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# How Does the Introduction of Pooled Service Influence the Behaviour of Ridehailing Users? Analysis of Didi Operations in Three Mexican Cities

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**Workshop on Building Capacity in Promoting Inclusive and Responsible Business for Sustainable Growth in Digital Society**
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# HOW DOES THE INTRODUCTION OF POOLED SERVICE INFLUENCE THE BEHAVIOR OF RIDEHAILING USERS? ANALYSIS OF DIDI OPERATIONS IN THREE MEXICAN CITIES

APEC Workshop: Building Capacity in Promoting Inclusive and Responsible Business for Sustainable Growth in Digital Society

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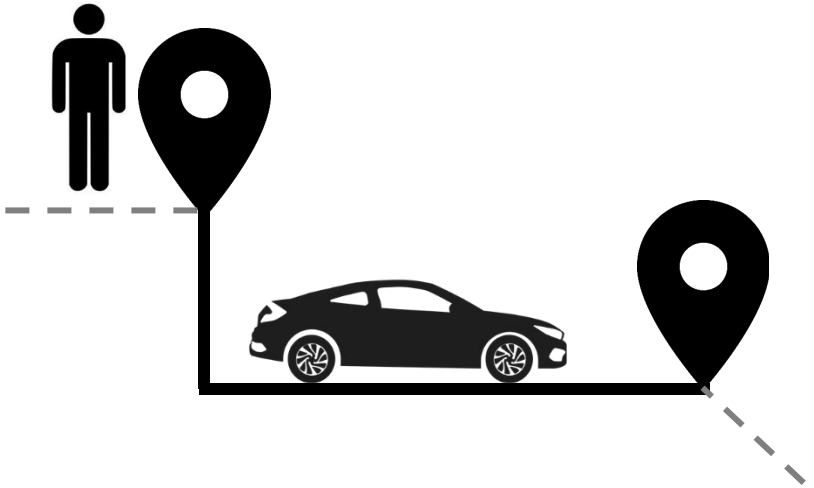
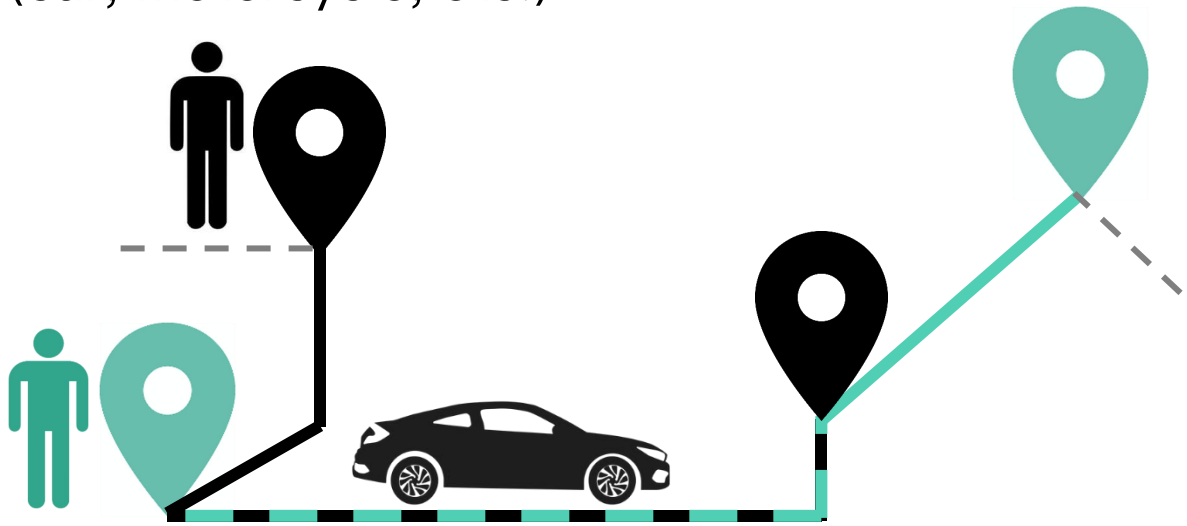
# TERMINOLOGY

**Ridehailing** — a digital platform / market where individuals can request a trip on-demand from an independently-operated vehicle (car, motorcycle, etc.)



