App-Based, On-Demand Ride Services:
Comparing Taxi and Ridesourcing Trips and User Characteristics in San Francisco

University of California Transportation Center (UCTC)
Working Paper

Lisa Rayle (corresponding author)
Doctoral Student
Department of City and Regional Planning
University of California, Berkeley
228 Wurster Hall #1850
Berkeley, CA 94720
(617) 899-3379; lrayle@berkeley.edu

Susan Shaheen, Ph.D.
Adjunct Professor, Civil and Environmental Engineering
Co-Director, Transportation Sustainability Research Center
University of California, Berkeley
408 McLaughlin Hall, Berkeley, CA 94720
(510) 642-9168; sshaheen@berkeley.edu

Nelson Chan
Survey Researcher, Transportation Sustainability Research Center
University of California, Berkeley
1301 South 46th Street, Building 190, Richmond, CA 94804
(510) 984-2291; ndchan@berkeley.edu

Danielle Dai
Student, Master of City Planning, MS Transportation Engineering
Department of City and Regional Planning
University of California, Berkeley
228 Wurster Hall #1850
Berkeley, CA 94720
(732) 977-9359; ddai@berkeley.edu

Robert Cervero
Professor of City and Regional Planning
Department of City and Regional Planning
University of California, Berkeley
228 Wurster Hall #1850
Berkeley, CA 94720
(510) 642-1695; robertc@berkeley.edu

November 2014

ABSTRACT
The rapid growth of on-demand ride services such as uberX and Lyft, or "ridesourcing," has prompted debate among policy makers and stakeholders. At present, ridesourcing's usage and impacts are not well understood. Key questions include: how ridesourcing and traditional taxis compare with respect to trip types, customers, and locations served; whether ridesourcing complements or competes with public transit; and potential impacts on vehicle kilometers traveled. We address these questions using an intercept survey. In spring 2014, 380 complete surveys were collected from three ridesourcing "hot spots" in San Francisco. Survey results are compared with matched-pair taxi trip data and results of a previous taxi user survey. We also compared travel times for ridesourcing and taxis with those for public transit.

The findings indicate ridesourcing serves a previously unmet demand for convenient, point-to-point urban travel. Although taxis and ridesourcing share similarities, the findings show differences in users and the user experience. Ridesourcing wait times are markedly shorter and more consistent than those of taxis, while ridesourcing users tend to be younger, own fewer vehicles and more frequently travel with companions. Ridesourcing, like taxis, appears to both substitute for and complement public transit; the majority of ridesourcing trips would have taken substantially longer if made by public transit. Impacts on overall vehicle travel are unclear. Future research should build on this exploratory study to further understand impacts of ridesourcing on labor, social equity, the environment, and public policy.

KEY WORDS: On-demand ride services, ridesourcing, taxis, transportation network companies (TNCs), ridesharing, intercept survey, travel behavior

INTRODUCTION

The recent emergence of app-based, on-demand ride services has sparked debate over their role in urban transport. By leveraging advances in technology, ride service companies such as Uber, Lyft, and their competitors—also known as "Transportation Network Companies" (TNCs) or, more colloquially, "ridesharing"—promise to increase reliability and reduce wait times of point-to-point transportation. We refer to these services as "ridesourcing." These services have directly challenged existing regulations and practices that have over the years shaped the taxi industry, raising questions about appropriate regulatory and public policy responses.

Supporters view ridesourcing as part of a suite of transport options that serves previously unmet demand for fast, flexible, and convenient mobility in urban areas. By providing an attractive alternative to driving, these services can potentially reduce auto use, ownership, and environmental problems. Ostensibly, taxicabs would fill the role played by ridesourcing services *(1–4)*, but in many cities they have not, due to regulations and monopolistic behavior that restrict supply and give rise to reliability and service quality problems *(3–6)*. Critics, however, charge that ridesourcing services unfairly flout existing regulations, compete with public transit, increase congestion at peak times, mislead consumers through opaque pricing practices, and endanger public safety. This position holds that ridesourcing is no different from a taxi service and, as for taxis, regulations are needed to counteract negative externalities and other market failures inherent in the sector *(7)*. It rests on the argument that governments should enforce regulations consistently and, as *quid pro quo* for complying with regulations, taxi companies are entitled to certain market protections *(8)*.

As city leaders revise policies on ridesourcing services, there is an urgent need for independent analysis of their mobility and environmental impacts. In this paper, we explore ridesourcing's role in urban transportation, particularly in comparison with taxis, through an intercept survey of ridesourcing users in San Francisco. While the survey represents a limited sample of users, the results nevertheless suggest that ridesourcing services fill an important urban mobility gap. By comparing survey data with existing taxi usage data, we find that ridesourcing serves a similar demand to taxis, although some characteristics of users and trips differ considerably. In addition, our data show a substantial portion of sampled ridesourcing trips are spatially and temporally not well served by public transit, suggesting a complementary relationship with transit, at least for some trips. Ridesourcing users also appear to be less likely to own an automobile. These exploratory findings provide an initial picture of the ridesourcing market that, we believe, calls for further investigation. We begin the paper by describing the context for these services, including definitions and reviewing related literature and policy developments. After explaining the survey methodology, we discuss results and conclude with discussions on policy implications and suggestions for future research.

BACKGROUND

In recent years, advances in information and communication technology have enabled new services that provide a wide variety of real-time and demand-responsive trips. Companies such as Lyft, Sidecar, and Uber (specifically uberX) have emerged offering smartphone applications to link riders with community drivers. Passengers request a ride from a private passenger vehicle driven by a (usually) non-commercially licensed driver through the mobile application, which then communicates the passenger's location to drivers via GPS. These apps charge a distance-variable fare, approximately 80% of which goes to the driver, with the remaining to the ridesourcing service. Many of these applications maintain a rating system that allows for drivers and passengers to rate each other after the trip is completed. A passengers' credit card information can be saved within the system to facilitate future trips. Complete characterization of ridesourcing is difficult though, as the services are quickly evolving.

In recent months these services have grown rapidly in terms of customers, drivers, and geographic areas served. In their current state, these services appear similar to taxis, which has caused a great deal of policy confusion and tension around "fairness" in regulatory treatment between taxis and ridesourcing companies. Proponents of these services maintain they differ from taxis in that they are dynamically linking passengers together to share a ride.

Much debate has gone into defining these services. At this time, there is no consensus on terminology. Other names include: "Transportation Network Companies (TNCs)," "real-time ridesharing," "parataxis," "ridematching," "on-demand rides," and "app-based rides." We chose to refer to these services as "ridesourcing" because we believe it succinctly conveys the essential technology—a platform used to "source" rides from a driver pool.

Ridesourcing has roots in ridesharing and shares traits of traditional taxis. Despite the claims of some ridesourcing supporters, *ridesourcing* differs from *ridesharing,* which involves the grouping of travelers in a private vehicle, each heading to a similar destination, with the goal of reducing congestion, travel costs, fuel consumption, and vehicle emissions *(9)*. In comparison, *ridesourcing* drivers usually do not share a destination with passengers; instead, the driver's motivation is income. In some ways, ridesourcing may become more similar to ridesharing by allowing unrelated passengers to share a ride. However, ridesourcing in its current state more closely resembles a taxi in that a driver offers a ride in exchange for a fare. Ridesourcing proponents maintain that, unlike taxis, ridesourcing enables more efficient use of vehicle that drivers already own. Some also argue that ridesourcing differs from traditional taxis due to the efficiency and reliability of the matching platform and pricing mechanisms, along with the accountability of the rating system. On the other hand, ridesourcing's apparent efficiency advantages may also be explained by its exemption from the supply restrictions that often govern taxis. Further blurring definitions, taxi companies are increasingly adopting app-based dispatch. For example, as of October 2014, 80% of San Francisco taxis (1,450 taxis) were reportedly using the e-hail app Flywheel (Sachin Kansal, unpublished data). Not surprisingly, regulatory agencies have struggled with how to define these services and what regulations, if any, to impose.

