GPS. With the support of GPS technology, digital maps, and routing algorithms, users are provided with real-time information about waiting times. Proponents of these services

argue that they provide a more safe, reliable, efficient transportation experience. However, others argue that they essentially operate as illegal taxis. While the regulation of these services continues to evolve, there is agreement on one issue: ride-hailing services have begun to disrupt traditional transportation systems in cities across the globe.

When ride-hailing services were first launched, they were commonly referred to as "ridesharing" or "peer-to-peer mobility" services. Many experts initially argued that this label was a misnomer because drivers and passengers did not share the same destination,[5] but rather, the drivers provided services analogous to limousines or taxis. In 2013, a California Public Utilities Commission ruling officially defined these services as transportation network companies (TNCs), although they are still often colloquially referred to as ridesharing, and more recently, ride-hailing services.

In 2014, both Uber and Lyft announced the pilot of new products that harness algorithms to match passengers who request service along similar routes in real-time, enabling them to share rides (UberPool, LyftLine). Although the paid drivers of UberPool and LyftLine rides typically do not share the same destinations as their passengers, other business models and apps are emerging in an attempt to enable traditional carpooling – where the driver does indeed share a similar route (Waze's Rider, Scoop).

Both carsharing services and ride-hailing services both reflect a shift away from vehicles as a *product* to vehicles as a *mobility service*. However, we find that the service models and rates of adoption are quite different, with ride-hailing services attracting a much larger and broader segment of the total population. The results of this study focus primarily on ride-hailing. In this report, we present new evidence on the adoption, utilization rates, and early impacts on travel behavior of these rapidly-growing services.

The remainder of this report is organized as follows. In Section 2, we elaborate on the academic and industry research on shared mobility adoption and their potential impacts. Section 3 briefly describes the methodology for the data collection. Section 4 presents early data on the demographics of ride-hailing adopters, utilization rates, and their correlation with earlier carsharing services. Section 5 examines vehicle ownership rates and potential impacts of ride-hailing on vehicle use. Section 6 presents data on the relationship between ride-hailing and transit use. We conclude with a discussion of this study's key findings, potential policy implications, and directions for future research. The findings presented here represent one study of a series of evaluations on future urban mobility trends based on this dataset.

2. Literature Review

This section presents a summary of the academic literature on shared mobility and recent industry figures on the adoption of shared mobility. As noted in a special issue on shared-mobility research in *Transportation* by Le Vine and Polak, the innovation in business models has outpaced the speed at which researchers can converge around a common lexicon.[6] Furthermore, we posit that the speed of innovation in mobility *business models*, as well as distinct mobility *products* (uberX, UberPool, Lyft Shuttle), presents significant challenges for transportation researchers to develop new data collection methods and methodologies that can effectively measure the potential impacts of these new mobility services on our transportation systems and infrastructure. Hence, in this review we draw on recent industry and consulting reports on the adoption and reported use of shared mobility.

Adoption of Carsharing and Ride-Hailing Services

Given the recent emergence of ride-hailing services (Uber, Lyft), the majority of academic studies on shared mobility to date have focused on the adoption and impacts of *carsharing* programs. Some of the earliest carsharing studies date back to 2001, when City CarShare was first launched in San Francisco. Based on surveys of members and non-members three months, nine months, and two years into the program, Cervero reported on the demographics of early adopters.[7, 8, 9] Cervero found that carsharing served a fairly distinct and unique market – young, moderate-income, non-traditional households without cars (over three-quarters of the surveyed carshare members had no household vehicles).

Similar studies deployed through carsharing organizations in North America found that members tended to be young, well-educated, and of moderate income levels.[10] However, a recent study by Clewlow using regional travel survey data from a representative sample suggests that not only are carsharing members more educated, they often have higher incomes than their non-carshare member counterparts.[11] Although global carsharing membership had grown to approximately 5 million users by 2016, after becoming commercially available 15 years ago,[1] it continues to represent a somewhat niche market – particularly compared to the rapid, and widespread growth of ride-hailing, which, according to news reports, has reached well over 250 million users globally.[2]

The neighborhood characteristics that support carsharing programs are generally similar to those of emerging ride-hailing services. Several studies have identified common factors that contribute to successful carsharing programs, including limited parking, availability of good public transportation, walkability, high density, and mixed-use neighborhoods.[3,12,13,14] Numerous theoretical studies found that dynamic ride-sharing models, the core enabling concept of ride-hailing, were more likely to work in cities with high population density, where lead (or wait) times

can more easily be reduced for both drivers and passengers.[15, 16, 17] As commercial ride-hailing services have expanded, they have initially targeted major, metropolitan cities around the globe.

Due to the competitive market for ride-hailing, there is limited data on the adoption of Uber, Lyft, and other similar services. However, very recently, new reports have emerged which find that ride-hailing users tend to be younger, more educated, have higher incomes, and live in more urban areas.[18] Based on a Pew study released in May 2016, one in five urban Americans (21%) had used ride-hailing services. While it may still be early in the rise of ride-hailing services, it seems clear that the adoption ride-hailing has already far out-paced the growth of traditional carsharing services of the past.

Impacts of Shared Mobility on Travel Behavior

Previous empirical research examining the possible impacts of shared mobility on travel behavior focuses almost entirely on carsharing. Cervero's initial studies indicated that carsharing appeared to induce travel by automobile among early adopters.[7] However, subsequent research revealed that as carsharing adoption spread, members were 12% more likely to shed a vehicle, and on average experienced a net reduction in vehicle miles traveled (VMT).[8] Martin and Shaheen found that joining carsharing reduced the average number of vehicles per household from 0.55 to 0.29 (a reduction of 0.26 vehicles).[10] More recently, Firnkorn and Muller estimated more modest vehicle reductions between 0.05 to 0.11.[19]

Another dimension of travel behavior explored in previous carsharing studies is the potential impact of carsharing on public transit and non-motorized travel (walking and bicycling). Martin and Shaheen found that there was a slight net decrease in public transit use, and a significant increase in walking, bicycling, and carpooling after individuals joined carsharing.[9] However, there were significant variations in travel behavior across the different carsharing organizations whose members were surveyed. Another study by Stillwater et al examined the relationship between carsharing and public transit use, finding ambiguous results.[20]

Almost all of the previous studies used before-and-after or retrospective questioning of carsharing members to establish a relationship between carsharing and travel behavior (vehicle holdings, VMT, and transit use). However, a critical issue that is often unaddressed is the likely spurious relationship between the built environment, carsharing adoption, and travel behavior. While previous studies have observed that carsharing members tend to own fewer vehicles and drive less after joining carsharing, what is less well understood is the extent to which the observed travel decisions can be attributed to *carsharing adoption itself*, as opposed to the *prior self-selection* of individuals into urban neighborhoods that are consistent with their travel preferences. By design, shared vehicle services are generally placed in high-density, transit-accessible neighborhoods where vehicle ownership and vehicle miles traveled (VMT) are known to be lower than average.[21] Hence, it is unknown whether the true "effect" of carsharing or ride-hailing (or some portion of the effect) may simply be due to the prior residential and travel preferences of carsharing

members. Previous studies control for residential changes *after* joining carsharing;[10] however, residential changes immediately *prior* to joining carsharing have not been measured.

In an attempt to control for built environment effects, Clewlow conducted a study comparing the travel behavior indicators of carshare adopters and non-adopters with residential locations in the same U.S. Census tracts using a statistically representative sample.[10] Carsharing members living in very dense, urban neighborhoods owned significantly fewer vehicles: 0.58 versus 0.96. However, there was no difference in vehicle holdings among suburban carshare members versus non-members. This recent work suggests that the core neighborhood characteristics that make carsharing successful (limited parking, good transit availability, walkability) likely also play a significant role in previously estimated "effects" of carsharing on vehicle holdings. As adoption of shared mobility becomes more widespread, continued attention to the relationship between the built environment and travel behavior is critical.

Only very recently have reports emerged that feature the potential travel behavior impacts of ride-hailing services, including an American Public Transportation Association (APTA) report released in March 2016 and a Pew Research Center report released in May 2016.[22, 18] The APTA analysis found that the more people used shared modes (including carsharing, ride-hailing, and bike-sharing), the more likely they were to use public transit and own fewer vehicles. Similarly, the Pew study found that frequent ride-hailing users were less likely to own a vehicle and more likely to use a range of transit options. The latter acknowledged that this trend carries a significant geographic component – that is, those Americans who live in an urban center are much more likely to have greater access to ride-hailing services, alongside a range of transportation alternatives that allow them to live a car-free (or car-light) lifestyle.