**Exclusive service** — a vehicle serves a single requested trip



**Pooled service** (also called 'ride-splitting' or 'ride-sharing') — a vehicle serves multiple requested trips dynamically matched based on similarity in request time and location

# MOTIVATION

- Ridehailing services expand mobility options for urban residents
- But exclusive services likely worsen urban transport emissions because they:
  - Replace trips that would have been made by public and non–motorized transport (more sustainable modes) rather than private car
  - Increase VKT on city roads (and associated emissions) because of low occupancy or vehicle utilization rates
- Pooling holds promise for encouraging higher vehicle occupancy to mitigate negative impacts of ridehailing services while maintaining (or even expanding) the mobility and access they provide
- But:
  - Survey studies of hypothetical consumer choice have indicated that consumers have an inherent aversion to pooling that could limit its adoption
  - **Little is known about how individuals choose to use pooling in practice**

# STUDY OVERVIEW AND KEY RESEARCH QUESTIONS

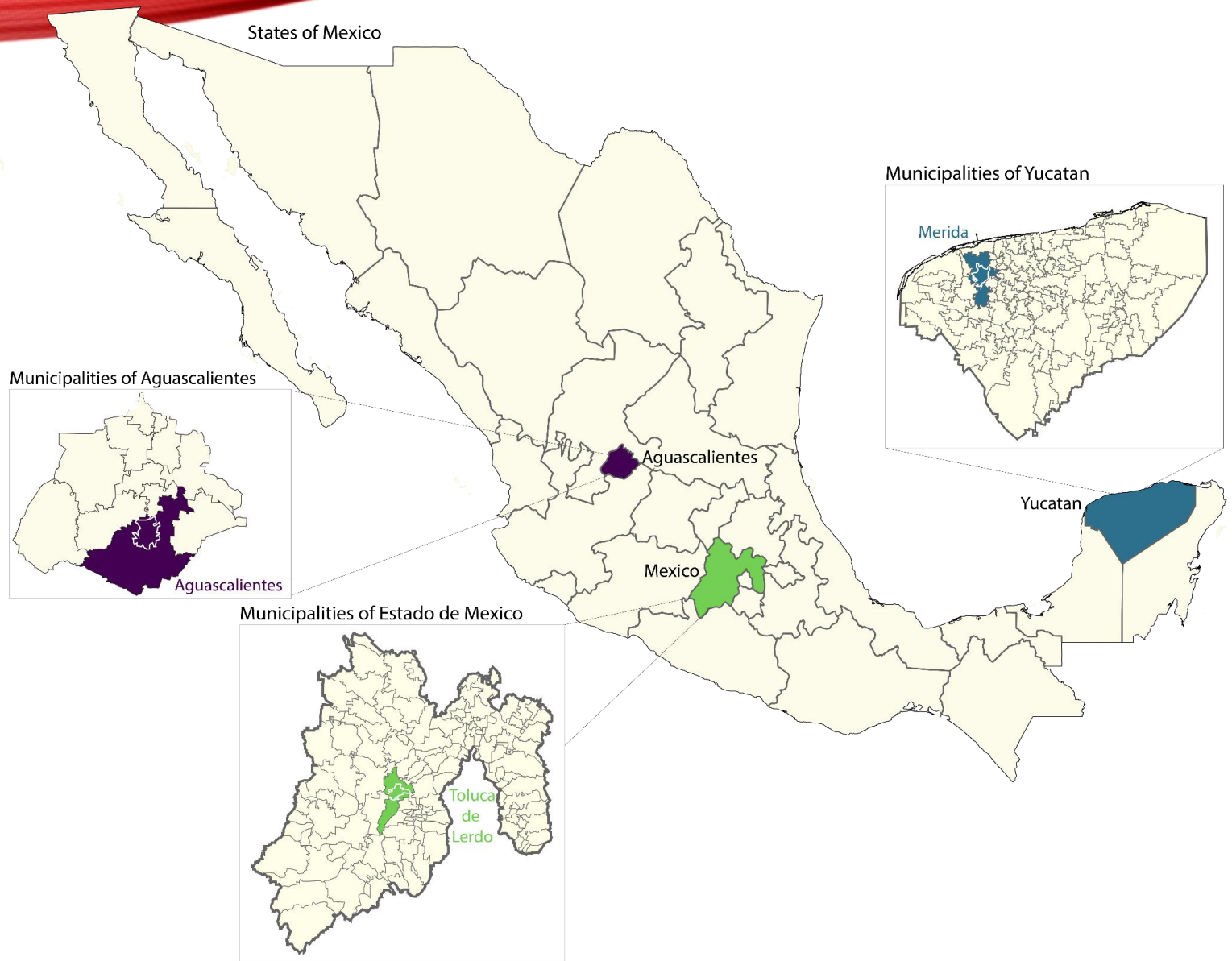
**Part 1. Collection and analysis of rider surveys (users and non-users of *comparte*)**

- If users were not taking ridehailing, how would they be traveling (**mode substitution**)? How does this vary between exclusive and pooled trips?