We surveyed users of three main ridesourcing companies: Uber, Lyft, and Sidecar. Uber offers several options that include both ridesourcing and professional driver services. The cheapest, uberX, matches travelers with "regular" drivers who usually do not have a commercial vehicle license. uberX is more of a "pure" ridesourcing service than Uber Black and Uber SUV, which use dedicated vehicles and drivers with a for-hire license. Lyft and Sidecar both offer ridesourcing services that provide on-demand rides through a network of community drivers.

RELATED LITERATURE

At present, we are not aware of any published literature on ridesourcing, so we rely on related research on ridesharing and taxis to provide insights into expected usage characteristics and potential impacts. Empirical evidence indicates that ridesharing can provide transportation, infrastructure, and environmental benefits, although the exact magnitude of these impacts is not well understood. While not specific to ridesharing alone, one report estimated that using information and communication technology to optimize logistics of individual road transport could save 70 to 190 million metric tons of carbon dioxide emissions by 2020 in the U.S. *(10)*. Individually, ridesharing participants benefit from shared travel costs, travel-time savings from high occupancy vehicle lanes, reduced commute stress, and often preferential parking and other incentives *(9)*. Despite its benefits, there are several barriers to increased ridesharing use, including reluctance to sacrifice the flexibility and convenience of the private automobile *(11)*, desire for personal space and time *(12)*, and personal security concerns about riding with strangers. For decades, federal and local governments have promoted various ridesharing policies. While these policies may have had some success, ridesharing's modal share declined after the 1970s *(9)*, although according to census data has increased slightly in recent years.

Taxis have historically accounted for a very small share of urban travel and are much less extensively studied than other transport modes. Despite their small modal share, taxis fill a critical gap by providing transportation when driving or other public transit modes are not possible *(3, 4)*. Notably, authors have found taxis to be both complements and substitutes for public transit *(1, 2)*.

Research suggests unregulated taxi services can create public costs, and almost all large- and medium-sized cities have regulated taxis since the 1930s *(3)*. The taxi industry has at various times suffered from numerous market failures, providing the rationale for regulation *(3, 7)*. Lack of information is a problem in street-hail and cab-stand markets: riders cannot compare information on price or service quality before choosing a vehicle, often resulting in poor service quality. Low barriers to entry in these markets tend to enable over-competition, leading to aggressive and unsafe driver behavior, poor vehicle maintenance, and congestion *(7)*. Regulatory responses include restrictions on market entry and supply (i.e., medallion systems); fare regulation; and vehicle and driver safety standards. However, as technology evolves, hailing a for-hire vehicle no longer requires standing on a street corner or placing a telephone call, and rating systems might resolve the lack-of-information problem. These advances bring into question how the need for regulation may have changed.

POLICY DEVELOPMENTS

Not surprisingly, transportation innovation has begun to outpace policy. This became evident shortly after ridesourcing services launched in San Francisco, California in summer 2012. Without formal definitions and lacking understanding about public safety and transportation-related impacts, policymakers were compelled to consider whether these new services, which called themselves "ridesharing," fell under the classical definitions of ridesharing, for-hire vehicle services, or peer-to-peer taxis services. In August 2012, the California Public Utilities Commission (CPUC) issued cease and desist letters to Lyft, SideCar, and Uber, which were followed by citations of US$20,000 apiece in November 2012 for purported illegal operations *(13)*. After holding public workshops, the CPUC established a new category of motor vehicle carriers, known as Transportation Network Companies (TNCs), in September 2013. CPUC defined a TNC as an operator that "provides prearranged transportation services for compensation using an online-enabled application or platform (such as smartphone applications) to connect drivers using their personal vehicles with passengers" *(14)*. Under the new rules, companies that approved to operate as a TNC were required to get a license from the CPUC, conduct criminal background checks of all drivers, have a driver training program, maintain a "zero tolerance" policy on drugs and alcohol, and maintain at least US$1 million per incident insurance coverage. In June 2014, CPUC adopted additional policy guidance regarding secondary insurance during two key stages of TNC operations: 1) "app on" and 2) in-service (i.e., passenger(s) in the vehicle). This required secondary insurance during "app on" operations, as well as additional coverage for uninsured and underinsured motorist coverage, and comp and collision coverage during tripmaking *(14)*. In August 2014, the California legislature approved Assembly Bill 2293, which is awaiting the Governor's signature. Key provisions include the separation of personal auto insurance from the commercial activities of TNCs, establishing insurance requirements of $50,000 per an individual and $100,000 total primary liability coverage during periods when a TNC driver is logged in but not handling service calls, reaffirms the CPUC's oversight of TNCs, and provides an expedited approval process for TNC insurance products. If signed into law, the main provisions would take effect July 1, 2015.

In spring 2014, Seattle attempted to cap the number of ridesourcing vehicles, similar to the limits imposed on the number of taxi medallions. In July 2014, Seattle's ordinance was repealed removing the cap on these vehicles and increasing the number of new taxi licenses *(15)*. On the East Coast, initial program launches in New York City, Washington, D.C., and Philadelphia resulted in vehicle citations and impounded vehicles. In New York City, the Taxi and Limousine Commission issued citations and impounded vehicles, which ultimately resulted in the withdrawal of Sidecar operations, and a temporary restraining order was imposed that prevented the launch of Lyft services in the city. A similar restraining order was also enacted in St. Louis, Missouri. Washington, D.C. amended the municipal regulations to govern the operations of ridesharing companies that "digitally dispatch" vehicles-for-hire *(16)*. In Philadelphia, the Philadelphia Parking Authority, which regulates taxicabs and for-hire vehicles initially impounded vehicles and issued citations against Sidecar drivers but later permitted the service to operate as long as rides were free of charge.

A list of approved, discarded, pending, and proposed public policy actions in the U.S., as of August 2014, is included in Table 1. Policy remains in a state of flux as governments in and outside the U.S. continue to debate the issue.

Table 1 Existing and Proposed Ridesourcing Public Policies

Approved Legislation:

California: The California Public Utilities Commission (CPUC) requires Transportation Network Companies (TNCs) to conduct criminal background checks of all drivers, have a driver training program, maintain a "zero tolerance" policy on drugs and alcohol, and maintain at least $1 million per incident insurance coverage, $5,000 medical payment coverage, $50,000 comprehensive and collision coverage, and $1 million uninsured/underinsured motorist coverage per incident.

Colorado: SB 125 establishes a framework for ridesourcing services to provide commercial liability insurance coverage when a driver logs onto the mobile app and is available for hire.

Chicago, IL: City Council Substitute Ordinance 2014-1367 requires ridesourcing companies to provide $1 million in liability coverage and $1 million of coverage for drivers from the time a ride is accepted until completion.

Nashville, TN: Municipal ordinance passed amending local codes pertaining to vehicles for hire.

North Carolina: The General Assembly passed a law prohibiting the regulation of "digital dispatching" services by local governments.

Pennsylvania: The Pennsylvania Public Utility Commission (PPUC) approved Yellow Cab Company's application to establish a peer-to-peer ridesharing service, known as Yellow X.

Seattle, WA: The city council passed an ordinance requiring commercial insurance coverage for ridesourcing companies whenever a driver is "available" to drive.

Pending Legislation:

Baton Rouge, LA: Proposed ordinance would amend the parish code to allow for ridesourcing companies to operate without having to follow rules of the Taxicab Control Board.