More recent work on the potential impacts of ride-hailing has found that after ride-hailing left the city of Austin, 41% of individuals turned to driving to fill the void and 9% of individuals purchased a vehicle.[23] The authors note that the data are based on a convenience sample that are not representative of the broader population. In another regional survey based in the Denver metropolitan area, research has found that 34% of people would have walked, biked, or used public transit instead of using ride-hailing. An additional 12% would not have made the trip at all.[24]

We build on prior research through this survey of several major U.S. metropolitan areas with a sampling method designed to be representative of the urban and suburban populations in those regions. Our research confirms and expands on the aforementioned research conclusions; however, we also find contradictory and new evidence about how ride-hailing services influence travel behavior. Further work on a variety of topics is needed.

3. Methodology

The objectives of this study were to examine the adoption of shared mobility services (carsharing and ride-hailing) in the United States, including the demographics of adopters, reasons for non-adoption and attrition, and potential differences in travel behavior between adopters and non-adopters. An internet-based survey was deployed in major metropolitan regions in the United States, gathering demographic, travel, and residential choice data as described briefly in the sections below.

Survey Design

This study is based on an extensive self-administered travel and residential choice survey, drawing on questions commonly used in the American Community Survey (ACS), regional transportation surveys (e.g., California Household Travel Survey), and previous travel behavior research. The survey was deployed in two phases, first between September 2014 to March 2015 (Survey 1), and again between August 2015 and January 2016 (Survey 2). The results of this report are based on the latter survey deployment.

The surveys were comprised of five and six sections, organized as follows: 1) attitudes towards travel, neighborhoods, technology, and environment; 2) household demographics; 3) current and previous residential decisions; 4) travel behavior including use of shared mobility services; 5) vehicle ownership and preferences; and 6) life stage events (Survey 2 only). A broader objective of the survey design and deployment was to gather extensive data on urban populations' current, past, and potential future travel, residential, and vehicle ownership choices. The findings presented here represent one study of a series of evaluations on future urban mobility trends based on these datasets.[25, 26]

Sampling

We selected seven major metropolitan areas in the United States for our survey: Boston, Chicago, Los Angeles, New York, San Francisco/ Bay Area, Seattle, and Washington, D.C. Using data from the 2011-2013 American Community Survey (ACS) 3-Year Statistics, we screened potential neighborhoods to vary systematically on population density and housing density. The age, income, and gender distributions of survey respondents were also constrained to match the reported distributions of each metropolitan region sampled.

We built our survey on an internet-based platform that enabled complex survey logic and branching. The survey was pre-tested on faculty and researchers with expertise in travel survey design, transportation modeling, and shared mobility, as well as a snowball sample of the general population. Through the sampling firm employed for this study, the survey was pre-tested on 50

respondents from five metropolitan regions. Between each pre-test, the survey was refined based on expert feedback, general feedback, and analysis of the survey data.

We administered the survey using a targeted email approach to adult respondents (18 and older) pre-identified as residing within the major metropolitan zip codes selected for this study. A total of 4,094 completed responses were collected between the two surveys, with 2,217 from respondents residing in dense, urban neighborhoods and 1,877 from more suburban locations. By design, the responses were evenly distributed between the five metropolitan regions, Boston, Chicago, New York, Seattle, and Washington, D.C. for Survey 1, and with an oversampling of respondents for the San Francisco and Los Angeles regions for Survey 2.

Following the survey deployment and data cleaning, the data were weighted using an iterative technique that matches gender, age, and income levels to ACS data at the metropolitan level. On the whole, the demographics of the respondents reflected the metropolitan areas surveyed. Less than 1% of the responses required weighted values of 5 or more. Similarly, the majority of ride-hailing and carsharing results varied little between the weighted and unweighted data. Unless otherwise noted, the results presented throughout this report are weighted.
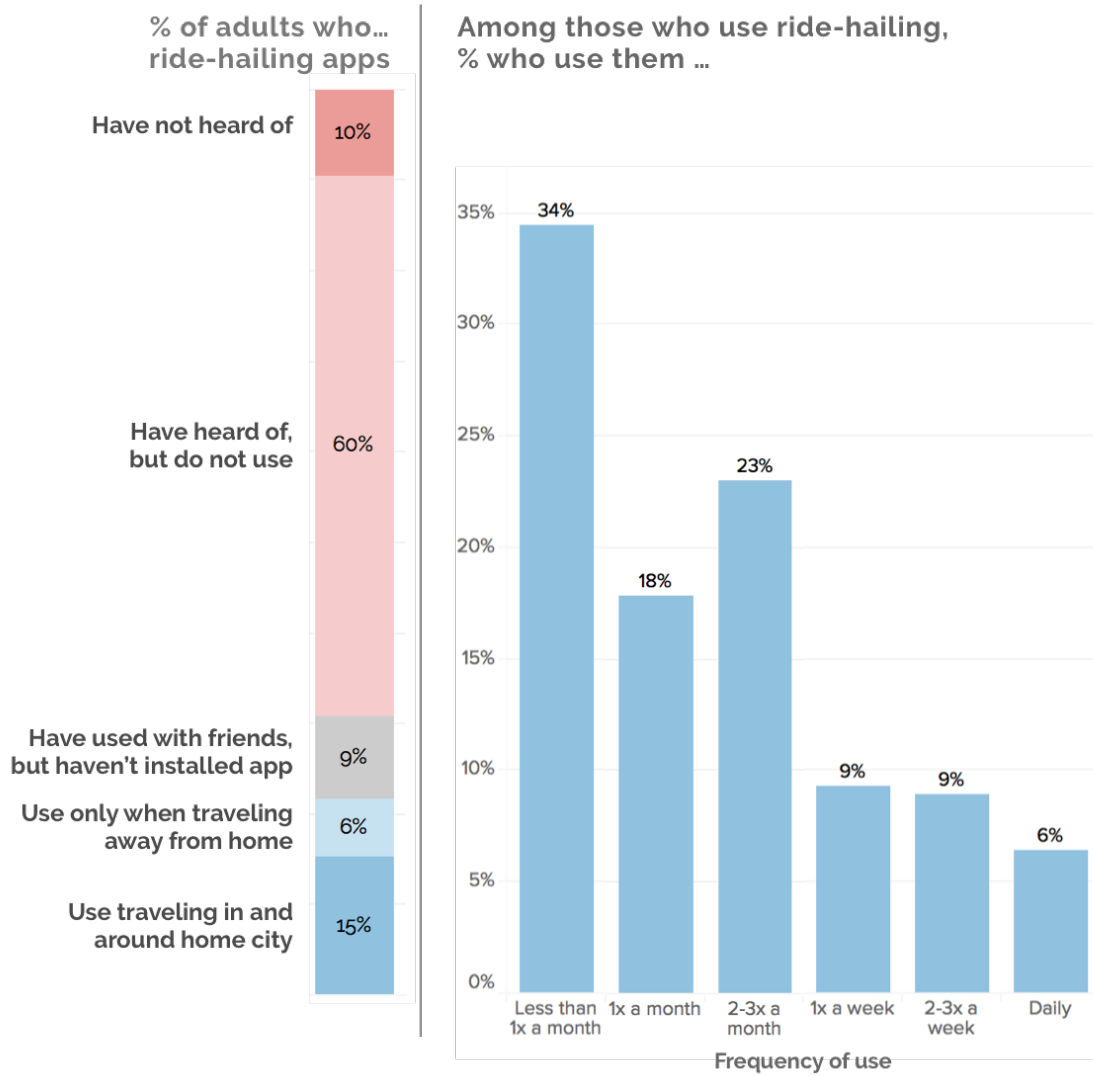
4. Adoption of Ride-Hailing Services

In major metropolitan areas, we find that 21% of adults have personally used ride-hailing services (i.e. they have installed and used ride-hailing apps), and an additional 9% of adults have used ride-hailing with friends (see Figure 2). Unlike previous studies, we find that only 10% of American adults in major cities have not heard of ride-hailing services such as Uber and Lyft. The adoption rates in our study are significantly higher than those found in previous reports (which range from 10% to 15%)[18] in large part due to our focused sampling of major metropolitan areas, including both urban and suburban neighborhoods. These results demonstrate the widespread use of ride-hailing services in cities, particularly as compared with the adoption rates of prior carsharing services, which are roughly an order of magnitude smaller.
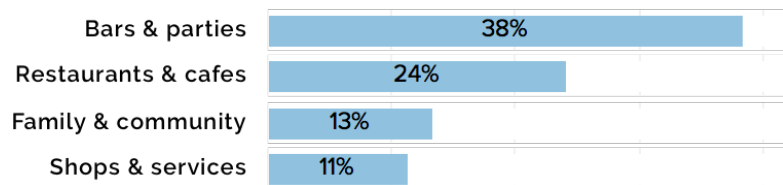
Frequency of Ride-Hailing Use

Similar to the higher ride-hailing adoption rates found in our survey as compared with previous research, we also find higher rates of *utilization* among ride-hailing users in cities. Nearly a quarter (24%) of users report that they use ride-hailing services on a weekly to daily basis. However, among the majority of ride-hailing adopters these services are used less frequently: 41% use them 1 to 3 times a month and 34% use them less than once a month.