**Part 2. Analysis of trip data records before and after the launch of *comparte* service**

- How does the introduction of pooled services on a ridehailing platform impact users' mobility, expenditures on ridehailing, and distances traveled?
- How much can pooling reduce the ridehailing system's revenue kilometers traveled (RKT)?

# CASE STUDY CITIES




| | **DiDi *express* introduced** | **DiDi *comparte* introduced** |
|---|---|---|
| Mérida | Nov. 2018 | Feb. 2019 |
| Toluca | Apr. 2018 | Sept. 2019 |
| Aguascalientes | Apr. 2019 | Dec. 2019 |

# PART 1. RIDER SURVEYS

Two surveys administered to separate cohorts of registered users of DiDi's ridehailing platform:

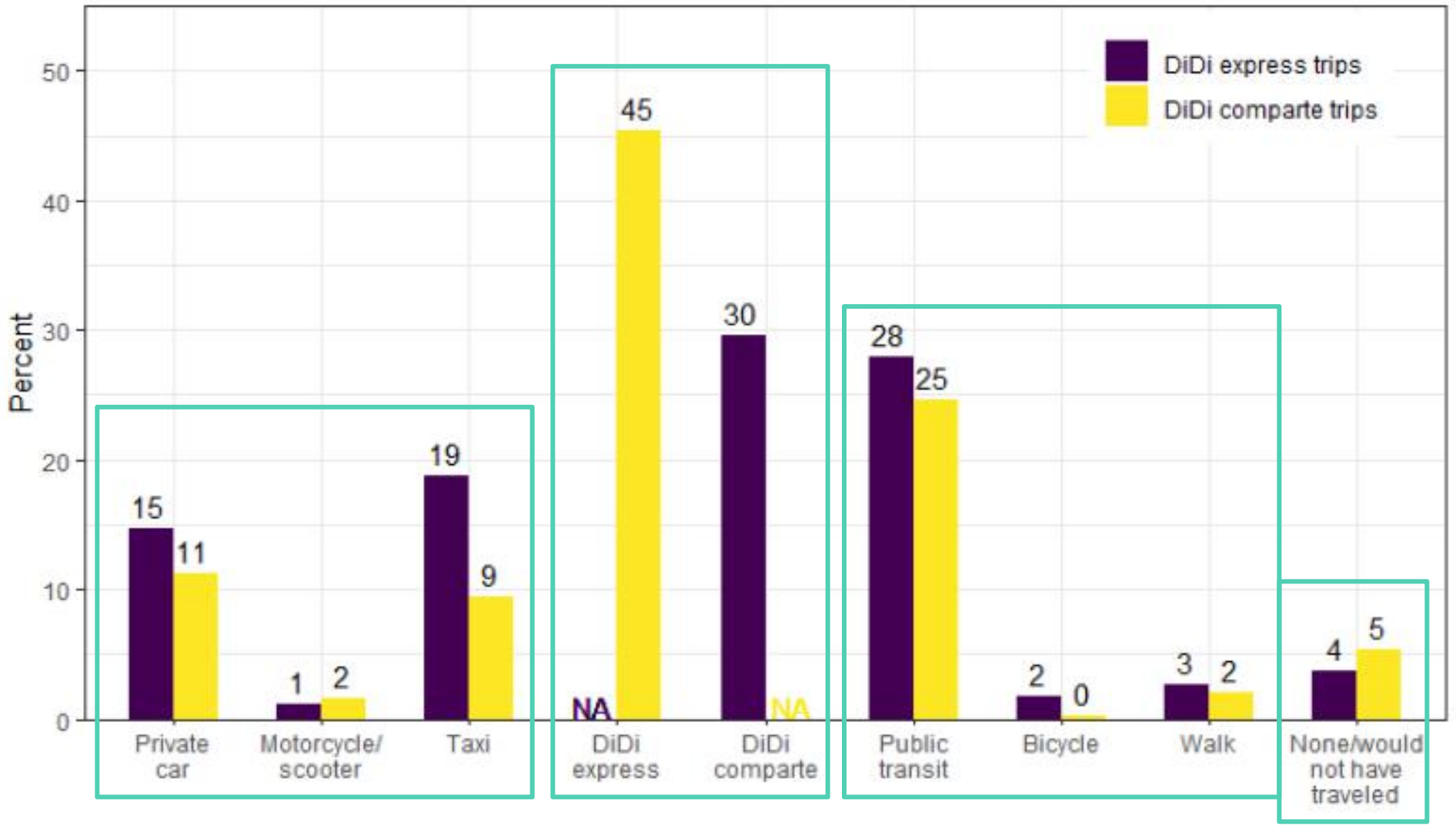
1. *Comparte* users – users who have taken at least one trip by pooled service
2. *Express* users – user who have taken at least one trip by exclusive service and who have not taken a trip by *comparte*