California: In August 2014, the California legislature approved Assembly Bill 2293. Kev provisions include the separation of personal auto insurance from the commercial activities of TNCs, establishing insurance requirements of $50,000 per an individual and $100,000 total primary liability coverage during periods when a TNC driver is logged in but not handling service calls, reaffirms the CPUC's oversight of TNCs, and provides an expedited approval process for TNC insurance products. If signed by California's Governor, the law's main provisions would take effect July 1, 2015.

Charlotte, NC: The City Council Community Safety Committee is considering possible regulation of ridesourcing companies.

Columbus, OH: Proposed ordinance would amend the city's vehicle for-hire regulations to encompass peer-to-peer transportation services.

District of Columbia: The D.C. Taxi Cab Commission has issued proposed rules to regulate ridesourcing companies. B20-753 establishes minimum commercial insurance requirements for ridesourcing services and imposes new regulations on the inspection and licensing of for-hire vehicles by a new District.

Illinois: HB 4075 (The Ridesharing Arrangements and Consumer Protection Act) requires that drivers working more than 18 hours a week obtain special licenses and vehicle registration; ridesharing cars be less than four years old; and that vehicle dispatchers insure drivers who do not have insurance. HB 5331 decreases the required insurance coverage to $350,000 to mirror the insurance requirement of Chicago taxis.

King County, WA: The county is considering an ordinance that would regulate ridesourcing companies similar to taxis.

Minneapolis, MN: The city council is considering regulations for ridesourcing companies that would address a wide array of issues including insurance and inspections.

New Jersey: AB3362 would mandate the New Jersey Motor Vehicle Commission to establish insurance and safety requirements for ridesourcing companies.

Rhode Island: HB 8298 and SB3146 is a joint resolution to establish a special legislative commission to study the Public Motor Vehicle Act and the impact of innovative technologies on transportation services and report back to the state's General Assembly by March 31, 2015.

Virginia: HB908 and SB531 relax regulations that apply to ridesourcing companies.

Wisconsin: The Madison and Milwaukee City Councils are considering municipal ordinances to regulate ridesourcing.

Vetoed/Inactive Legislation:

Arizona: HB2262 limited an insurer's ability to exclude commercial activity in its contract by stating an exclusion for "commercial, fee or livery activities" is only applicable during a ridesourcing trip but not while a driver is looking for passengers.

Georgia: HB 907 originally sought to prohibit ridesourcing companies from operating in Georgia. The bill was later amended to regulate ridesourcing companies. ***Maryland:*** HB 1160 and SB 919 would have exempted ridesourcing companies from regulation and oversight that taxicab companies and drivers must adhere to. ***Oklahoma:*** SB1703 was intended to address insurance issues with ridesourcing companies and exempt its drivers from commercial operator insurance requirements. ***Washington:*** HB2782 would have directed the Joint Transportation Committee to study ridesourcing companies and issue a report to the state legislature on insurance, safety, and barriers faced by taxicab companies.
Cease and Desist Orders: ***Ann Arbor, MI:*** Cease and desist letters issued to Uber and Lyft. ***Columbus, OH:*** City orders Uber and Lyft to cease and desist operations. ***Nebraska:*** Cease and desist letters issued to Lyft and Uber by the Nebraska Public Service Commission. ***New Mexico:*** Cease and desist order issued to Lyft by the Public Regulation Commission. ***St. Louis, MO:*** Cease and desist order issued by the taxi commission. ***Texas:*** Cease and desist orders issued by Austin, Dallas, Houston and San Antonio. ***Virginia:*** Cease and desist orders issued to Uber and Lyft by the Department of Motor Vehicles.
Temporary Restraining Orders: ***Kansas City, MO:*** Temporary restraining order filed against Lyft. ***New York City:*** Temporary restraining order filed against Lyft.

Sources: Property Casualty Insurers Association of America
Jergler, D. "Uber, Lyft, Sidecar Toe-to-Toe with Insurers State-by-State" The Insurance Journal. June 27, 2014. http://www.insurancejournal.com/news/national/2014/06/27/332942.htm
Daus, Matthew. "Ridesharing Applications: Illegal 'Hitchhiking-for-Hire" or Sustainable Group Riding?" May 2013
http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M098/K126/98126852.PDF
http://www.cpuc.ca.gov/PUC/Enforcement/TNC/

It is in this environment of evolving technology and policy that we conducted this study. At present, the emergence of ridesourcing companies draws attention to a gap in the transportation system not quite met by the taxi and ridesharing market. With characteristics similar to taxis, but also the potential to realize some of the benefits of both taxis and ridesharing, ridesourcing poses a challenge for regulators. In this working paper, we hope to contribute initial empirical evidence to this discussion.

METHODOLOGY

To collect data on ridesourcing users and trips, we conducted an intercept survey in San Francisco during May and June 2014. The survey was conducted by intercepting ridesourcing customers on the street in key locations expected to have a high concentration of such users. We identified potential locations based on conversations with drivers and our own observations. After conducting pretests at these locations, we chose the three with the highest response rates (see Figure 1):

1) Mission District (Valencia Street between 16th Street and 19th Street, and 16th Street between Mission Street and Guerrero Street);
2) Marina District (Chestnut Street between Pierce Street and Laguna Street); and
3) North Beach (Columbus Avenue between Broadway and Union Street).

The pretests yielded an acceptable response rate only in evenings and during peak hours—Thursdays from 5:30pm to 8:30pm, Fridays 6:30-9:30pm, and Saturdays 7:30-10:30pm. In June, surveying on Wednesdays from 6:30-9:30pm was added, and Saturday surveying was shifted to 6:30-9:30pm in response to surveyor feedback from the field. While ridesourcing companies and drivers advised many trips are taken throughout the day, including the AM and PM commute, pretesting conducted downtown during commute times yielded an extremely low response rate; hence, we did not attempt to survey at these times and locations.

Surveyors recruited two types of potential respondents: individuals who had just completed a ridesourcing trip ("intercept trips"), and individuals passing on the street who had used ridesourcing within the last two weeks ("previous trips"). Both groups responded to identical surveys. Surveyors were instructed to prioritize intercepting anyone exiting a ridesourcing vehicle, which were identifiable either by a sign (e.g., the company's logo or Lyft's pink mustache), passengers riding in the backseat, or a driver using the company's smartphone app. Our pretests suggested it was relatively easy to distinguish ridesourcing vehicles and passengers from those getting a ride from a friend or family member simply based on the passenger and driver behavior. The intercepted respondents were asked about the trip they just completed (i.e., an intercept trip). For the "previous trips," surveyors were instructed to intercept every fifth person encountered on the sidewalk. These individuals were asked if they had taken a ridesourcing trip within the past two weeks. If not, they were not eligible to complete the survey. If so, they were asked to recall their most recent trip. Those approached who did not have time to complete a survey were given a link to an equivalent online survey, which they could complete later on a computer or smartphone.

Of the 757 approached to participate in the survey over two months, 380 completed the questionnaire (i.e., response rate of 50.2%). Of the n=380 completed responses, 294 (77%) were about trips within San Francisco, but 21 (6%) had at least an origin or destination elsewhere in the Bay Area, and 24 (6%) answered about trips entirely outside of San Francisco. Another 41 (11%) were discarded due to missing data (e.g., missing origin/destination, unintelligible locations). This analysis focuses mainly on trips taken within San Francisco. Of the 380 trips, 316 (83%) were "previous trips," while 64 (17%) were "intercept trips." For analysis of demographics and non-location-specific topics, we include all Bay Area trips, as noted in the findings.

The survey asked 18 questions regarding trip origin and destination, trip purpose, previous and alternative modal choice, car ownership, and basic demographics. After survey completion, respondents received a US$5 gift card to a local coffee vendor. Survey instruments were pre-tested and modified slightly based on user feedback.