In a portion of our survey focused on trip purpose and travel mode, respondents were asked to select their top three modes for several common activities, including going to 1) restaurants and cafes, 2) shops and services, 3) family and community activities, and 4) bars and parties. By a fairly wide margin, the most common activity ride-hailing is used for is going to bars and parties: 38% of adopters regularly use it for this purpose (see Figure 3).

# Figure 2. Adoption and utilization of ride-hailing

% of adults who…
ride-hailing apps

Have not heard of	10%
Have heard of, but do not use	60%
Have used with friends, but haven't installed app	9%
Use only when traveling away from home	6%
Use traveling in and around home city	15%

Among those who use ride-hailing,
% who use them …

Frequency of use	%
Less than 1x a month	34%
1x a month	18%
2-3x a month	23%
1x a week	9%
2-3x a week	9%
Daily	6%

Figure 3. Trip purpose

Bars & parties	38%
Restaurants & cafes	24%
Family & community	13%
Shops & services	11%

Among those who own a vehicle, respondents also were asked to select the top reason that they use ride-hailing services instead of driving themselves (see Figure 4). Both urban and suburban respondents cite the desire "to avoid driving when I might have alcohol" as one of the top reasons they use ride-hailing (33%). Uber and Mothers Against Drunk Driving (MADD) jointly released a study in 2015 which found that drunk-driving crashes fell among drivers under the age of 30 in markets where Uber operates following the launch of their uberX service.[27] Similarly, another study found that drunk driving deaths fell by 3.6% to 5.6% following the availability of Uber in California markets.[28] Based on our survey data on the reasons for ride-hailing use, these new findings similarly suggest that ride-hailing may reduce the number of drunk drivers on the road.

Parking constraints also play a critical role in the choice among both urban and suburban ride-hailing adopters to use these services versus drive. Difficulties finding parking and the price of parking are cited as the second and third most common reasons that adopters used ride-hailing. Among urban respondents, 37% of respondents cited parking-related reasons for substituting ride-hailing for personal driving. These results on ride-hailing substitution reinforce the well-documented research that pricing and constraining parking can reduce driving and vehicle miles traveled.[29, 30]

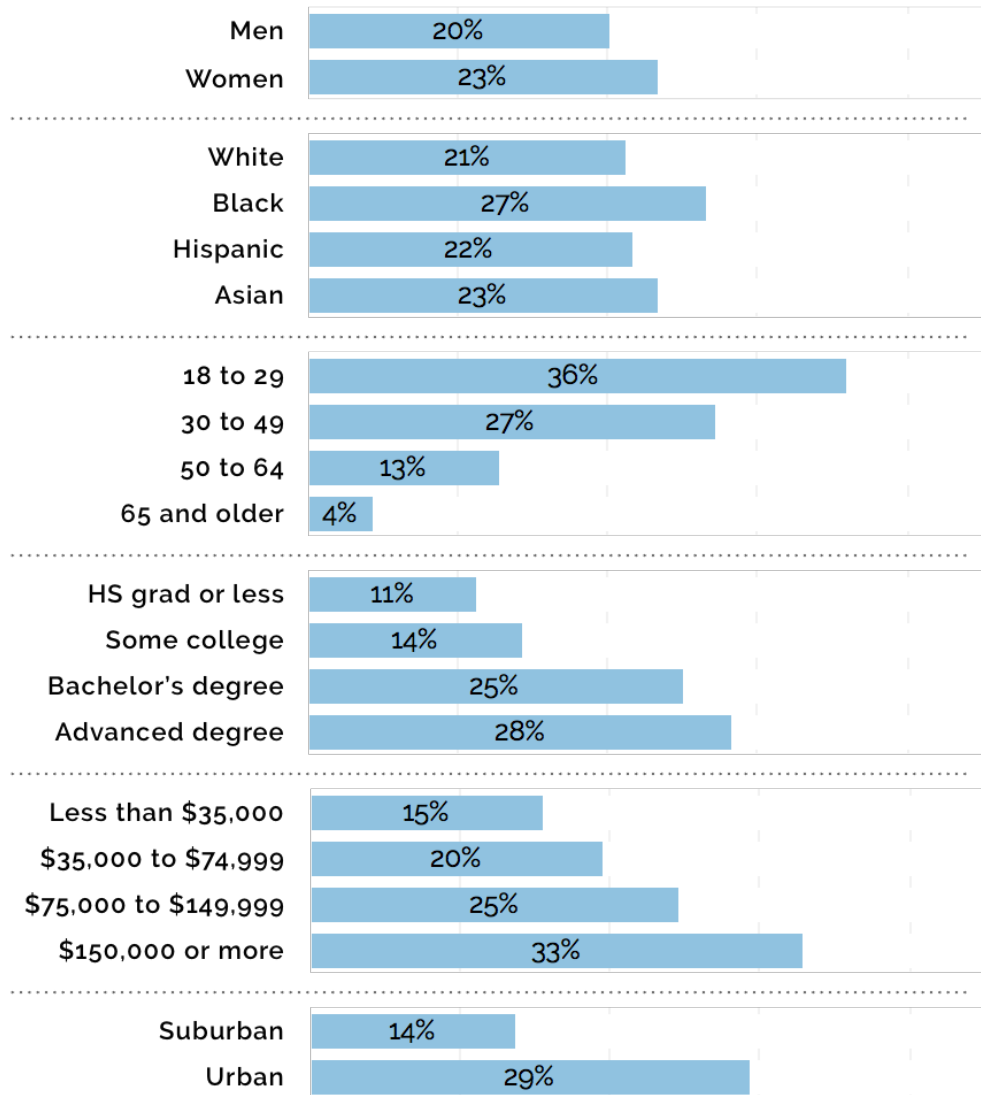**Figure 4. Reasons for using ride-hailing services instead of driving oneself**
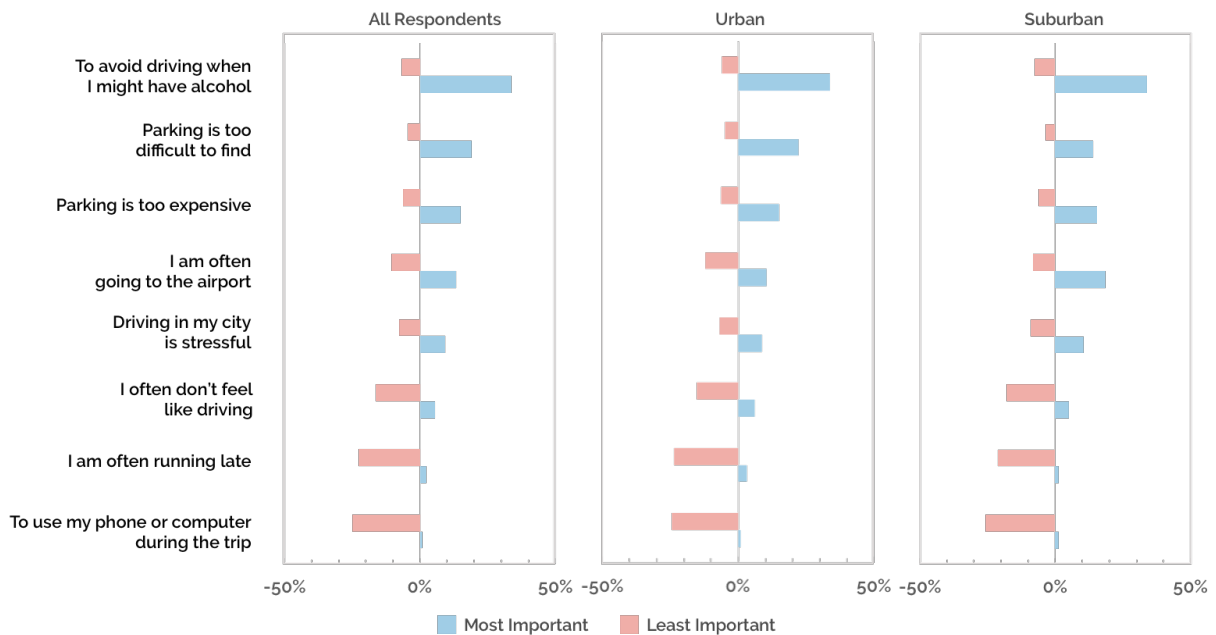
Demographics of Ride-Hailing Users

Similar to the adoption trends for new technologies and for prior carsharing services, we find that early ride-hailing adopters tend to be younger, more educated, and have higher incomes than the rest of the population (see Figure 5). The average age of respondents who have not used ride-hailing is 51, as compared with the average age of ride-hailing users: 37. There is a fairly significant gap in adoption between the youngest and oldest segments of the population. More than one-third (36%) of those between 18 and 29 years of age use ride-hailing services, while only 4% of those 65 and older do. Although ride-hailing (and in the future potentially autonomous vehicles) are often cited as a possible mobility solution for the aging Baby Boomer population, this research suggests that there are significant hurdles to overcome from a technology adoption perspective.

