# The Last Mile Problem – A Grand Transportation Challenge

## 1 Research Question

Mass transit infrastructure projects require scarce financial, time, land and administrative resources. Ridehailing services, such as Uber, have the potential to raise ridership on existing services without major capital investments. A recent McKinsey report claims that "integrated mobility systems could produce benefits... worth up to $600 billion" a year. However, there is little rigorous evidence about how urban residents would actually respond to these types of supply-side interventions, making these estimates unsatisfying. At the same time, there is widespread concern that ridehailing platforms could crowd out and reduce public transit ridership, though the literature that assesses the impacts of ridehailing services on public transit ridership is in its infancy. Available studies rely on aggregate observational data and have not yet been able to provide evidence on the individual demand response or behavioral mechanisms (Hall et al., 2018; Sadowsky and Nelson, 2017; Barrios et al., 2020; Berger et al., 2018).

We propose a study that will estimate the degree of complementary between Uber services and existing public transit services using an experimental intervention that addresses the 'last mile problem,' which is considered one of the most intractable public transit problems in the United States. The academic and policy communities are considering ways to leverage ridehailing technologies that boost, rather than compete with, existing public transit systems. Local governments and companies have developed a range of small-scale pilot programs that use 'shared mobility services' to facilitate linked trips around mass transit stations (Shaheen and Chan, 2016). A few pilot cities have begun experimenting with bundling Uber or other types of ridehailing services with access to transit. This may be a cost-effective way of increasing transit ridership outside existing catchment zones or expanding transit services to populations that lack access. However, the effects of these pilot programs have not been rigorously studied and initial results have focused on costs and utilization of the program. Our proposed study will provide a comprehensive characterization of this complementarity by leveraging a collaborative experiment with the world's most widely adopted ridehailing company (Uber). This project provides a unique opportunity to improve our understanding of rider demand for last-mile services while also providing the potential to scale this intervention if it is found to be a success.

Our study is designed to ask three main questions: (1) What is the demand response to subsidies that target linkages to metro/rail services, as measured by changes in: (a) public transit ridership, (b) transit-linked Uber usage, and (c) total mobility? (2) Do reductions in travel cost differentially affect riders that are underserved by existing public transit networks (live/work in less accessible zones)? (3) What are the impacts of the subsidy program on city-level congestion? Our experimental findings will advance the state of academic and policy/industry understanding of the effects of ridehailing services as complements/substitutes to public transit. By integrating a field experiment with cutting-edge congestion simulation methods, we will contribute to the literature on the effects of transport policy on city-level congestion externalities (e.g. Kreindler (2018), Tsivanidis (2018)).