We compare ridesourcing survey data with data from three other sources: (1) a survey of taxi users conducted for the San Francisco Municipal Transportation Agency (SFMTA), (2) trip logs from one medium-sized taxi company in San Francisco, and (3) the American Community Survey (ACS) 2012 one-year estimates. The SFMTA taxi user survey, completed in early 2013, was a telephone survey of a representative sample of San Francisco households that asked questions about respondents' typical taxi usage *(5)*. The taxi trip log data included origins, destinations, fare, distance, and passenger data for all trips provided by the company's vehicles in October 2013. To enable a matched comparison between taxis and ridesourcing, a random sample of taxi trips was generated to match the day of the week and time of day of surveyed ridesourcing trips. For example, for each surveyed ridesourcing trip that took place on Fridays between 7-8 PM, one taxi trip was randomly selected from the same Friday, 7-8 PM time period. From the approximately 150,000 logged taxi trips, 290 trips overlapped with ridesourcing trips. While the dates of the ridesourcing survey did not align with the taxi trip logs, all observations excluded summer vacation and rainy seasons, which are factors that can influence travel behavior. The ACS data provided information on demographic characteristics of the San Francisco population for comparison.

Limitations

Like all intercept surveys, this survey was not completely representative of the ridesourcing market. Data were collected from three neighborhoods, capturing primarily evening trips to dining and entertainment venues. While these social, evening trips likely comprise a large—and perhaps the largest—part of the ridesourcing market, other types of trips are underrepresented. Informal conversations with drivers tell us many people use ridesourcing services for their commute, airport trips, and other errands. Thus, the survey does not adequately capture these trips. Respondents did not represent all ridesourcing users in San Francisco or the greater Bay Area. The survey oversampled users who were likely to be in the survey locations in the evenings. Given these limitations, we intend this as an exploratory study that can guide future research.

RESULTS

In this section, we discuss key findings from the intercept survey including user demographics, trip characteristics, and reasons for using ridesourcing. We compare ridesourcing survey data with census and taxi data and public transit availability.

Ridesourcing Market Share

Of all surveyed trips, uberX provided the majority (53%), while other Uber services (black car, SUV) represented another 8%. Lyft provided 30% of trips, Sidecar 7%, and the remainder was other services. This is consistent with anecdotal information on the market share of each service.

Respondent Demographics

Respondents were generally younger and better educated than the average population in San Francisco (see Table 2). The age distributions for ridesourcing and frequent taxi users skew younger than that for the city as a whole. Compared with frequent taxi users, as reported in the SFMTA taxi survey, ridesourcing survey respondents were generally younger, although this difference may be influenced by the sampling method—individuals surveyed may be younger on average than the actual ridesourcing user base.

Table 2 Descriptive Statistics of Survey Respondents

Age	*Ride-sourcing*	*%*	*Taxi %* [a]	*SF %* [b]
15-24	50	16%	3%	11%
25-34	178	57%	43%	22%
35-44	59	19%	27%	16%
45-54	20	6%	13%	14%
55-64	3	1%	9%	12%
65-74	0	0%	4%	7%
75+	0	0%	2%	7%
n	*310*			

Gender	*Ride-sourcing*	*%*	*Taxi %* [a]	*SF %* [b]
Female	124	40%	n/a	49%
Male	184	60%	n/a	51%
n	*308*			

2013 Household Income	*Ride-sourcing*	*%*	*Taxi %* [a]	*SF %* [b]
$30K or less	28	9%	n/a	26%
$30-70K	74	23%	n/a	22%
$71-100K	56	18%	n/a	13%
$100-200K	86	27%	n/a	25%
$200K+	35	11%	n/a	13%
(Decline to Respond)	37	12%	n/a	n/a
n	*316*			

Education	*Ride-sourcing*	*%*	*Taxi %* [a]	*SF %* [b]
Less than a bachelor's degree	51	16%	n/a	46%
Bachelor's degree	173	54%	n/a	33%
Graduate degree (Master's/Ph.D.)	87	27%	n/a	21%
Other degree	10	3%	n/a	n/a
n	*321*			

Sources:
[a] *2013 SFMTA taxi user survey*
[b] *2012 ACS one-year estimate*

Respondents were relatively well educated–84% of customers had a bachelor's degree or higher, more than for the general San Francisco population. Surveyed ridesourcing customers matched the income profile of San Franciscans fairly closely, with the prominent exception that households making less than US$30,000 were underrepresented. However, a high percentage of respondents (12%) refused to answer; these individuals may not have the same distribution as the rest of the sample. Note that income and education data for taxi users are not available.

Measured by home zip code, survey respondents reflected most of the spatial distribution of population in the city, except respondents were more likely to live in the Marina, Russian Hill, Nob Hill, and Castro neighborhoods. Neighborhoods in the southern part of the city, like Outer Mission and Bayview, were underrepresented.

Trip Origins and Destinations

The survey captured trips from across San Francisco and elsewhere in the Bay Area, as did the sampled taxi trips. The spatial distribution of trip origins and destinations within San Francisco is shown in Figure 1. As expected, the ridesourcing destinations are concentrated in the three survey locations, while the taxi origins and destinations are more concentrated in the downtown area. Still, both cover similar areas: for the sampled taxi trips, more than half (58%) of ridesourcing trips began within 200 m of the taxi trip, and 81% within 400 m. (The same numbers for destinations were 51% and 86%, respectively.) Since we lack data on the overall spatial distribution of ridesourcing trips, we cannot say how representative our data are.

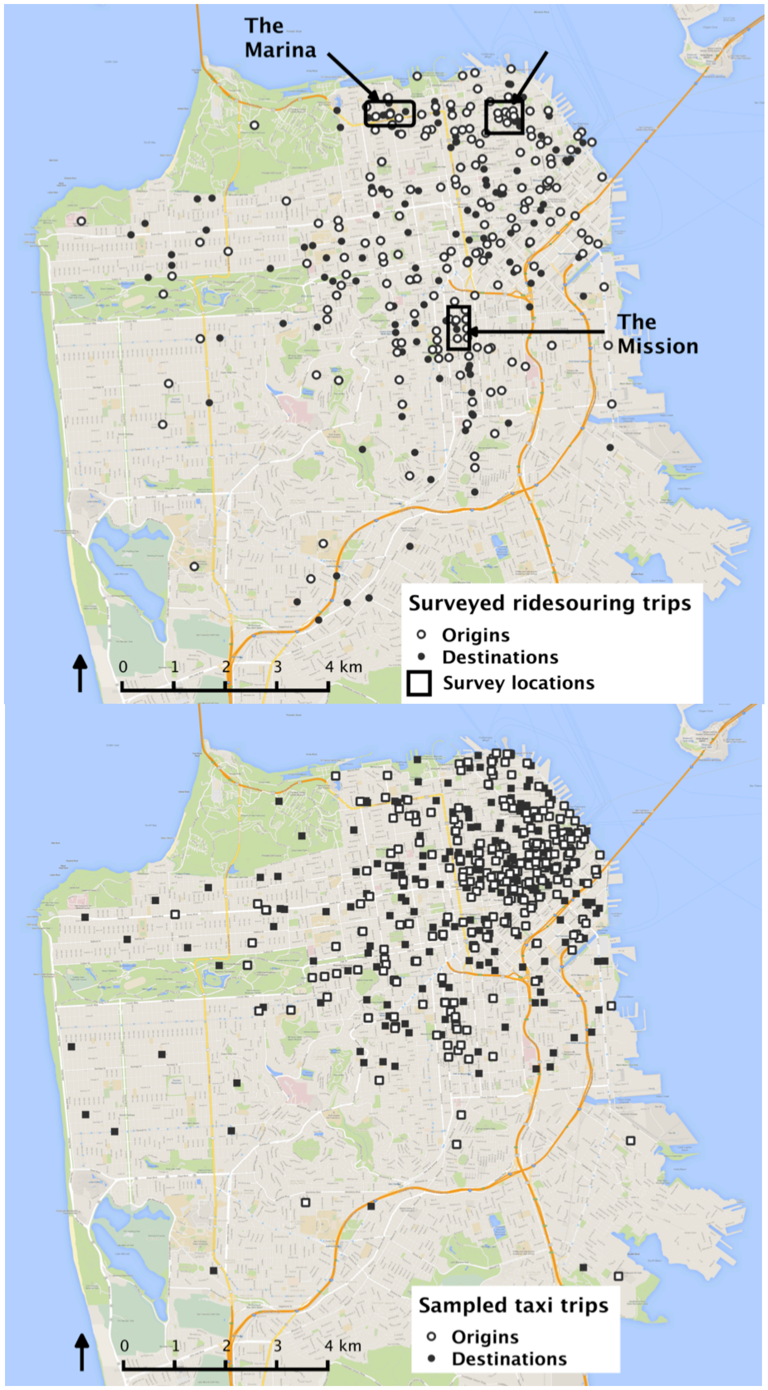

Figure 1 Sampled ridesourcing and taxi trips in San Francisco (Ridesourcing N = 294, Taxi Sample N = 290)