The other significant differences in adoption rates are between those who are more educated and have higher incomes, and those who do not. The adoption rate among the college educated is double (26%) the adoption rate of those without a college degree (13%); those with advanced degrees also have slightly higher adoption rates than those with a bachelor's degree. Similarly, respondents with an annual household income of $35,000 or less had an adoption rate of 15%, as compared with 33% of those earning $150,000 or more. As cities and transit agencies consider whether or how to integrate these services into publicly-subsidized transportation networks, these gaps in adoption among the wealthy and the poor will need to be addressed.

Similar to carsharing business models, ride-hailing services tend to be offered primarily in more urban neighborhoods, where higher population density enables higher frequency of use and utilization rates of vehicles. Unsurprisingly, we find that 29% of urban Americans had used ride-hailing services, as compared with 14% of those living in suburban neighborhoods. In addition, while 23% of urban respondents use ride-hailing in and around their city (versus only while traveling away from home); only 7% of suburban respondents use them in their home area. Some have suggested that the current ride-hailing business model is beginning to hit a ceiling. We believe that a significant factor influencing the long-term growth of ride-hailing is whether these services can prove to be more viable in suburban geographies.

Figure 5. Ride-hailing adoption by demographics and geography

Category	Adoption
Men	20%
Women	23%
White	21%
Black	27%
Hispanic	22%
Asian	23%
18 to 29	36%
30 to 49	27%
50 to 64	13%
65 and older	4%
HS grad or less	11%
Some college	14%
Bachelor's degree	25%
Advanced degree	28%
Less than $35,000	15%
$35,000 to $74,999	20%
$75,000 to $149,999	25%
$150,000 or more	33%
Suburban	14%
Urban	29%

There is a significant overlap in the adoption of carsharing adoption and ride-hailing adoption, but not vice versa. The vast majority of carsharing adopters (both current and previous members) have used ride-hailing (65%); however, given the relatively niche market that carsharing served, and the much higher adoption rates of ride-hailing, the opposite does not hold (see Figure 6). Further, when we explored reasons that previous carsharing members dropped their membership, the top reason was that they "started using services like Uber, Lyft or other on-demand mobility" (23%). Another common reason for dropping carharing membership was the purchase of a vehicle (16% of those who dropped membership). This early research suggests that although carsharing and ride-hailing use may be complementary, the convenience of ride-hailing lends itself to easily substitute for trips that may have previously been served by carsharing. In

fact, current industry news points to challenges facing the carsharing industry given the rising popularity of ride-hailing services such as Uber and Lyft.[31]

Figure 6. Carsharing membership among ride-hailing users
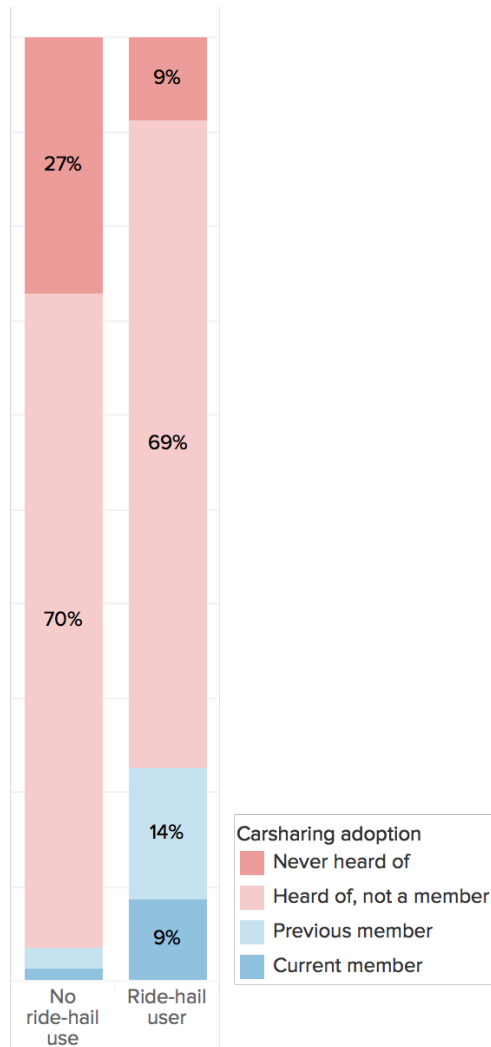
**KEY FINDINGS: ADOPTION OF RIDE-HAILING**

- In major cities, 21% of adults have personally used ride-hailing services; an additional 9% use ride-hailing with friends.

- Nearly a quarter (24%) of ride-hailing adopters in metro areas use them on a weekly or daily basis.

- Parking represents the top reason that urban ride-hailing users substitute a ride-hailing service in place of driving themselves (37%).

- Avoiding driving when drinking is another top reason (33%) that those who own vehicles opt to use ride-hailing versus drive themselves.

- Only 4% of those aged 65 and older have used ride-hailing services, as compared with 36% of those 18 to 29.

- College-educated, affluent Americans have adopted ride-hailing services at double the rate of less educated, lower income populations.

- 29% of those who live in more urban neighborhoods of cities have adopted ride-hailing and use them more regularly, while only 7% of suburban Americans in major cities use them to travel in and around their home region.

- Among adopters of prior carsharing services, 65% have also used ride-hailing. More than half of them have dropped their membership, and 23% cite their use of ride-hailing services as the top reason they have dropped carsharing.

5. Vehicle Ownership and Driving

Two important questions facing policymakers are whether the adoption of ride-hailing services can reduce vehicle ownership and/or total vehicle miles traveled (VMT). Contrary to recent research on the topic, with this more representative sample of people in major cities we find that ride-hailing users on average do not possess significantly fewer vehicles than their non-ride-hailing counterparts, and have more vehicles than those who only use transit. For this analysis, we segment the respondents into the following categories (see Figure 7):

- "Transit only": people who said they used a public transit service (bus, heavy rail, light rail, or ferry) for their commute or as a mode for the regular trip-generating activities (social, shopping, services, eating) within the last three months, and who have not downloaded a ride-hailing app.
- "Transit and ride-hail": people who use transit in the ways described above, and who have downloaded and use a ride-hailing app.
- "Ride-hail only": people who have downloaded and use a ride-hailing app, and who do not use transit regularly for common trip-generating activities.
- "Neither": people who do not use transit regularly and who have not used a ride-hailing app. For the most part, these are car-centric respondents.

