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The Potential Effect of the Ride-sourcing Disruption: A Stated Preference Analysis in Chengdu, China

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Abstract

A stated preference survey was performed in Chengdu, China, in November 2018, and 435 reported ride-sourcing trips were obtained. Survey data shows that public transit, taxi, active modes (walking and biking), and private vehicles account for 53.71%, 27.36%, 10.80%, and 7.13% alternative modes. The **mixed logit model** is constructed to identify factors influencing **ride-sourcing users' AMC behaviors**. Results show that the density of metro stations around the trip origin is positively associated with choosing transit instead of private vehicles as the best alternative. Besides, **the suspension of ride-sourcing services could decrease environmental emissions but deteriorate current users' mobility efficiency** after our approximate estimation. Therefore, tradeoffs should be carefully measured by policy-makers before the suspension of ride-sourcing services.

Introduction

Debates about ride-sourcing services

- A more reliable and cheaper transportation mode; reducing private vehicle use, car ownership, and exhaust gas emissions, etc.
- inducing road congestion, reducing public transit use, and aggravating social inequality by only catering to the young and the well-to-do, etc.

The possible ride-sourcing suspension

- 268 cities initiated requirements for ride-sourcing vehicles in 2019
- *hukou* and the license plate regulations restricted its development
- Outbreak of Covid-19 suspended ride-sourcing services
- Social safety problems and protests from traditional taxi drivers forced governments like London, Denmark, and France to ban the ride-sourcing services

Objective

Quantifying individual and social impacts of the ride-sourcing suspension

- Individual level: factors influencing AMC behaviors of ride-sourcing users after ride-sourcing suspension via the mixed logit model
- Social level: vehicle emission and mobility change after the ride-sourcing suspension via relative indexes

Data collection

Questionnaire

- Ride-sourcing trip characteristics (OD, trip purpose, departure time, waiting time, travel time, and travel cost)
- Stated AMC after the suspension of ride-sourcing services
- Demographics of ride-sourcing users (age, gender, income, and vehicle ownership, etc.)

Baidu Map API & Open Street Map

- Baidu Map Place API collected Point of Interest (POI) information around OD
- Baidu Map direction API estimated travel time, travel cost, and travel distance of AMC
- Road network density around OD

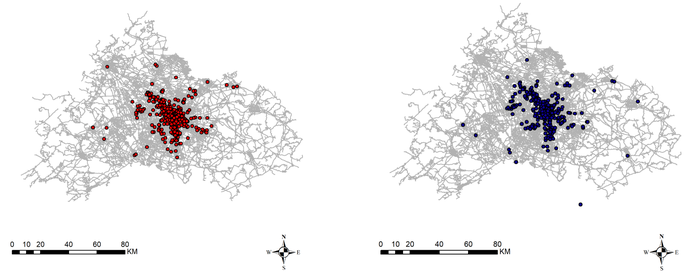

Figure 1 Spatial distribution of OD

Methodology

Mixed logit model ('mlogit', R package)

- Definition: ride-sourcing user n is assumed to choose AMC with the highest utility j from the choice set J.
- $U_{nj} = \beta_n X_{nj} + \epsilon_{nj}$, where X_{nj} are covariates related to respondent n and AMC j, ϵ_{nj} follows iid extreme value distribution.
- However, the unconditional probability is unclosed-form, represented as $P_{ni}(\theta) = \int \frac{e^{\beta_n X_{ni}}}{\sum_{j=1}^{J} e^{\beta_n X_{nj}}} f(\beta_n|\theta) d\beta_n$. Therefore, Markov simulation is used to estimate the model parameters.

Emission and mobility change (ride-sourcing services vs AMC)

- Vehicle emission estimation given vehicle emission indexes, average population load, and average travel distance, and the relative proportion of AMC
- Mobility efficiency evaluated by average travel time given average travel time and the relative proportional of AMC

Results

Impacts at the individual level

Variables	Private vehicles		Active modes		Taxis	
Base AMC: public transit	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Trip purpose (social/leisure activities:1, others:0)	-0.88	0.48	-0.32	0.35	-0.71**	0.26
Age	0.14***	0.03	-0.11	0.07	0.05*	0.02
Gender	**0.38**	**0.43**	**0.92****	**0.34**	**0.46**	**0.24**
Number of private cars per person household (number of cars/number of persons)	2.72***	0.77	1.16	0.68	0.86	0.51
Annual household income (≥100,000 CNY: 1, others: 0)	-0.25	0.59	-0.92*	0.42	-0.24	0.33
Number of metro stations within the trip origin buffer	**-2.19***	**0.94**	**-0.20**	**0.21**	**-0.36**	**0.19**

Note: public transit is the reference level for AMC; *p < 0.05, **p <0.01, ***p <0.001.

Impacts at the social level

Variables	Ride-sourcing services (before)	AMC (after)	Before-after changes
Average vehicle emission per trip per person			
CO	207.39	67.53	**-67.44%**
VOC	18.02	5.93	**-67.11%**
NO_X	15.77	7.02	**-55.49%**
PM	0.09	0.05	**-45.31%**
CO_2	3113.18	1188.43	**-61.83%**
Average travel time per trip per person (h)	0.32	0.35	**+9.38%**

Highlights

- Transit, taxi and active modes account for 53.71%, 27.36%, and 10.80% of AMC.
- Male respondents are more likely to choose active modes as alternative modes.
- Metro station density is positively related to the probability of choosing transit.
- The suspension policy could decrease vehicle emissions but reduce mobility.

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