Trip Purpose

As expected, trips were mainly social and leisure trips. Of all responses, 67% were social/leisure (bar, restaurant, concert, visit friends/family). Only 16% were work, 4% were to or from the airport, and 10% were other (doctor's appointment, volunteer). A large percentage (47%) of trips began somewhere other than home or work—a restaurant, bar, gym, etc.—and 40% were home-based. Although the survey did not ask about connections with public transit, 4% named a specific transit station as their origin or destination, suggesting that many respondents used ridesourcing to access transit. Almost half (48%) occurred on Friday or Saturday. While evening hours are heavily represented, the survey did capture trips at times throughout the day and night.

Trip Distance and Vehicle Occupancy

Surveyed ridesourcing trips were slightly shorter than matched taxi trips, but they carried more passengers. Trip distances and travel times were calculated by entering the geocoded origins and destinations into Google Directions API; trip lengths therefore reflect the street network distance. Of ridesourcing trips with a destination in San Francisco, the average length was 4.9 km (3.1 miles), while equivalent taxi trips were on average 6.0 km (3.7 miles).

Vehicle occupancies were somewhat higher than for taxi trips and about the same as for driving journeys-to-work. Half of ridesourcing trips had more than one passenger, and the average number of passengers was 1.8. For the matched taxi sample, the average was only 1.1. According to the 2011 ACS, the average vehicle occupancy for work trips of San Francisco workers, it was 1.15. For surveyed ridesourcing journeys-to-work trips within San Francisco, the average occupancy was nearly the same, 1.14.

Combining trip distance and vehicle occupancy, ridesourcing provided more overall mobility in fewer vehicle kilometers/miles. The average passenger kilometers/miles traveled for ridesourcing was 8.3 km (5.14 miles), while vehicle kilometers/miles traveled (averaged to 5.0 km (3.12 miles). Those figures for taxis were 6.5 km (4.02 miles) and 6.0 km (3.70 miles), respectively. Therefore, for the sampled trips, ridesourcing was somewhat more efficient.

Wait Time

Ridesourcing wait times are dramatically shorter than typical taxi dispatch and hail times (Table 2). When calling a taxi to their home, only 35% of San Francisco residents said they usually waited less than ten minutes on a weekday during the day; on nights and weekends, this figure dropped to 16%. By comparison, close to 90% of ridesourcing respondents said they waited ten minutes or less, at all times, and 67% waited five minutes or less. Ridesourcing wait times are also much more consistent than those of taxis: whereas taxi waits are more variable by time and day, ridesourcing customers could expect a wait of ten minutes or less regardless of day or time.

The discrepancy in wait times might result from location biases in our sample, since most surveyed ridesourcing trips did not begin at home, while the taxi survey asked about home location. However, when we analyzed the data by city zone, as defined in the taxi survey, the pattern of shorter and more consistent wait times held (Table 3). Ridesourcing response times were longer in Zone 1 (which includes downtown) than other parts of the city, but the difference was very small compared with the variation in taxi times. For instance, on a weekday before 6pm, 88% of ridesourcing wait times in Zone 1 were ten minutes or less, whereas only 43% of taxi dispatches were as quick. Wait times for taxi street hails show the same pattern of longer and less consistent wait times relative to ridesourcing. The lowest wait times for street hails were in Zone 1 during weekdays; even then only 53% of respondents said they could hail a taxi in ten minutes or less.

Bias and inaccuracy in respondent perception or recollection of wait time might partially account for the difference between modes. For instance, ridesourcing apps provide the user with an estimated wait time, but the actual wait time may be longer—without the user noticing or recalling the longer wait. In contrast, respondents may overestimate taxi wait times. For example, they may recall one negative experience more than several positive ones. Even so, ridesourcing's short wait times and consistency across time and location—or at least perceptions of quick, consistent response—represent an important difference between ridesourcing and traditional taxis services from the user's perspective. Since our survey, more taxis have adopted e-hailing apps, such as Flywheel, which reportedly have brought taxi wait times closely in line with those of ridesourcing (Sachin Kansal, unpublished data).

Table 3 Ridesourcing Wait Times Compared with Taxi Dispatch and Hail Times

	Ridesourcing[a]						**Taxi Dispatch to Home**[b]						**Taxi Hail Near Home**					
	All	Zone[d]					**All**	Zone					**All**	Zone				
		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5
Mon-Fri 4am-6pm																		
<= 10 mins	**93%**	88%	100%	n/a	83%	100%	**35%**	43%	42%	23%	25%	36%	**39%**	53%	46%	6%	24%	30%
10-20 mins	**7%**	12%	0%	n/a	17%	0%	**41%**	41%	42%	41%	48%	38%	**29%**	32%	27%	17%	29%	36%
> 20 mins or never[c]	**0%**	0%	0%	n/a	0%	0%	**23%**	16%	16%	36%	27%	26%	**32%**	15%	27%	78%	48%	33%
n	***97***	*43*	*24*	*n/a*	*6*	*14*	***282***	*79*	*57*	*39*	*56*	*47*	***226***	*81*	*48*	*18*	*42*	*33*
Mon-Fri 6pm-4am																		
<= 10 mins	**92%**	89%	100%	n/a	93%	100%	**16%**	17%	16%	14%	6%	27%	**33%**	38%	40%	0%	24%	36%
10-20 mins	**6%**	10%	0%	n/a	7%	0%	**47%**	43%	54%	45%	54%	35%	**31%**	39%	21%	17%	31%	38%
> 20 mins or never	**1%**	2%	0%	n/a	0%	0%	**37%**	40%	30%	41%	40%	38%	**36%**	23%	38%	83%	44%	26%
n	***144***	*61*	*30*	*n/a*	*15*	*23*	***254***	*77*	*56*	*29*	*52*	*37*	***230***	*82*	*42*	*18*	*45*	*39*
Sat-Sun																		
<= 10 mins	**88%**	85%	100%	n/a	100%	89%	**16%**	23%	16%	12%	7%	17%	**25%**	33%	18%	0%	20%	32%
10-20 mins	**12%**	15%	0%	n/a	0%	11%	**39%**	28%	36%	54%	50%	37%	**35%**	43%	36%	19%	33%	32%
> 20 mins or never	**0%**	0%	0%	n/a	0%	0%	**45%**	49%	47%	35%	43%	46%	**39%**	24%	45%	81%	48%	37%
n	***75***	*39*	*13*	*n/a*	*8*	*9*	***251***	*75*	*55*	*26*	*56*	*41*	***232***	*86*	*44*	*16*	*46*	*38*

[a] The survey question read: "About how long did you wait for your ride (from the time you made the request to the time the vehicle arrived)?"
[b] Taxi survey questions read: "Thinking about the times you've used a San Francisco taxi in the past 6 months, approximately how long does it take…" "…for a cab to arrive to your home after you've called taxi dispatch?" and "… to hail a cab in a street near your home?"
[c] The taxi survey included the response option: "Often never arrives." This was not included in the ridesourcing survey.
[d] Zones are defined to include the following neighborhoods: Zone 1—Chinatown, Civic Center/Downtown, North Embarcadero, Potrero Hill, SOMA; Zone 2—Laurel Heights/Anza Vista, Marina, Pacific Heights, Richmond, Sea Cliff, Presidio, Western Addition; Zone 3—Inner Sunset, Sunset, Lake Merced; Zone 4—Diamond Heights, Excelsior, Outer Mission, Haight-Ashbury, Ingleside, Noe Valley, Upper Market, West of Twin Peaks; Zone 5—Bayview/Hunters Point, Mission, Bernal Heights, Portola, Visitacion Valley.
n/a indicates there were too few observations available to calculate percentage.