Figure 7. Segments compared: transit only, transit and ride-hail, ride-hail only, and non-users of shared mobility
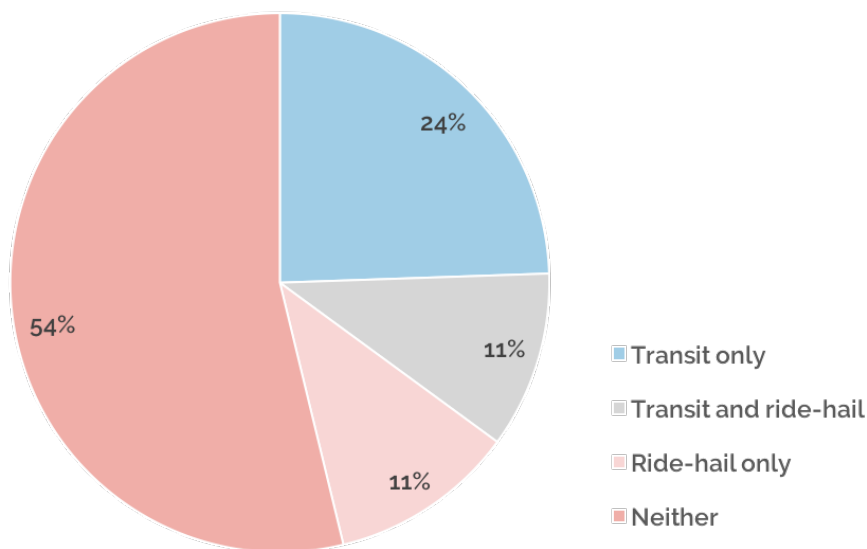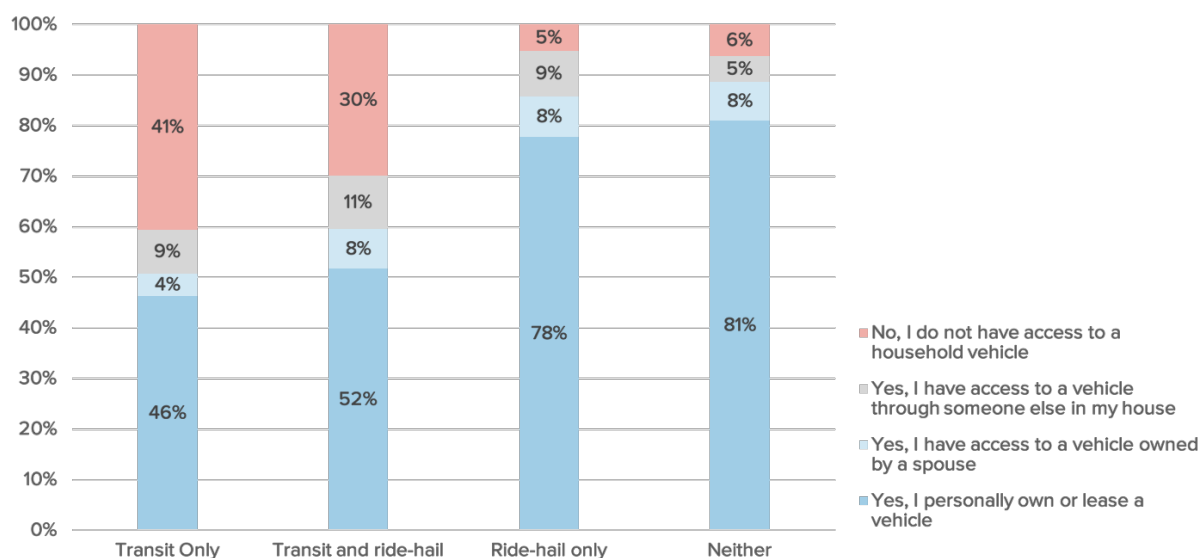
Personal Vehicle Ownership Among Ride-Hailing Users

We find that personal vehicle ownership rates of the "transit and ride-hailing" segment (52%) are higher than those who only use transit (46%). We find that personal vehicle ownership between "ride-hailing only" users are not that different from the rest of the car-centric population (78% and 81%, respectively). Figure 8 provides a detailed overview of personal vehicle access. Similarly, a larger portion of "transit only" respondents have no access to a household vehicle (41%), as compared with "transit and ride-hail" respondents (30%), who have greater access to a vehicle.

In our survey, we examined both the number of household vehicles (see Figure 9), as well as how the respondents characterized their relationship to vehicles (i.e. whether they personally owned a vehicle, or had access to one through a household member). In general, we found that large numbers of Millennials did not personally own vehicles, but may have had access to one – typically through a parent or roommate.

Our results are a bit different from a recent APTA report which defined a classification of "supersharers": people who had used some combination of bikesharing, carsharing, or ride-hailing across common trip types over the past three months. The difference between prior results and ours can likely be explained by the representative sampling approach used in this study, as compared with the convenience sampling approach in the former. The respondents from the former study were sourced through carsharing and bikesharing firms, members of which likely represent less than 5% of the population. Previous research has shown that they are particularly affluent, educated, and often have environmentally-oriented preferences. What the APTA data likely confirms is that carsharing members own fewer vehicles and use more transit; little can be concluded about ride-hailing users from a non-representative convenience sample.

**Figure 8. Vehicle ownership and access, by ride-hailing and transit use**

Household Vehicle Ownership Among Ride-Hailing Users

At the household level, we also find that ride-hailing users have slightly more vehicles than those who only use transit (see Figure 9). "Transit-only" respondents own on average 1.02 cars per household, and "transit and ride-hail" respondents own on average 1.07 cars per household. We found no significant differences in household vehicle ownership rates between "ride-hail only" respondents and those who use neither ride-hailing nor transit.

That there is little difference between ride-hailing users and the rest of the population in terms of vehicle ownership is not particularly surprising. Vehicle ownership decisions are mid- to long-range choices that individuals and households make, influenced primarily by other factors other than access to a service like ride-hailing. Household income, employment status, and access to parking are all strongly correlated with personal vehicle ownership decisions. While access to transit, and potentially ride-hailing, may influence these decisions over the long term, it is important that future research account for the primary factors influencing these choices: socio-demographic, attitudinal, and built environment characteristics.

Figure 9. Household vehicle ownership, by ride-hailing and transit use
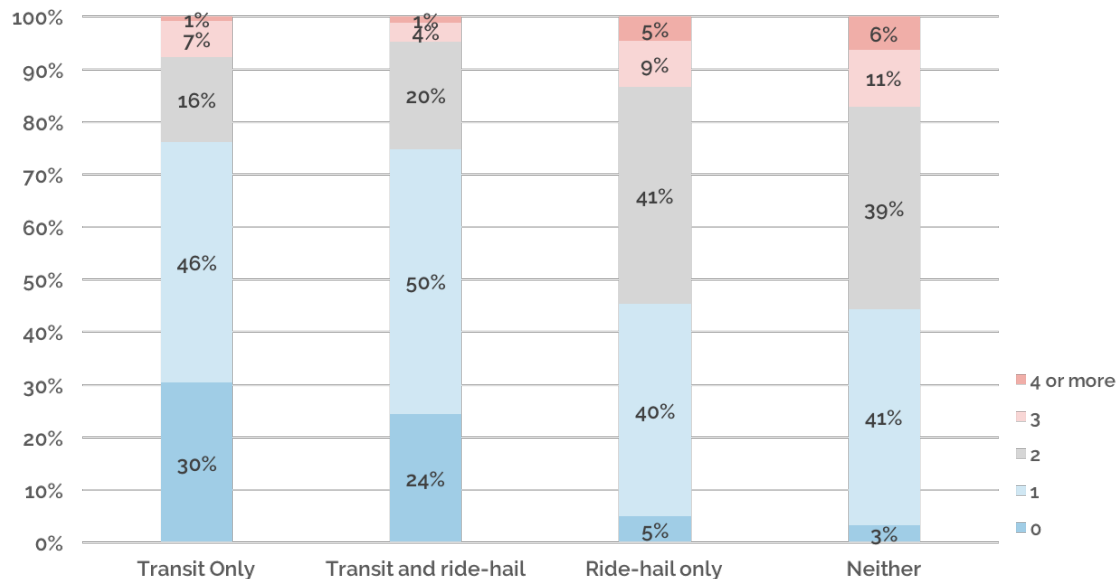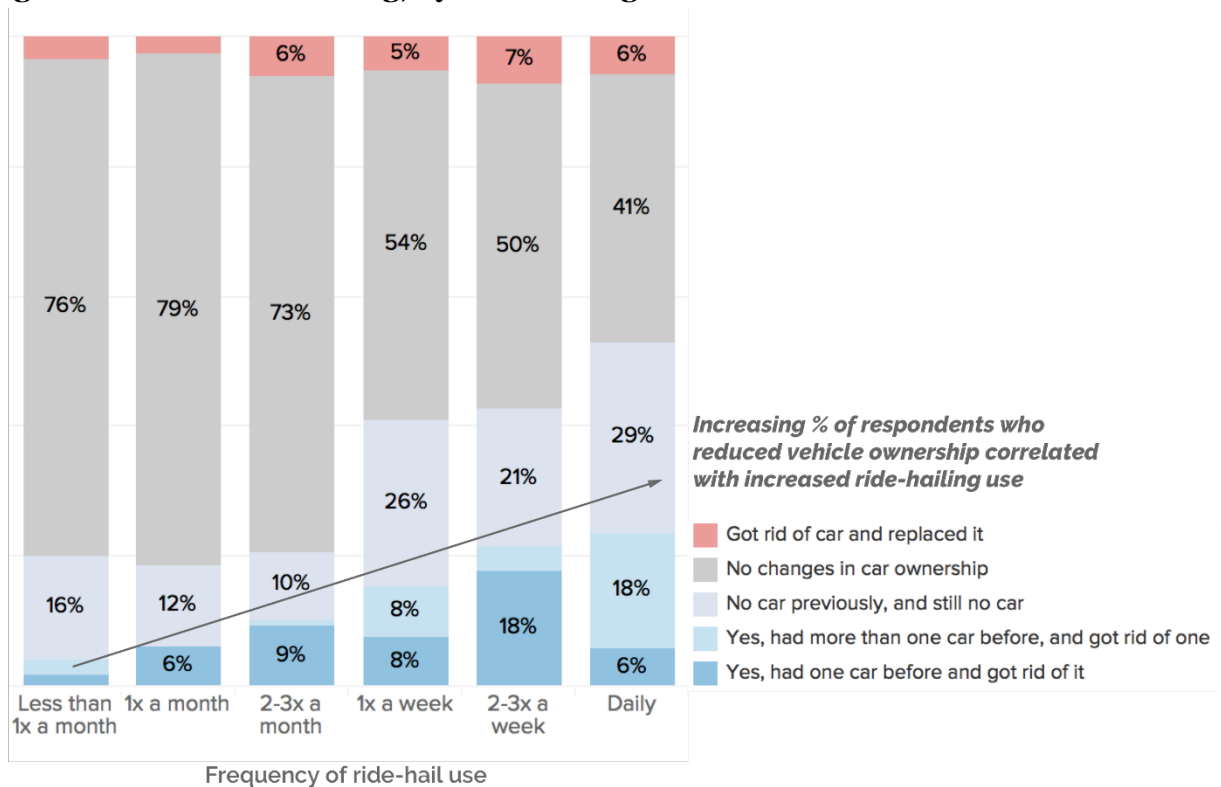
Vehicle Reduction and Ride-Hailing Utilization