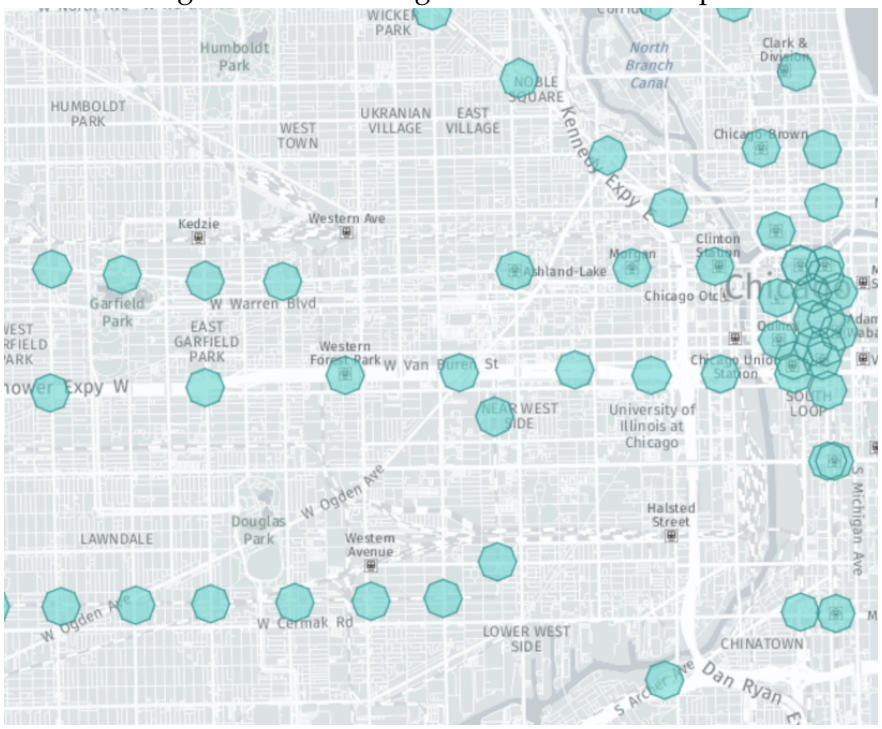
## 2 Data & Methods

### 2.1 Study Area and Treatment Design

The proposed field experiment will be implemented in Chicago, IL. Using direct communication through the Uber platform, we will recruit a sample of existing Uber users who are willing to participate in the study. Riders in the experiment will be randomized into one of three levels of subsidy for a period of two months

(0%, 25%, 50%). The subsidy treatments are geographically targeted using a geo-fence, such that riders in in the treatment groups receive a price discount on trips that begin or end within 200 meters of a transit station (illustrated in Figure 1 below). Variation in the subsidy level allows us to measure riders' demand response.

Figure 1: Geo-fencing for Transit-linked trips




## 2.2 Questions and Exprimental Outcomes

This design, along with our detailed data collection (outlined below) will allow us to answer the following questions:

1. What is the demand response to subsidies that target linkages to metro/rail services?
   (a) How does this affect transit-linked Uber utilization (VMT/day)?
   (b) How does this affect public transit ridership (VMT/day)?
   (c) How does this affect trips made by other modes (i.e. private car, taxi) (VMT/day)?
   (d) How does this affect total mobility (VMT/day)?
2. Do reductions in travel cost differentially affect riders that are underserved by existing public transit networks (live/work in less accessible zones)?
3. If the subsidy program were scaled up and implemented at the city-level, would the effects quantified in 1 and 2 result in a significant reduction in congestion externalities?

## 2.3 Experimental Protocol

Uber has approved the design that we outline below and is willing to make adjustments as appropriate. Much of the compute infrastructure that we will use for the intervention and data collection has been tested and

utilized in an earlier research collaboration the PIs implemented with Uber in Cairo, Egypt (Christensen and Osman, 2020).

1. Registration: Using the following notification through the Uber platform, we will recruit a sample of existing Uber users: "Uber is partnering with academic researchers on a study of transport behavior. Participants will be eligible for discounts on Uber services for 2 months, and additional Uber credits. Those interested in learning more and participating in the study should sign up at the following webpage and will be separately contacted by the research team."

   Willing participants will be directed to a landing website for the research project. It will be hosted on a University of Illinois domain and will provide instructions on how to register. Registration involves two steps: (1) participants are instructed to enable Google Timeline (a feature inside the Google Maps app) on their phones and are informed that participation will require downloading their Timeline data once per month, (2) participants fill out a short baseline survey that includes the questions listed below and Uber account information needed to enroll them in the subsidy program.

2. Subsidy Provision: Subsidies are provided directly on the Uber platform through a direct modification of the estimated price that is reported to users. An individual will remain in their overall subsidy group for the entirety of the experiment. To ensure high response rates on the baseline/endline surveys and Google Timeline data, individuals in the treatment/control groups will receive Uber credit for each time they comply with a data request.

3. 1 Month Follow-up: After 1 month, participants will be contacted by text and email to inform them that they need to share the data from their Google Timeline. They will be directed to a webpage with detailed instructions and offered individual phone support if needed.

4. 2 Month Follow-up & Additional Data Collection: After completion of the 2 month study, participants will be contacted by text and email to inform them that they need to upload their Google Timeline and complete the endline survey. Conditional on funding availability we will aim to collect data after the end of the subsidy to assess if the intervention led to longer-term changes in behavior.

## 2.4 Data Collection

We will collect three main types of data as part of the study.

1. Baseline and endline surveys: These surveys will include information on: home location (address or nearest intersection), work location (address or nearest intersection), employment status, income, perceptions of available modes of transit (cost, duration, convenience, comfort), and vehicle ownership.