Vehicle Ownership and Driving Frequency

Ridesourcing serves many residents who do not own a car. While the majority of respondents said they had a vehicle at home, the proportion that was car-less (43%) was greater than that for frequent taxi users (35%) and for the overall city population (31%). Ninety percent of vehicle owners said they had not changed their ownership levels since they began using ridesourcing and those who did were as likely to own more cars as those with fewer, so the change likely had little to do with the presence of ridesourcing. However, ridesourcing appears to have allowed some people to drive less frequently. Of respondents who owned a car, the majority said they drove about the same as before they started using ridesourcing; however, 40% said they drive less.

Modal Shift and Induced Travel

Respondents were asked if they still would have made the trip had ridesourcing services not been available and, if so, how they would have traveled. An overwhelming 92% replied they still would have made the trip. This suggests ridesourcing has a small but not inconsequential (8%) induced travel effect. Of those who would have still made the trip, a large number (39%) said they would have used a taxi, while 33% said bus or rail, and 6% drive (Table 4).

Table 4 How Would You Have Made This Trip If uberX/Lyft/Sidecar Were Not Available?

	All respondents	Do you have a car at home?	
		Yes	No
Taxi	39%	41%	35%
Bus	24%	17%	33%
Rail (BART, streetcar, Caltrain)	9%	7%	10%
Walk	8%	9%	6%
Bike	2%	2%	3%
Drive my own car	6%	10%	0%
Get a ride with friend/family	1%	1%	2%
Other*	11%	12%	10%
Total	100%	100%	100%
n	*302*	*175*	*124*

* *"Other" includes several responses indicating the respondent would have used another ridesourcing service, even though they were instructed not to.*

The cross-tabulation of reason by alternative mode suggests speed (shorter wait times and travel times) and convenience make ridesourcing more appealing than the alternatives (Table 5). Those who would have taken the bus are drawn to the ease-of-payment and travel time savings of ridesourcing. Those who would have taken a taxi prefer convenience—ease of call and payment and perceived shorter wait times—of ridesourcing. Note that those who would have taken a taxi do not consider ridesourcing to generally be cheaper, faster, or more reliable; the convenience factor seems to be key. Those who would have otherwise driven might have been drawn to the ability to avoid parking hassles and drinking and driving.

Table 5 Reasons For Choosing Ridesourcing By Alterative Mode

	How would you have made this trip, if Lyft/Uber/Sidecar were not available?							
Reasons for choosing ridesourcing	Bus	Rail	Taxi	Walk	Bike	Drive	Get a ride	Other
Ease of payment	10%	14%	25%	8%	0%	14%	0%	13%
Short wait time	12%	16%	17%	14%	0%	11%	0%	16%
Fastest way to get there	24%	22%	9%	16%	25%	6%	0%	8%
Easy to call car	11%	8%	11%	16%	8%	8%	13%	8%
Didn't want to drive after drinking	8%	8%	10%	4%	8%	19%	0%	19%
Don’t need to park	9%	10%	7%	10%	8%	25%	13%	8%
Reliable	8%	6%	7%	6%	0%	11%	13%	9%
Comfort/safety	8%	6%	5%	4%	8%	3%	0%	8%
Cost (cheaper than alternatives)	5%	6%	3%	8%	17%	0%	0%	8%
No public transit option	2%	0%	2%	8%	0%	0%	38%	2%
Could not get taxi	1%	0%	0%	2%	8%	3%	25%	0%
Other reason	2%	4%	3%	2%	17%	0%	0%	3%
Total	100%	100%	100%	100%	100 %	100%	100%	100%
n	*139*	*50*	*236*	*49*	*12*	*36*	*8*	*64*

Reasons for Choosing Ridesourcing

When asked why they chose ridesourcing, variations on speed and convenience were the main attractions (Figure 2), but other reasons were important too. More than 20% said they wanted to avoid drinking and driving. Only 2% said they couldn’t get a taxi, and only 4% said public transit was not available.

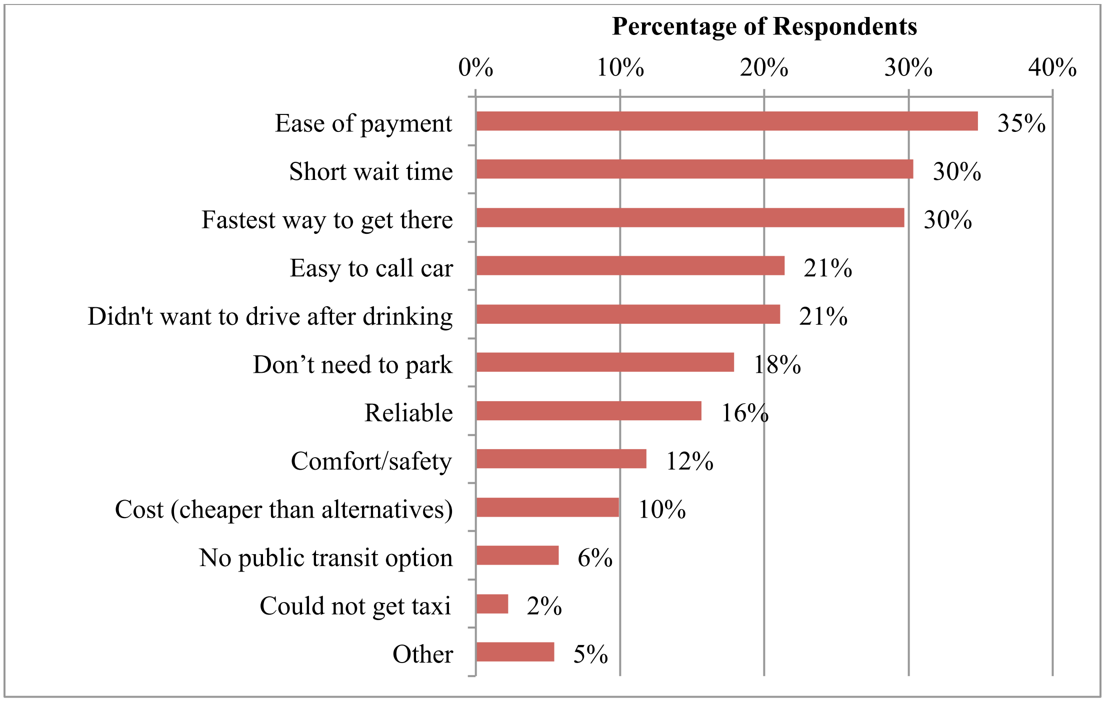

Figure 2 Responses to "What are the top two reasons you used [X service] for this trip? (n = 313).