When asked whether they had made any decisions to get rid of a vehicle, the vast majority of ride-hailing respondents (91%) had made no changes in their vehicle ownership, with 16% indicating that they had no vehicle to begin with. However, 9% respondents indicated that they had disposed of one or more household vehicles. This figure is significantly lower than previous work on shared mobility,[22] most likely due to the representative nature of this sample versus the convenience-based nature of prior survey samples.

When we examined the relationship between ride-hailing utilization and vehicle reduction, we found a strong correlation between increasing ride-hailing use and increasing rates of vehicle reduction. That is, the more frequently an adopter uses ride-hailing services (from once a month to daily), the more likely they were to have reduced their household vehicles (see Figure 10).

From an environmental benefits perspective, the reduction of vehicle ownership is primarily of value insomuch as it reduces total vehicle miles traveled (VMT). What is currently unclear is the net vehicle miles traveled (VMT) adjustment due to the introduction of ride-hailing – has it gone up or down? And what are the likely longer-term impacts of these services?

**Figure 10. Vehicle shedding, by ride-hailing utilization rate**

Vehicle Miles Traveled and Ride-Hailing Utilization

While the majority of individuals (59%) individuals who use ride-hailing indicated that there was no change in their personal driving habits, 29% of individuals indicated that they reduced their personal driving by 10 or more miles a week since they started using ride-hailing services. Given that some of these adopters use ride-hailing services often, we examine their self-reported change in vehicle miles traveled (VMT) in the context of their ride-hailing use (see Figure 11).

The key takeaway is that while some portion of ride-hailing users reduce the miles that they personally drive, these miles return in the form of miles traveled in a ride-hailing vehicle. One might assume that the net change in VMT is negative; that is, a reduction in VMT. However, in order to definitively quantify the VMT impacts we must determine:

- What modes ride-hailing trips substitute for (personal driving, transit, biking, walking)
- Passenger miles within ride-hailing vehicles
- Additional "dead-heading" vehicle miles (those driven without a passenger)

Figure 11. Driving reduction, by ride-hailing utilization rate
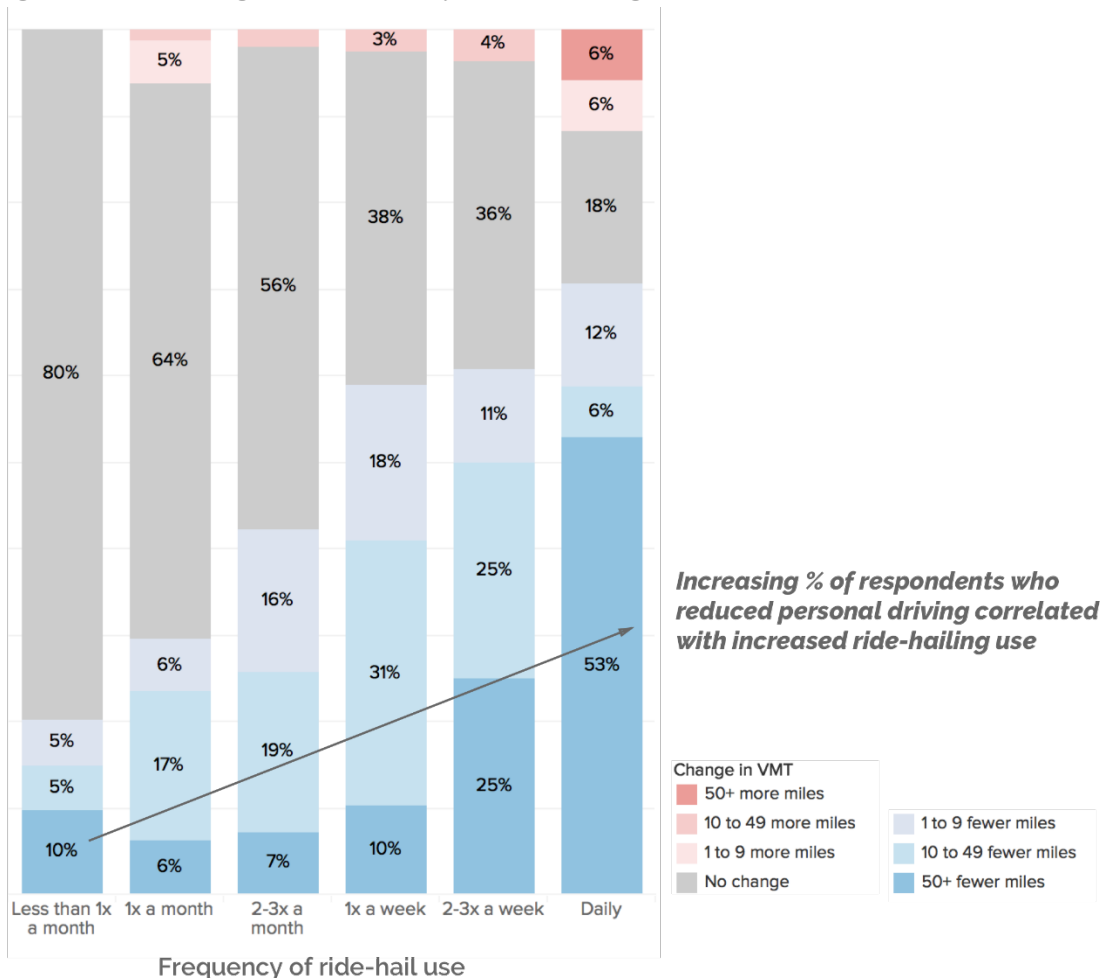
**KEY FINDINGS: VEHICLE OWNERSHIP AND DRIVING**

- Ride-hailing users who also use transit have higher personal vehicle ownership rates than individuals who only use transit: 52% versus 46%.

- A larger portion of "transit only" travelers have no household vehicle (41%) as compared with "transit and ride-hail" travelers (30%).

- At the household level, ride-hailing users have slightly more vehicles than those who only use transit: 1.07 cars per household versus 1.02.

- Among non-transit users, there are no differences in vehicle ownership rates between ride-hailing users and traditionally car-centric households.

- The majority of ride-hailing users (91%) have not made any changes with regards to whether or not they own a vehicle.

- Those who have reduced the number of cars they own and the average number of miles they drive personally have substituted those trips with increased ride-hailing use. The net VMT effects are unknown.

6. Impacts of Ride-Hailing on Transit Use

Another important policy question that these results address is the extent to which ride-hailing complements or substitutes for public transit services. We address this question with a more nuanced approach based on the premise that not all "public transit" services are created equal. Some are more frequent, reliable, and operate in environments where they may be the most convenient choice, while others are not. In short, the question of whether ride-hailing competes with or complements transit depends on the circumstances. Survey respondents were asked whether they use different public transit services, including bus, heavy rail, and light rail, more or less after they began using ride-hailing. Results are displayed in Figure 12 below.