| | ***Comparte* users** | ***Express* users** |
|---|---|---|
| Survey launch (2020) | June 25 | July 22 |
| Sample size | 440 | 882 |
| City: (% of sample) | | |
| Merida | 50.0 | 31.5 |
| Toluca | 37.5 | 48.2 |
| Aguascalientes | 12.5 | 20.3 |

Matched survey responses to DiDi account data on number of trips that the respondent actually took on the platform in the third month after launch of *comparte* service in each city—prior to the COVID-19 pandemic

Moody, J., E. Esparza-Villarreal, and D. Keith. 2021. Use of exclusive and pooled ridehailing services in three Mexican cities. *Transportation Research Record: Journal of the Transportation Research Board.* https://doi.org/10.1177/03611981211002835

# Ridehailing trips are more likely to substitute public transport and taxi trips, but that the mode substitution depends on the service offering with high substitutability between *express* and *comparte*.



# PART 2. ANALYSIS OF TRIP DATA

1. Does the introduction of pooling **expand users' mobility**?

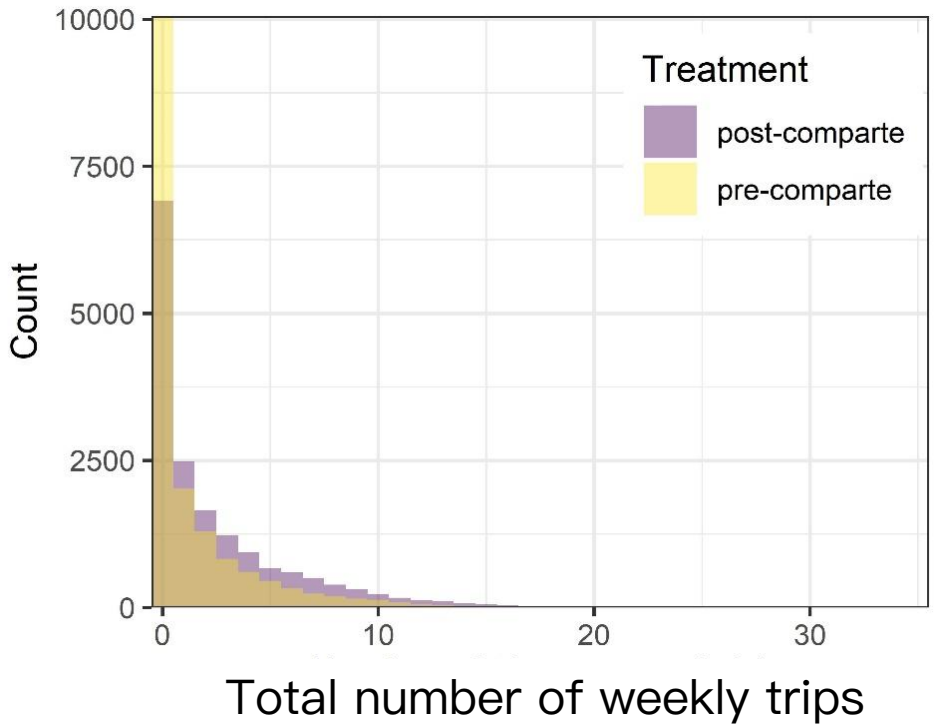
2. Does the introduction of pooling **improve user affordability**?

3. How does the introduction of pooling impact **users' travel distances** and the **system's revenue kilometers traveled (RKT)**?

