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Using Disaggregate Vehicle Data to Investigate How Ride-Hailing Services Influence Personal Vehicle Use Across a Metropolitan Region

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POLICY BRIEF

BACKGROUND AND OBJECTIVES

App-based ride-hailing has become a fixture of urban transportation. Using ride-hailing instead of one's own vehicle could conceivably reduce overall vehicle use. However, existing research suggests that it has caused more congestion and vehicle miles traveled (VMT).

Our research examined ride-hailing's impact on vehicle use and ownership using improved data and methods. Previous research has relied on stated-preference surveys or aggregate measures of travel, and has typically focused solely on auto use. In this study, we explored ride-hailing's relationship to both vehicle use and ownership across all vehicles in the Boston metropolitan area, using vehicle-level mileage from state-mandated vehicle inspection records and ownership data from registration records.

Boston was one of the first American cities to host Uber's ride-hailing service, and Uber's availability expanded across the region in a spatially defined way. High-quality vehicle-level data are also available there. Thus, Boston presents a unique opportunity to investigate this important question empirically.

METHODOLOGY

Given the potential influences of Uber availability, transit access, and neighborhood change on vehicle use and ownership, we ask:

(Q1) How did the average daily VMT of individual vehicles change after the introduction of Uber?
(Q2) Are those changes mediated by the level of transit access?
(Q3) Is the introduction of Uber associated with neighborhood changes?

Disaggregate vehicle-level data from the Massachusetts Vehicle Census (MAVC) of 2009 to 2014 (*available from the Metropolitan Area Planning Council*) were used along with temporal data about the roll-out of Uber services across the region between 2011 and 2014, year and mode-specific spatial data of Massachusetts Bay Transportation Authority (MBTA) transit stops and stations, and neighborhood demographics sourced from the U.S. Census and American Community Survey (ACS).

The MAVC provides a detailed record of state-mandated vehicle inspections including odometer readings, vehicle identification numbers (VINs), registration information including parcel identifiers, and other information that allow for calculation of the average daily VMT of individual automobiles based upon odometer measurements. It also allows for us to track the ownership status of individual vehicles, their storage location, and vehicle turnover. We analyzed about 1.6 million vehicles over a five-year period.

We carried out two sets of regression analyses, one at the individual vehicle level and one aggregating vehicles to the Census tract level. The first analysis relied on a negative binomial, fixed-effects panel regression with a dependent variable consisting of the average daily VMT of individual vehicles, and independent variables including the availability of Uber services in the Census tract. The second analysis consisted of fixed-effects panel regressions of VMT and auto ownership at the Census tract level, as well as a similar regression to assess whether neighborhood change as measured by vehicle turnover at the Census tract level could have contributed to observed changes in VMT.

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RESEARCH FINDINGS

Our analysis of individual vehicle level data suggests that the introduction of Uber had a small influence on VMT, and any influence was limited to vehicles registered outside the core of the metropolitan area. We also found that ride-hailing's influence on vehicle use and ownership may differ between central and peripheral areas, and is likely not related to neighborhood change, as we describe below.

In our analysis the introduction of Uber was associated with only a very small increase in VMT, and only in less-central areas of a metropolitan region. The average daily VMT of vehicles located outside of the core cities of Boston and Cambridge climbed by 0.6% above the mean of 27.6 average daily miles after the introduction of Uber, all else equal. We found similar results in the aggregate model: average vehicle mileage in Census tracts outside of Boston and Cambridge was 0.34 miles per day higher after the introduction of Uber, controlling for other factors. However, within the cities of Boston and Cambridge, we found no significant relationship between Uber availability and VMT.

Interestingly, we also found in our Census-tract level analyses that Uber availability related to 0.22 less vehicles per population, but again only outside the metropolitan core. This reduction in vehicles per population could signal lower dependence on private vehicles, and when paired with the small increase in VMT per vehicle, suggests that ride-hailing-related reductions to auto dependency could occur alongside additions to VMT in some areas.

We offer two reasons why Uber may have influences changes to VMT and ownership only outside central areas. First, in urban cores, where auto ownership and use are already lower than suburban and exurban areas, private vehicle trips that can be replaced by ride-hailing trips may be less prevalent. For example, a resident in a central city who owns a car may use non-automotive modes for most regularly occurring trips, but still keep a car for highly specific trips such as leaving the city on weekends, or large shopping trips. As such, Uber availability may not affect changes to how these residents utilize their vehicles. Second, ride-hailing drivers may be more likely to live outside urban cores; if so, VMT reductions from suburban car owners slightly reducing their auto ownership could be partly offset by the increased VMT produced by ride-hailing vehicles.

Additionally, we looked for but did not find any indication that vehicle turnover or transit service mediated how Uber's availability affected auto ownership or use. In interaction with Uber, all but one of the mode-specific transit variables were insignificant in both the individual vehicle level and Census tract level models regressing over VMT. The one transit variable in interaction with Uber availability that was significant, commuter rail station density, was significant only in the individual vehicle level model where we found evidence that Uber relates to a small reduction in the association between commuter rail station density and decreased VMT. However, this interaction was found to be significant only in Boston and Cambridge, where Uber on its own was found not to be related to VMT. This result is consistent with the hypothesis that the potential to reduce vehicle use through complementary ride-hailing and transit services may exist primarily outside central areas—perhaps because ride-hailing mainly replaces the last-mile travel related to park-and-ride transit services in peripheral areas, and these services are less common in urban cores.

POLICY AND PRACTICE RECOMMENDATIONS

When considering how ride-hailing can or should be utilized across a metropolitan area, it might be helpful for planners to identify guiding transportation planning goals. If those goals include reducing auto dependency or auto ownership, then the results of this study support policies that encourage use of ride-hailing outside of metropolitan cores. Conversely, if goals include reducing VMT or congestion, then government-supported use of ride-hailing should be more heavily scrutinized, but not necessarily avoided. Within cities, our findings suggest that ride-hailing has no significant impact on the use of vehicles owned by residents of core areas, and promoting the use of other modes besides ride-hailing or personal vehicles may be an appropriate course of action for either goal.

Use of individual vehicle level data is an underutilized avenue to investigate ride-hailing's impact on travel behavior. Ideally, more recent data from the time period up until and through the Covid-19 pandemic would be used. Research is also needed into ride-hailing's potentially variable influence across a metropolitan area, as well as into locating where TNC drivers live, as their auto use has the potential to affect aggregate level VMT data. In all, this study found much smaller influences of ride-hailing upon vehicle use than survey-based research, research using aggregate data, or travel-model-based simulation studies. Using actual vehicle mileage data is a fruitful area for future research, and may be more reliable than these other methods.

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