2. Google Timeline: Participants will provide access to trip-level data on their mobile device (Google Timeline) that is linked to an extraction and aggregation software infrastructure that we have developed at the National Center for Supercomputing Applications (NCSA) at the University of Illinois. Participant information will be anonymized in this system and trip-level aggregates will be extracted: Origin/Destination locations (aggregated to census block), distance, time and duration of trip, mode (motorized private, public transit system, or non-motorized mode).

3. Uber Administrative Data: Uber will provide trip-level administrative data on utilization of Uber services for each participant as defined by an existing data sharing agreement developed for the current collaboration between UIUC-Uber. Trip-level data include: origin/destination locations (aggregated to census block), Uber service used (UberX, Uber Pool, etc.), time and duration of trip, and monetary cost (with/without subsidy discount).

### 2.5 Experimental Analysis and Power Calculations

The randomized design allows for simple experimental tests of impacts using a standard ANCOVA specification, where we regress the outcome variable on treatment assignment while controlling for baseline values of the variable. We will include cohort and survey round fixed effects and cluster our standard errors at the individual level. Using data from Christensen and Osman (2020) to guide power calculations, we estimate that we will have 80% power to detect a 0.135 standard deviation difference between treatment and control with our proposed sample of 200 riders in each treatment arm and 200 riders in control. The average distance traveled is approximately 10km per day, with a standard deviation of 16km a day. Given these magnitudes, power analysis indicates that we will be able to detect a 21% difference in mobility (MDE). The correlation between follow-up rounds is 0.15. (sampsi 1 1.165, n(200) n2(200) sd(1) pre(1) post(8) r1(.15)). For reference, Christensen and Osman (2020) finds a larger than 42% increase in mobility in the context of subsidies for all trips.

### 2.6 Calculating Impacts on City-level Congestion

The experimental tests will provide estimates that we can use to asses how congestion can change if the policy is scaled up using a city-level transit simulation model from local transit agencies. For select areas, the route-changes will also be simulated precisely by creating a bespoke model in microsimulation software (AIMSUN). Travel behavior changes may also be combined with calls to the Google Maps API to estimate the monetized benefits of reductions in congested areas at peak times as in Kreindler (2018) and Akbar and Duranton (2017), providing the ability to estimate the potential costs and benefits from a scaled-up policy.

## 3 Research Team and Partners

This project leverages the expertise from an interdisciplinary team to address key gaps in research on a major sustainable transportation challenge. The research team is composed of (1) Peter Christensen, Assistant Professor, Agricultural and Consumer Economics, UIUC, (2) Lewis Lehe, Assistant Professor, Civil Engineering, UIUC, (3) Adam Osman, Assistant Professor, Department of Economics, UIUC. Christensen will serve as a PI in the oversight of development of computational infrastructure for data collection. Lehe will oversee the transit simulations need to produce estimates of how a scaled version of this intervention would impacts city-level congestion. Osman will oversee the implementation of the experimental protocol and data collection activities. All researchers will contribute to analysis and writing.

In addition to the research team, this project will benefit from commitments from industry and government partners. The study builds upon an ongoing collaboration with Uber's mobility research team, who secured internal legal and administrative commitments for this project in Spring 2020. Data-sharing agreements and an implementation plan will be finalized in December, positioning the team to execute the study as soon as COVID conditions allow. The team is also actively engaged with policymakers in Chicago (and Cook County) who are also interested in using the results from this project to guide Chicago's multi-modal mobility programs. This effort is led by the Chicago Metropolitan Agency for Planning (CMAP). Our experimental findings will advance the academic/industry/government understanding of the implications of mobility-on-demand services for public transit. By integrating experimental methods with cutting-edge transport simulation techniques, we will also contribute to the frontier of the literature on the effects of transport policy on city-level congestion externalities (Kreindler, 2018; Tsivanidis, 2018).

At present, committed funding for this project includes grants totalling approximately $75,000. Committed funds will be cover all experimental incentives and the development of compute infrastructure for data collection. The team has requested no funding support to date for data analysis by faculty PI's or student RA's.

# 4 Conflict of Interest Statement

Christensen reports no financial or other conflicts of interest that might bear on the proposed work.
Lehe reports no financial or other conflicts of interest that might bear on the proposed work.
Osman reports no financial or other conflicts of interest that might bear on the proposed work.

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