4. What are the implications of RKT changes on system **emissions**?

# DATA AND QUASI-EXPERIMENTAL DESIGN

- Received all trip records from a sample of ~2,100 unique users of DiDi's ridehailing platform in our three cities
- Characteristics of all trips made by these users were recorded for:
  - 6–8 week period directly before the launch of pooled service (*pre-comparte* period)
  - 8-week *post-comparte* period skipping the first month after the launch of *comparte* in order to avoid the period of promotions and better capture its steady-state use
- Aggregate data into equally spaced time intervals (weeks) per user for:
  - 1) trip number (**mobility**),
  - 2) fares paid (**affordability**) per trip, and
  - 3) **travel distance** per trip



# QUASI-EXPERIMENTAL APPROACH

- Because pooling was introduced at different times in the three cities, we can treat the introduction of *comparte* as a natural experiment and measure the impact over time
- Use a **mixed effect** regression model with **first-order autoregressive AR(1) covariance structure**
  - **Mixed effect** means that we include a random intercept to account for natural heterogeneity among ridehailing users
  - **First-order autoregressive AR(1) covariance structure** controls for underlying time trend and serial correlation across weeks

# PREDICTORS

**Treatment (T):** pooled service available in given week (0/1)

**Adoption (a):** user who adopted pooling once it was introduced (took at least one trip by *comparte*; 0/1)

**Controls:**

- Weather and air quality per city–week, including average temperature, average relative humidity, total precipitation, and maximum $SO_2$
- City dummies (0/1): account for differences in built environment, sociodemographics, and other characteristics of the three markets
- Passenger characteristics: proportion of trips paid by credit card

# DOES THE INTRODUCTION OF POOLING EXPAND USERS' MOBILITY?

Individuals who adopted pooling were able to take 2 times more trips in weeks after pooling was introduced than weeks before.

| **Predictors** | **Model 1** | **Model 2:** |
|---|---|---|
| Random intercept | –1.058*** | –0.998*** |
| Pooling available, *T* (0/1) | 0.414*** | –0.055 |
| Pool adopter, *a* (0/1) | 0.853*** | 0.466*** |
| Pooling available * pool adopter, T * a (0/1) | –– | 0.699*** |

Overall, the introduction of pooling increased user mobility via ridehailing

**Gains in mobility were almost exclusively experienced by those who adopted pooling** even after controlling for the fact that individuals who adopted pooling were more frequent users even before pooling was introduced

Significance codes: p–value * < 0.10, ** = 0.05, *** < 0.01

# DOES THE INTRODUCTION OF POOLING IMPROVE USER AFFORDABILITY?

| | Predictors | Model 1 | Model 2 |
|---|---|---|---|
| **Conditional model:** weekly fare per trip > 0 | Random intercept | 3.599*** | 3.594*** |
| | Pooling available, *T* (0/1) | −0.093*** | 0.007 |
| | Pool adopter, *a* (0/1) | −0.169*** | −0.080*** |
| | *T* * *a* (0/1) | −− | −0.147*** |
| **Zero−inflation model:** was weekly fare per trip = 0 in given week (0/1) | Random intercept | 0.905* | 1.052** |
| | Pooling available, *T* (0/1) | −0.882*** | 0.098 |
| | Pool adopter, *a* (0/1) | −1.492*** | −0.587*** |
| | *T* * *a* (0/1) | −− | −1.621*** |

After the introduction of DiDi *comparte*, individuals who adopted pooling:

- Were much less likely to have weeks with no expenditures (e.g., trips)
- Spent 10% less per trip in weeks where they did travel