On the whole, the majority of respondents indicated that there was no change in their transit use. However, based on the results of those who did change their behavior, we find that shared mobility likely attracts Americans in major cities away from bus services and light rail (6% and 3% net reduction in use, respectively), and may serve as a complementary mode for commuter rail (3% net increase in use). As compared with previous studies that have suggested shared mobility services complement transit services, we find that based on the type of transit service in question the substitutive versus complementary nature of ride-hailing services varies.

**Figure 12. Changes in transit use, biking, and walking after adoption of ride-hailing services**
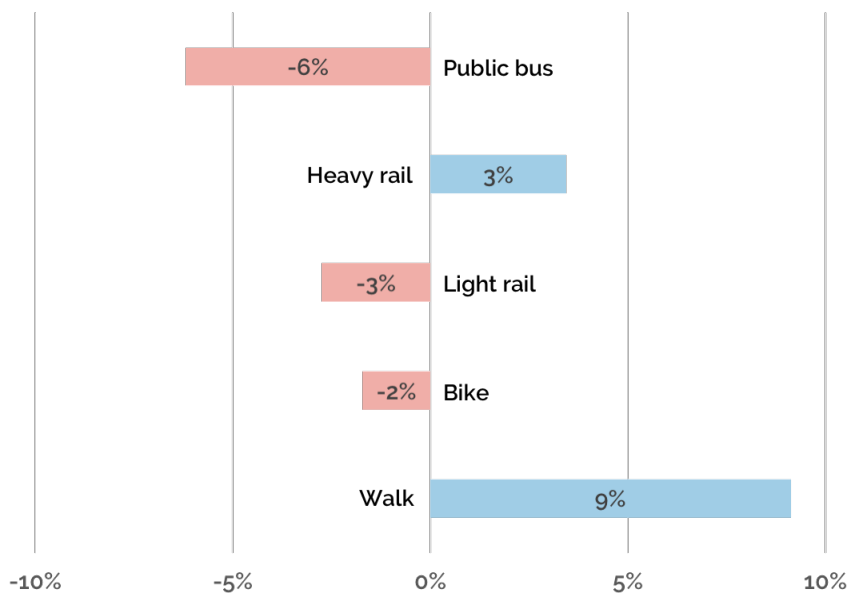
Survey question: "Since you started using on-demand mobility services such as Uber and Lyft, do you find that you use the following transportation options more or less?"

When asked explicitly why one might substitute ride-hailing for public transit, the most popular response of all ride-hailing respondents was that "services are too slow" (see Figure 13). We also segmented regular (versus infrequent) transit users as shown below. A variety of other reasons people use ride-hailing over transit were common, including the lack of available stops, traveling at times when transit services are not available, and perceived unreliability of transit services.

Recent research of New York City data also finds that travel demand growth has shifted away from public transit services towards ride-hailing services.[3] While many suggest that ride-hailing can be complementary to public transit, current evidence suggests that ride-hailing is pulling more people away from public transit in cities rather than adding riders. The broader implications are significant, particularly if autonomous vehicle technology becomes commercially viable. The few modeling simulations of cities that consider a replacement of transit services have found that total vehicle miles traveled (VMT) increase moderately to substantially if shared-ride autonomous vehicles replace transit: a 6% increase if buses are replaced, and a 89% increase if high-capacity transit is replaced.[32] These simulations are based on existing travel activity, and most transportation economists presume that some level of induced demand will be realized with fully autonomous vehicles – due in part to the increased ability of populations who currently travel less (e.g., the elderly, those unable to drive), and in part due to the potentially lower costs of travel.

Figure 13. Reasons for substituting ride-hailing for transit services
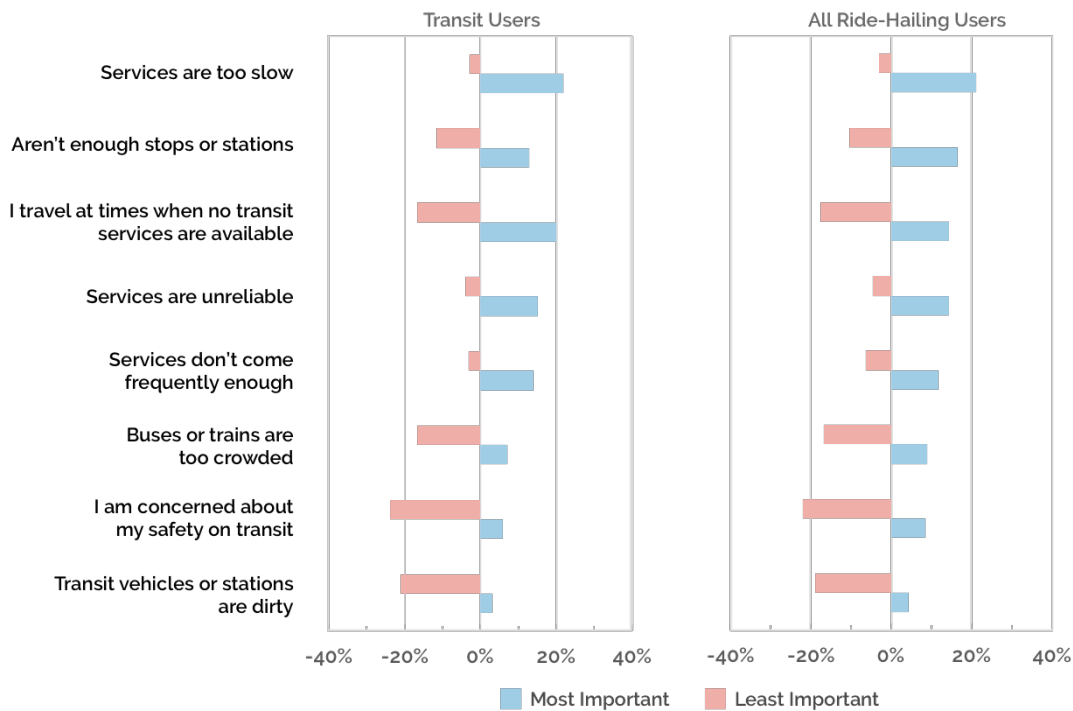
Survey question: "What would you consider the most important versus least important reason you use on-demand mobility services such as Uber or Lyft instead of public transit?"

Substitution of Transit and Driving

Ride-hailing users were asked which transportation alternatives they would have used for the trips that they currently make using Uber and Lyft. Based on frequency of ride-hailing use weighted data, a majority (61%) of trips would have not been made at all, or by walking, biking, or transit. 39% of trips would have been made by car (drive alone, carpool, or taxi). Using data unweighted by frequency of ride-hailing use, 49% of ride-hailing trips were likely to have not been made at all, or by walking, biking, or transit.

Directionally, this new evidence of mode substitution suggests that ride-hailing is likely adding vehicle miles traveled to transportation systems in major cities. The 49% to 61% of ride-hailing trips that would have not been made at all, or by walking, biking, or transit, are adding vehicles to the road. In addition, depending the volume of deadheading miles associated with ride-hailing trips (miles traveled without a passenger, which have previously estimated to be 20%[33] to 50%[34]), the VMT associated with a ride-hailing trip is potentially higher than a trip taken in a personal vehicle.

While this data provides initial insights into the travel behavior changes associated with ride-hailing, it is still limited in that it does not provide a complete picture of individual travelers' trip generating activities, the modes they used before ride-hailing services, and the potentially new patterns of behavior that have since emerged. Further research in this area is needed to help cities and transportation planners make critical policy decisions about how we allocate public space.

Figure 14. Mode substitution, weighted by frequency of ride-hailing use
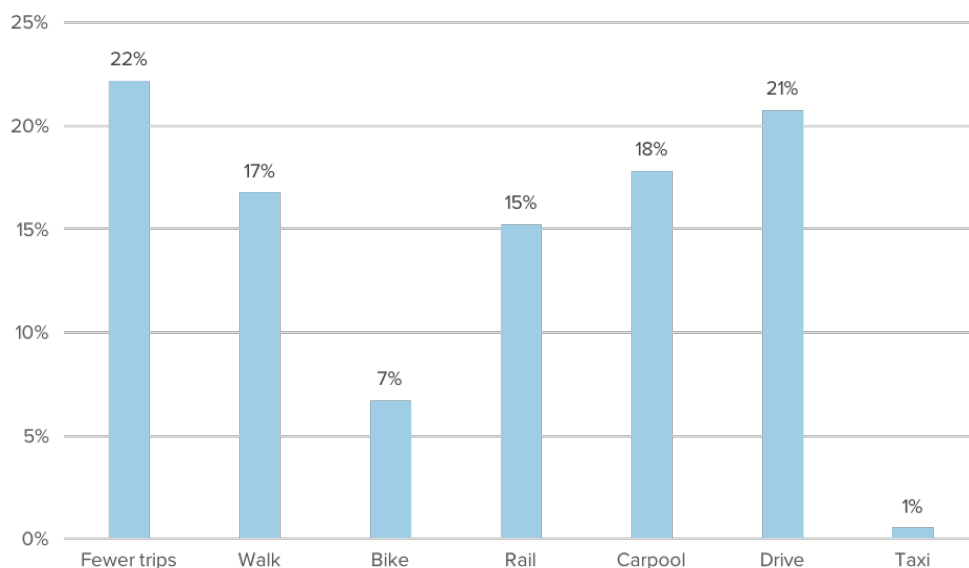
Survey question: If Uber or Lyft were unavailable, which transportation alternatives would you use for the trips that you make using Uber or Lyft?