Reasons for using ridesourcing varied by alternative mode. Among those who would have taken the bus, the most common responses were "fastest way to get there" (24%) and short wait time (12%). For those who would have taken a taxi, the top reasons were about convenience—25% said ease of payment, 17% said short wait time, and 11% said easy to call car. These particular respondents did not consider ridesourcing to be generally cheaper or more reliable—only 3% said they chose ridesourcing due to cost and only 7% cited reliability. Users who would have otherwise driven appeared to want to avoid driving hassles. Of these respondents, the greatest number (25%) said: "don't need to park" and 19% "didn't want to drive after drinking." Overall, speed (shorter wait times and travel times) and convenience appear to make ridesourcing more appealing than the alternatives.

Public Transit Analysis: Complement or Substitute

We investigated the extent to which ridesourcing complements or competes with public transit using two measures: proximity to transit stops and relative transit travel time. If a trip begins and ends within a typical walking distance, 400 m (1/4 mi) of a rail transit station (streetcar, subway, or commuter train) and during service hours, it is a possible transit substitute. Even in this case, the trip could serve a complementary role to public transit—e.g., the trip would require transfers, the traveler is carrying heavy items, is running late, or feels unsafe walking to the transit stop. We calculated transit accessibility by selecting origins and destinations of trips lying within a 400m buffer of rail transit stations and within 200 m (1/8 mi) of bus stops. Trips included only those made during normal transit service hours.

To estimate travel time by public transit and by driving, as well as transfers required, geocoded origins and destinations for each trip were entered into the Google Directions API. For transit time, departure time was defined using the survey response for time of day and day of week. Google Directions calculates the travel duration as the sum of in-vehicle time, walking time to and from the public transit stop, and, if there are transfers, the transfer wait time. It does not include the wait time for the first vehicle; it directs the traveler to depart at precisely the correct time to minimize the wait time. In reality, most travelers will not calculate their departures so precisely. Wait time was estimated as the difference between the given departure time as defined by the survey response time and the suggested departure time returned by Google Directions. (In a few cases, it was faster to simply walk than take public transit; these are included with transit wait time equal to zero.) The estimated total transit travel time equals travel duration plus wait time. For ridesourcing, the wait time was estimated as the midpoint of the interval provided in the survey response (e.g., 1 to 5 minutes, 6 to 10 minutes). The taxi trip log did not include wait times, so we conservatively assumed a wait time of five minutes, at the low end of the wait times suggested by the taxi user survey. The estimated total travel time by ridesourcing (or taxi) equals the travel duration by driving plus the wait time. Of trips that began and/or ended in San Francisco, we were able to obtain transit and driving directions for 283 observations (the remainder were missing departure time information).

Of the ridesourcing trips, 28% began and ended within 400m of rail transit (Table 6). That is, just over a quarter were plausibly rail transit substitutes. Many more (81%) were accessible by bus, although fewer (63%) were bus-accessible and did not require a transfer. We observed similar values for the sampled taxi trips.

Table 6 Public Transit Accessibility and Estimated Travel Times for the Surveyed and Sampled Trips

	Ridesourcing trips	**%**	**Taxi trips**	**%**
<400m of rail station	79	28%	85	31%
<200m of bus stop	230	81%	213	77%
Requires transfer	78	28%	64	23%
<200m of bus stop, no transfer	177	63%	166	60%
Trips that are twice as long by public transit	185	66%	169	61%
Trips that are 50% or longer by public transit	243	86%	242	88%
Average total time by transit (mins) (wait + travel)	32.5		31.0	
Average total time by ridesourcing/taxi (mins) (wait + travel)	22.1		23.7	
Average travel time by transit (mins) (in-vehicle + walk access + transfer wait)	27.8		26.6	
Average travel time by ridesourcing/taxi (mins) (in-vehicle only)	17.0		18.7	
Average wait time by transit (mins)*	5.7		5.5	
n	*283*		*277*	

**Excludes "transit" trips that are walking only.*

Not surprisingly, estimated total travel times, including wait and in-vehicle times, were consistently greater for transit than ridesourcing, although a few trips would have been faster by transit (Figure 3). The estimated average total travel time was 22 minutes for ridesourcing trips, while the same trips would have taken on average 33 minutes by public transit; a typical ridesourcing trip saves about 10 minutes of travel time. These figures do not appear to be significantly different for taxis. Overall, 66% of ridesourcing trips would have been at least twice as long in minutes if taken by public transit. These trips would not have been easily made by public transit, indicating a possibly complementary relationship with transit.

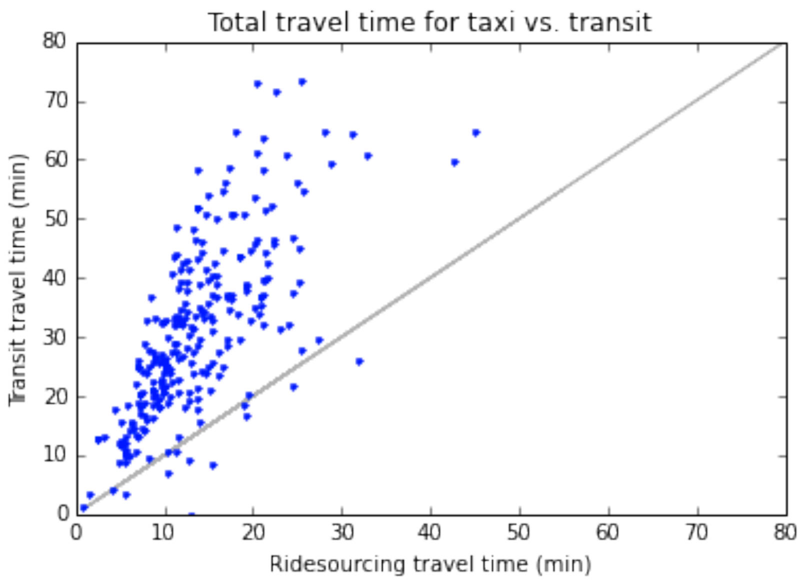

FIGURE 3 Comparison of transit travel time with ridesourcing travel times (total travel time = wait + in-vehicle time)

DISCUSSION

The survey data provide some evidence of ridesourcing's relation to taxis and public transit and the impact on automobile use and overall mobility. The data suggest that ridesourcing services and taxis serve a similar market demand: the plurality of ridesourcing users said they would otherwise have used a taxi for the same trip, and the trips covered similar areas and trip lengths. Yet, users of each service experienced very different wait times. Ridesourcing response times were not only much shorter overall, they were markedly more consistent across day, time, and location. While there may be some bias in respondent recall of wait time, it is unlikely this would affect the consistency across time or space. Previous studies have found short wait times and real-time arrival information to be critical for public transit *(17, 18)*, and these factors are likely equally critical for ridesourcing users, as noted by the respondents themselves. Notably, wait times appear to be reliably short in outer parts of the city, where public transit and traditional taxi service are sparser and auto dependency is higher. Ridesourcing's gap-filling role may be especially important in improving access to these neighborhoods; this is a question for future research.

Compared with taxi users, surveyed ridesourcing customers own fewer vehicles and travel with more companions. Both of these findings might be associated with less vehicle travel—ridesourcing might allow users to own fewer cars, and passengers get more mobility for less VKT/VMT—at least for the surveyed trips. However, these findings might be a consequence of the sampling method, ridesourcing user age, or both. People at the survey locations might be younger and more social than average and hence might be less likely to own a car and more likely to travel in groups. Moreover, the overall impact on VKT/VMT depends on the number of extra kilometers/miles driven by ridesourcing vehicles between passenger rides. This analysis is beyond the scope of this study but warrants future investigation.

The survey provides evidence that ridesourcing both complements and competes with public transit, at least with respect to individual trips. About a third of respondents said that they otherwise would have used transit, and respondents often chose ridesourcing due to its travel time savings. The majority of trips were accessible by transit, but most would have taken more than twice as long by public transit. The 43% of ridesourcing users without a vehicle likely use public transit at least occasionally, and some ridesourcing trips began or ended at a specific transit stop. Ridesourcing, therefore, appears to substitute for long transit trips, but otherwise it complements public transit.