Significance codes: p−value * < 0.10, ** = 0.05, *** < 0.01

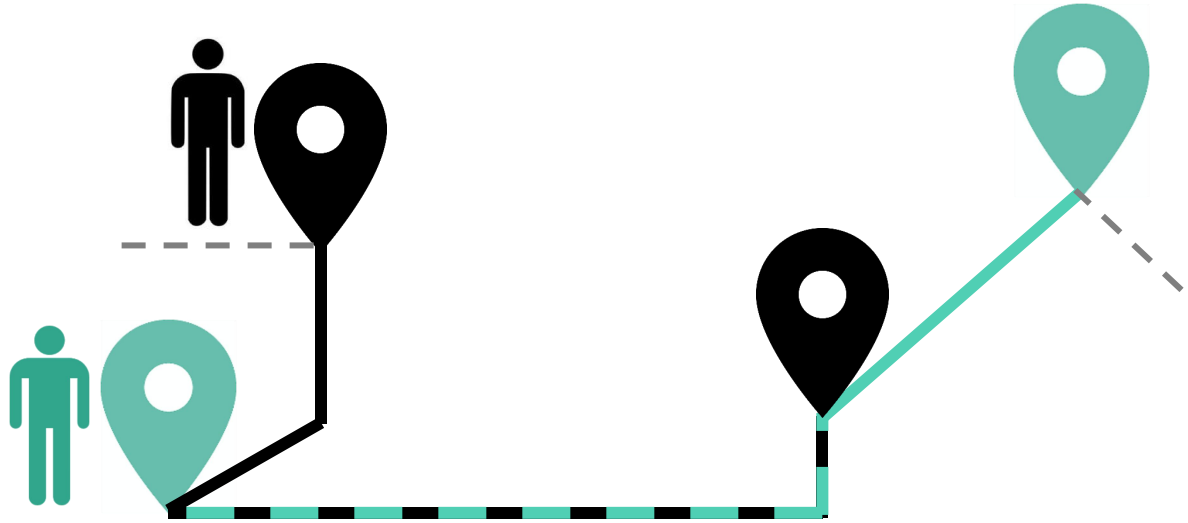
1. Does the introduction of pooling **expand users' mobility**?
2. Does the introduction of pooling **improve user affordability**?

**YES**

3. How does the introduction of pooling impact **users' travel distances** and the **system's revenue kilometers traveled (RKT)**?
4. What are the implications of RKT changes on system **emissions**?

# ADDITIONAL CONSIDERATIONS REGARDING TRIP DISTANCE

- RKT = vehicle kilometers traveled with a paying passenger inside
- For user: trip distance recorded is what they traveled (including any detours from picking up / dropping off passengers in pooled ride)
- From system's perspective, we want to avoid double-counting kilometers traveled in vehicle with another passenger
  - PRF = pooling reduction factor; assumption regarding the typical proportion of trip distance that overlaps across two pooled trips paired in the same vehicle



# HOW DOES THE INTRODUCTION OF POOLING IMPACT USERS' TRAVEL DISTANCES?

**PRF = 0**

| | Predictors | Model 1 | Model 2 |
|---|---|---|---|
| **Conditional model:** RKT per trip > 0 | Random intercept | 1.794*** | 1.793*** |
| | Pooling available, *T* (0/1) | 0.006 | −0.010 |
| | Pool adopter, *a* (0/1) | −0.110*** | −0.123*** |
| | *T* * *a* (0/1) | -- | 0.023 |
| **Zero-inflation model:** was RKT per trip = 0 in given week (0/1) | Random intercept | 1.358*** | 1.503*** |
| | Pooling available, *T* (0/1) | −0.901*** | 0.105 |
| | Pool adopter, *a* (0/1) | −1.470*** | −0.570*** |
| | *T* * *a* (0/1) | -- | −1.668*** |

For weeks in which the user travels, the introduction of pooling has a non-significant impact on user trip distance, even for individuals who adopt pooling

Given current penetration and matching efficiency of DiDi *comparte* services, detours involved in picking-up and dropping off additional passengers while pooling are negligible

Significance codes: p-value * < 0.10, ** = 0.05, *** < 0.01

# HOW DOES THE INTRODUCTION OF POOLING IMPACT SYSTEM RKT? **PRF > 0 (SENSITIVITY)**

| | | Model 2 | | |
|---|---|---|---|---|
| | **Predictors** | **PRF = 0.3** | **PRF = 0.5** | **PRF = 0.7** |
| **Conditional model:** weekly fare per trip > 0 | Random intercept | 1.643*** | 1.523*** | 1.316*** |
| | Pooling available, *T* (0/1) | 0.000 | 0.006 | 0.017 |
| | Pool adopter, *a* (0/1) | −0.129*** | −0.135*** | −0.140*** |
| | *T* * *a* (0/1) | −0.121*** | −0.236*** | −0.371*** |
| **Zero−inflation model:** was weekly fare per trip = 0 in given week (0/1) | Random intercept | 1.503*** | 1.472*** | 1.400*** |
| | Pooling available, *T* (0/1) | 0.105 | 0.103 | 0.106 |
| | Pool adopter, *a* (0/1) | −0.570*** | −0.565*** | −0.562*** |
| | *T* * *a* (0/1) | −1.668*** | −1.654*** | −1.599*** |