KEY FINDINGS: RIDE-HAILING IMPACTS ON TRANSIT

- After using ride-hailing, the average net change in transit use is a 6% reduction among Americans in major cities.
- As compared with previous studies that have suggested shared mobility services complement transit services, we find that the substitutive versus complementary nature of ride-hailing varies greatly based on the type of transit service in question.
- Ride-hailing attracts Americans away from bus services (a 6% reduction) and light rail services (a 3% reduction).
- Ride-hailing serves as a complementary mode for commuter rail services (a 3% net increase in use).
- We find that 49% to 61% of ride-hailing trips would have not been made at all, or by walking, biking, or transit.
- Directionally, based on mode substitution and ride-hailing frequency of use data, we conclude that ride-hailing is currently likely to contribute to growth in vehicle miles traveled (VMT).

7. Conclusions and Policy Implications

Ride-hailing services have exploded in popularity around the world in a relatively short period of time, and initial evidence suggests that they capture a relatively significant share of how people travel in major cities. Looking forward towards a future with automated vehicle technology – which is estimated to accelerate adoption of these services, it is critical that transportation planners and policymakers begin to understand how "mobility as a service" models shape travel patterns. Without a clear understanding of how these services influence transportation decisions, cities will be limited in their ability to make effective mid- to long-range infrastructure and policy choices aimed at ensuring that transportation services are equitable, sustainable, and safe.

By collecting data through a representative panel in seven major U.S. metropolitan areas, this study presents initial evidence on the adoption of ride-hailing services and their potential impacts on travel behavior, including vehicle ownership, trip generation, mode substitution, and vehicle miles traveled. We caution readers that one cannot assume the travel behavior impacts associated with ride-hailing transfer to other shared modes, or vice versa. That is, the results presented here are specific to ride-hailing, and do not necessarily apply to carsharing, bikesharing, or microtransit services. Further research on a variety of topics is needed.

Key Takeaways

There is uneven adoption of ride-hailing across income classes and age groups
As anticipated, we find that ride-hailing adopters tend to be younger, more educated, and have higher incomes than the rest of the population. Educated, affluent Americans have adopted ride-hailing services at double the rate of those who make $35,000 or less a year. Similarly, those aged 18 to 29 have adopted ride-hailing at a rate of 36%, while only 4% of those 65 and older use ride-hailing. If one hopes that these services can provide mobility to an aging population or improve transportation equity, there are clearly significant adoption issues that must be addressed.

Ride-hailing is used regularly by urban Americans, less so by those in the suburbs
While 29% of the urban population surveyed have adopted ride-hailing and use them on a regular basis, only 7% of suburban Americans in major cities use them to make trips in and around their home region. Another 7% of suburban Americans utilize ride-hailing primarily when they are traveling away from home. A significant factor influencing the long-term growth of ride-hailing is whether these services can prove to be more viable in suburban America, where most the urbanized population lives.

Ride-hailing users have similar vehicle ownership rates as everyone else

Ride-hailing users who use transit have higher vehicle ownership rates than individuals who only use transit in cities: 52% personally own vehicles compared to 46%. As compared with Americans who do not use transit or shared modes, ride-hailing users have the same levels of personal vehicle ownership. This finding, based on a representative sample of Americans in cities, is contrary to previous studies based on convenience samples.

Ride-hailing users who disposed of a vehicle use ride-hailing more frequently

Although the majority of ride-hailing users (91%) have not made any decisions about vehicle ownership since they started using ride-hailing, we find that 9% have disposed of a vehicle. Reduced vehicle ownership and reduced driving are both highly correlated with increased ride-hailing use. The net vehicle miles traveled (VMT) effects are unknown and are arguably a more important metric.

Ride-hailing users report a net decrease in their transit use

Contrary to previous studies that report on ride-hailing as having a primary complementary relationship to public transit, we find mixed results depending on the type of transit service. The net effect is negative – that is, on average, respondents reduce their transit use. Bus services and light rail services experience the largest reductions in use after individuals begin using ride-hailing services (6% and 3% respectively). Respondents reported using heavy rail systems more after ride-hailing (3%). This data demonstrates that the substitutive versus complementary nature of ride-hailing varies considerably based on the prevalence and quality of public transit services.

Approximately half of ride-hailing trips are ones that would have been made by walking, biking, transit, or avoided altogether

We find that 49% to 61% of ride-hailing trips would have not been made at all, or by walking, biking, or public transit. This mode substitution data suggests that directionally ride-hailing is likely contributing more vehicle miles traveled (VMT) than it reduces in major cities. This data is consistent with recent efforts to estimate the volume of traffic in cities which are associated with ride-hailing services. It suggests that substantial policy action may be required to ensure that ride-hailing can effectively be woven into the transportation network while reducing congestion and the emissions of transportation services. Absent of these efforts, congestion and emissions appear likely to grow.

Future Research and Policy Implications

Given the rapid growth of ride-hailing in cities around the world, it is critical to begin collecting data on their potential impacts on travel behavior, including vehicle ownership, vehicle miles traveled, and mode shares. Further research is needed to understand how ride-hailing may influence future trajectories of traffic volumes and associated emissions so that cities can effectively plan for transportation infrastructure and public transit investments. Absent of data, cities and transit agencies are essentially in the dark when making important decisions that

influence how citizens move in their regions. Based on this initial evidence, there are several viable choices that are likely to lead to improved mobility in major cities, while paving the way for more informed decision-making in the future.

Pricing and/ or priority to improve the flow of high-occupancy vehicles
In the near term, policymakers need to address the issue of additional vehicle miles that ride-hailing services contribute to cities (as well as those from personally-owned vehicles)– which can further erode high-capacity transit services. Given limited road infrastructure and the expanding population of cities, it is critical that high-occupancy vehicles be prioritized on the roadways if they are carrying a sufficient number of passengers. Both congestion pricing and enforced priority lanes can serve as effective measures to ensure that scarce roadway space is used effectively.

Improving data access for cities and transportation planners
There is an increasing data gap between privatized mobility operators and those in the public sphere who make critical short-to-long range transportation planning and policy decisions. As private mobility services providers continue to rapidly expand service, they gather massive amounts of data about how people move in cities – data that for the most part, are unavailable to transportation planners. Limited data in the public sector perpetuates less-informed decision-making, which in turn results in transportation systems that do not meet the public's needs. We need a solution to this growing problem.

There are several potential solutions for bridging the data gap: 1) mandated data-sharing for mobility operators that use public infrastructure (i.e. roads); and 2) investment in more frequent data collection efforts. The New York Taxi & Limousine Commission approved regulations requiring companies like Uber and Lyft to share detailed data on rides in New York City.[35] Provided they are sufficiently anonymized, this data is essential for cities to make informed transportation planning and policy decisions, and reasonable for cities to require given mobility operators' use of public infrastructure. Similar examples of mandated data-sharing exists across the transportation sector, including data required of airlines in exchange for use of airports.

Second, while research that harnesses data from ride-hailing providers themselves may shed light on the utilization, demographics, and miles traveled of these services, the more complex decisions that individuals and households make over time require continued data collection efforts through representative samples of the population. Given the pace of innovation in the transportation sector, data collection and analysis efforts to understand travel decisions are currently insufficient.

Ride-hailing services have disrupted traditional transportation providers, including public transit agencies and automobile manufacturers. The expansion of ride-hailing has highlighted a number of opportunities for cities to harness new technologies, data, and business models that can serve a greater portion of the population more efficiently. While the introduction of ride-hailing has brought about welcome innovation in the transportation sector, further data and collaboration

are required to ensure that these services can be effectively woven into the fabric of cities such that they are sustainable, equitable, and safe.

Acknowledgements

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