EFFECTS OF ON-DEMAND RIDESOURCING ON VEHICLE OWNERSHIP, TRAVEL, ENERGY, AND ENVIRONMENTAL OUTCOMES IN THE UNITED STATES

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Overview

We estimate effects of on-demand ridesourcing services Uber and Lyft on vehicle ownership, travel, energy, and environmental outcomes using a set of difference-in-difference propensity score-weighted regression models that exploit staggered market entry across the U.S. from 2010 to 2017. Specifically, we use state-level data to estimate effects of Uber market entry on vehicle registrations, gasoline consumption, travel distances, and emissions, and we use zipcode-level data to estimate effects on vehicle registration patterns, air quality, and transit use in urban areas. We find evidence that TNC entry causes a 3% decline in per-capita vehicle registrations when averaged across states but a 0.7% increase when averaged across urban areas. This difference is due, in part, to heterogeneity in the effects of TNC entry on different cities: TNC entry appears to increase ownership in large dense cities and small family-focused cities with low per-capita vehicle registrations, while the effect on other groups of cities is not statistically significant in our clustering results. Our results regarding transit ridership, travel distances, gasoline consumption, and several air pollutants are not conclusive, but we also find evidence of a negative association between TNC entry and EPA-estimated emissions of highway vehicle volatile organic compounds (VOCs).

Introduction

Transportation now contributes more carbon dioxide emissions than any other U.S. economic sector (1), and new personal transportation options are rapidly changing transportation. Transportation network companies (TNCs), like Uber and Lyft, now provide on-demand mobility services that complement and compete with personal vehicle ownership and transit use, changing urban travel patterns and affecting energy and environmental implications of transportation. By 2017, Uber had entered 46% of U.S. urban areas. TNCs made more than 170,000 vehicle trips in San Francisco (15% of all intra-San Francisco vehicle trips) on an average weekday in 2016 (2) and more than 90,000 rides in Seattle (more than total average weekday ridership on Seattle’s light rail) on an average weekday in 2018 (3). Prior studies have examined effects of this rise in TNC use on outcomes as varied as traffic congestion, drunk driving, local entrepreneurship, ambulance use, and vehicular deaths, but the net effect of these services on vehicle ownership, travel, energy, and the environment is either unexplored or still debated in the literature.

Methods

We use difference-in-difference (DiD) models to estimate effects of the intervention (TNC entry) by comparing the trends of treated and untreated groups before and after the intervention occurs. DiD methods have been used previously to evaluate the effect of TNCs on other outcomes, including traffic congestion (4), vehicle-related homicides (5), entrepreneurial activity (6), and new vehicle ownership in China (7). Our regression model is informed by models used in prior literature for our outcomes of interest, and we pose the model at the state level and the urban area level. At the state level, we examine four types of dependent variables: 1) vehicle registrations per capita; 2) VMT per capita; 3) gasoline use per capita, or 4) several species of per capita passenger vehicle emissions (CO, NH3, NOx, PM10, PM2.5, SO2, and VOCs) as a function of relevant available control variables (state population, income, gasoline price, emissions standards, and largest city population, density, and GDP). At the urban area level, we examine four related but distinct types of dependent variables 1) vehicle registrations per capita, 2) the percentage of registered vehicles that are electric, 3) concentrations of each of several vehicle-related air pollutants (carbon monoxide, oxides of nitrogen, benzene, toluene, and xylene), or 4) transit ridership as a function of relevant available control variables (population, portion of population over age 16 and over 65, population density, unemployment rate, income, and percent of population commuting by transit). Regression analysis is conducted using inverse probability of treatment weighting, and we estimate propensity scores using gradient boosting (8), which previous studies have shown as superior to simple logistic regression models for propensity score estimation (9).
Results

First, propensity scores are estimated, and a weighted control groups is confirmed as balanced compared to the treatment group. Second, linear regression models are specified to isolate the treatment effect of on-demand ridesourcing market entry on several dependent variables of interest: vehicle registrations, fuel economy, electric vehicle registration percentage, transit ridership, and several species of automotive-relevant air pollutant concentrations. We find declines in vehicle registration at the state level and an increase at the urban area level, and both results are statistically significant and robust to a series of alternative specifications. Third, we examine the seemingly opposed effects detected at the state and urban area levels through an exploration of heterogeneity. Hierarchical clustering and a re-application of linear models that include urban area cluster indicators yield results that suggest on-demand ridesourcing increases vehicle ownership in large dense cities and small family-focused cities with low per-capita vehicle registrations.

Conclusions

Our results suggest that access to TNC services is associated with a significant effect on per-capita vehicle registrations: a decrease of 3% when averaged across states and an increase of 0.7% when averaged across urban areas. The effect flips direction when averaged over different units of observation, in part, because of underlying heterogeneity of the effects of TNCs in different types of cities. Our cluster analysis suggests that TNC entry tends to increase per-capita vehicle registrations in large dense cities and in small family-focused cities with low per-capita vehicle registrations. Effects on our other clusters is not statistically significant in our cluster analysis, though additional research is needed to assess robustness of the characterization of heterogeneity to alternative approaches.

References