The survey provides tentative evidence that ridesourcing enables lower levels of driving among vehicle owners. However, so far ridesourcing seems to have had little impact on auto ownership, which is not surprising given the newness of these services. Notably, a large number of car owners used ridesourcing to avoid drinking and driving—clearly a positive effect—although we cannot say if taxis would have performed this function equally. Just four stated induced trips were associated with drinking/driving avoidance. We also found a small induced travel effect of people who took trips they otherwise would not have. It is possible the data underestimate this effect. San Francisco contains several neighborhoods with poor transit access, poor taxi availability, or scarce parking. Travelers who previously avoided these neighborhoods might now consider them accessible, perhaps without being conscious of the effect. Without ridesourcing, they may have chosen a different destination or forgone the activity altogether; our intercept survey may not have captured this decision-making process. Thus, our results should be interpreted as a lower bound on the induced travel effect.

To reiterate the study limitations, the survey was not representative of the ridesourcing market, but oversampled social and leisure trips. Therefore, it likely underrepresented trips made for work purposes, airport trips, and other errands. Despite this limitation, our intercept survey provides the best data available on this emerging service. At present, ridesourcing is a new and controversial subject, and access to industry and membership data for research purposes is limited. Since data on ridesourcing market size and user characteristics are unavailable, we are unable to describe the sample relative to the larger user population.

San Francisco may not be a typical market for ridesourcing. As the birthplace of these services, San Francisco probably has the highest adoption rate, implying a greater density of drivers and users, and hence efficiency, compared with other cities. The city is well-suited for ridesourcing for several other reasons: it has a restricted taxi supply *(5)*, scarce parking, an incomplete public transit system, an urban form that lies somewhere between walkable and car-oriented *(19)*, and a large population of highly paid young professionals. Cities like Boston, Seattle, and Washington, D.C. share these traits, although other cities in which ridesourcing operates do not.

CONCLUSIONS

As a relatively new transportation option, ridesourcing is not yet well understood. In this paper, we presented exploratory evidence of its role in urban transportation using an intercept survey of ridesourcing users in San Francisco. We compared the survey results with data from a previous taxi survey and taxi trip logs, as well as public transit. The findings suggest ridesourcing meets a latent demand for urban travel, appealing to generally younger, well-educated users looking for short wait times and fast point-to-point service, while avoiding the inconveniences of driving like parking and having to drink and drive. Despite similarities, ridesourcing differs from taxis in important ways, especially in consistently shorter waiting times. Ridesourcing competes with public transit for some individual trips, but often appears to serve as a complement. The majority of ridesourcing trips would have taken more than twice as long if made by public transit. Finally, ridesourcing might replace some private automobile use, but because it might also induce travel, the impacts on overall VKT/VMT and traffic volume are uncertain.

Although still exploratory, these findings nevertheless indicate ridesourcing enriches mobility options for city dwellers, particularly in large, dense cities like San Francisco where parking is constrained and public transit incomplete. Thus, outright bans on ridesourcing would negate these mobility gains. Ridesourcing may also have negative aspects not captured in our survey results, and further work is needed to better understand its impacts.

Future research should investigate the potential hypotheses outlined in this study using more representative data. Access to ridesourcing trip and user data would provide a much more detailed and representative picture. Other aspects could be captured using online or household surveys. Future research could attempt to measure the induced travel effect or the possible long-term impact on driving and vehicle ownership. It is still unclear which advantages of ridesourcing arise from essential characteristics of the services (e.g., app-based hailing) versus from its exemption from taxi regulations. Studies could also expand the scope to include other neighborhoods in San Francisco or other cities. As ridesourcing and similar travel modes rapidly evolve, other questions will surely emerge.

ACKNOWLEDGMENTS

We thank the University of California Transportation Center and Transportation Sustainability Research Center at UC Berkeley for supporting this research. The San Francisco Municipal Transportation Agency helpfully provided us with the taxi data. Thanks also go to the student researchers who helped with data collection and processing: Dylan Baker, Apaar Bansal, Shuchen Gong, Lindsay Lewis, Brandon Harrell, An-Yu Liu, Rebecca Lopez, Kevin Otis, Samuel Penny, Diwen Shen, Christine Vandevoorde, and Isabel Viegas. Ian Johnson assisted with the taxi data. The contents of this paper reflect the views of the authors and do not necessarily indicate sponsor acceptance.

CORRECTION

This paper was updated 9/2/2014 to include approved and pending legislation in California. It was further updated 11/15/2014 to reflect additional analysis and discussion.

REFERENCES

1. King, D. A., J. R. Peters, and M. W. Daus. Taxicabs for Improved Urban Mobility: Are We Missing an Opportunity? Presented at the Transportation Research Board 91st Annual Meeting, 2012.
2. Austin, D., and P. Zegras. Taxicabs as Public Transportation in Boston, Massachusetts. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2277, 2012, pp. 65–74.
3. Gilbert, G., and R. E. Samuels. *The Taxicab: An Urban Transportation Survivor*. University of North Carolina Press, Chapel Hill, 1982.
4. Wohl, M. The Taxi's Role in Urban America: Today and Tomorrow. *Transportation*, Vol. 4, 1975, pp. 143–158.
5. Hara Associates. *Best Practices Studies of Taxi Regulation: Taxi User Surveys*. SFMTA, San Francisco, 2013.
6. Cervero, R. *Paratransit in America: Redefining Mass Transportation*. Praeger, Westport, CT, 1997.
7. Schaller, B. Entry controls in taxi regulation: Implications of US and Canadian experience for taxi regulation and deregulation. *Transport Policy*, Vol. 14, 2007, pp. 490–506.
8. Kahn, A. E. *The Economics of Regulation: Principles and Institutions*. The MIT Press, 1988.
9. Chan, N. D., and S. Shaheen. Ridesharing in North America: Past, Present, and Future. *Transport Reviews*, Vol. 32, No. 1, 2012, pp. 93–112.
10. Global e-Sustainability Initative. *SMART 2020: Enabling the Low Carbon Economy in the Information Age. United States Report Addendum.* 2008.
11. Dueker, K. J., and I. P. Levin. *Carpooling: Attitudes and Participation. Technical Report No. 81*. Center for Urban Transportation Studies, Institute of Urban and Regional Research, University of Iowa, Iowa City, IA, 1976.
12. Bonsall, P., H. Spencer, and W. Tang. What makes a car-sharer? *Transportation*, Vol. 12, No. 2, pp. 117–145.

13. California Public Utilities Commission. Carrier Investigation. http://www.cpuc.ca.gov/PUC/transportation/Passengers/CarrierInvestigations/. Accessed Aug. 8, 2014.
14. California Public Utilities Commission. Transportation Network Companies. http://www.cpuc.ca.gov/PUC/Enforcement/TNC/. Accessed Jul. 16, 2014.
15. Soper, T. Seattle prepares to legalize Uber, Lyft on Monday. http://www.geekwire.com/2014/taxi-seattle/. Accessed Jul. 16, 2014.
16. District of Columbia Taxicab Commission. *Application for Operating Authority Digital Dispatch Service (DDS)*. 2013.
17. Turnbull, K., and R. H. Pratt. *Traveler Response to Transportation System Changes Handbook, Chapter 11: Transit Information and Promotion*. Publication TCRP Report 95. Transportation Research Board, Washington, D.C., 2003.
18. Evans, J. E. *Traveler Response to Transportation System Changes Handbook, Chapter 9: Transit Scheduling and Frequency*. Publication TCRP Report 95. Transportation Research Board, Washington, D.C., 2004.
19. Henderson, J. *Street Fight: The Politics of Mobility in San Francisco*. University of Massachusetts Press, Amherst, 2013.