With PRF as low as 30%, the introduction of pooling brings a significant reduction in system RKT

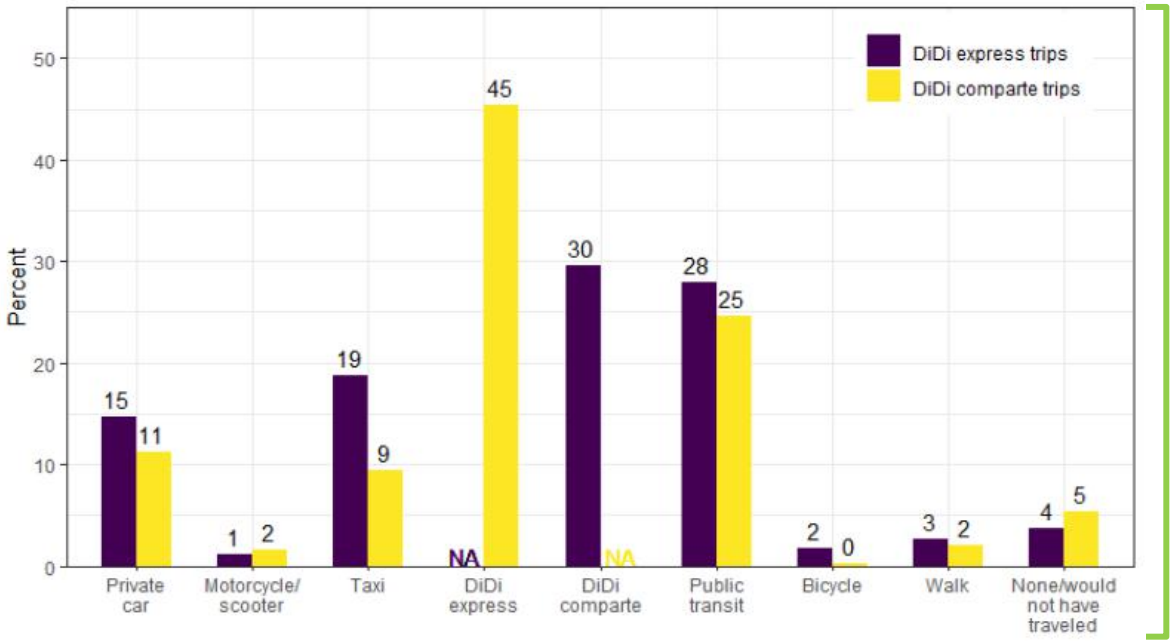
Assuming PRF = 0.5, adopters of pooling contribute 20% less RKT to the system in weeks after pooling was introduced compared to before.

Significance codes: p−value * < 0.10, ** = 0.05, *** < 0.01

# WHAT ARE THE IMPLICATIONS OF RKT CHANGES ON SYSTEM EMISSIONS?

**Assumptions:**

- 1,000 adopters of pooling
- Who each take 3 trips per week (finding from RQ1) for 4 weeks (1 month)
- With existing split of ridehailing trips between exclusive and pooled services
- Pooled ridehailing trips are replacing exclusive ridehailing trips (does not consider switching from other modes)




| **Monthly savings** | **PRF = 0.3** | **PRF = 0.5** | **PRF = 0.7** |
|---|---|---|---|
| RKT (km) | 7,092 | 13,080 | 19,320 |
| Gasoline (gal) | 132 | 246 | 364 |
| $CO_2$ emissions (metric tons) | 1.2 | 2.2 | 3.2 |

# KEY TAKE AWAYS

**For users:**

- Adopt pooling!
- It can enable you to take more trips, reduce the fare you pay per trip (without significant increases in travel distance per trip from detours), and help reduce the carbon footprint of your ridehailing use.

**For ridehailing platforms:**

- Launch pooled ridehailing services in more cities and scale the service in existing cities
- Incentivize use of pooled service over exclusive service through discounted pricing, setting of defaults when booking trips, and improving certainty of information provided on the app
- Improve matching efficiency

# KEY TAKE AWAYS

**For policymakers:**

- Improve regulatory certainty around ability of ridehailing platforms to operate pooling
- Encourage pooling in cities by accounting for vehicle occupancy in road use charges and other regulations on ridehailing services, particularly in areas underserved by existing public transport services (formal and informal)