Dynamic Ridesharing Services: An Exploration of the Potential for Greenhouse Gas Reductions

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Thank You to Our Funders!

• The Mineta Transportation Institute
• The California Department of Transportation
• The UC Davis Honda Endowment
• The UC Davis Sustainable Transportation Energy Pathways Program
• New vehicle and fuel technology necessary, but not sufficient, to meet deep GHG reduction goals
• Demand management strategies, such as TODs and auto pricing, also needed
• Shared vehicle services, such as dynamic ride sharing (DRS), also show promise for reduced VMT/GHG
Study Questions

• What is the potential magnitude of the market for dynamic ridesharing service?

• How might such services change VMT/GHG reductions from TOD and auto pricing policies?
Case Study

• San Francisco Bay Area in 2010

• MTC’s Activity Based Travel Demand Model (ABM)

• Model used in last regional transportation plan
Dynamic Ridesharing Services (DRS)

- Automatically matches drivers and riders with similar spatial and temporal constraints
- Communicates match in advance or on demand (e.g., 15 to 60 minutes)
- Smart phone applications
- match requests/accept/reject
- driver and rider reviews and ratings
- pay drivers
- Social networks and incentive systems
1. Peer-to-peer DRS:
   – Drivers independent service participants
   – Reimbursed for trip related costs (e.g., Zimride and/or Carma)

2. Taxi-sharing services
   – Drivers licensed taxi drivers or independent contractors (e.g., Uber or Lyft)
   – Fees established by operator to compensate driver and service (e.g., London, New York City, and Taipei)
DRSs provide a new mode of travel at new travel time and cost price points to many destinations in a service area.

Ubiquitous DRSs may result in a series of complex and inter-related behavioral and systems level effects, with both positive and negative effects, on congestion, VMTs, and GHGs.
• Few DRS modeling studies of DRS
• Many test different optimization techniques to match potential drivers and passengers
• Other simulate the decision to share based on DRS fees and travel time
• Demand is almost always fixed; not sensitive to changes in travel time/cost from DRS
• Including origin and destination locations as well as departure and arrival times
Differs from the literature:

• ABM from an actual metropolitan region
• Trip list used to estimate potential DRS based on spatial/temporal constraints
• Affordability of DRS service is not considered (future research)
• Represent induced travel with elasticity of VMT w/t average MPH from literature
• Intent is to understand potential VMT/GHG reductions from a regionally ubiquitous DRS service
Methods

Stage I: Setting I/O path, required classes

Stage II: Pre-process conditions:
1. Income level
2. Trip length
3. Number of stops
4. Participation rate

Stage III: Generate list of proximate zones (maxdist)

Stage IV: Find/match trips by:
1. Departure time
2. Close origin and destination
3. Driver available
4. Verification of rideshare feasibility

Stage V: Feedback (identify orphan trips and their effect on other trips)

Stage VI: Calculate number of DRS trips and update trip list

Assigning new vehicle trips to obtain VMT and average vehicle MPH by time of day and then apply short and long term elasticity of VMT wrt average vehicle MPH
Representation of Induced Travel

- DRS scenarios involved the post processing of the Base Case, VMT Fee and TOD model files.
- This method did not allow MTC’s ABM convergence procedure to represent induced travel.
- Average change in average vehicle MPH by time of day calculated for all scenarios after one simulation run of from the converged 2010 Base Case.
- Short run (0.3) and long run (0.64) elasticities of VMT with respect to average vehicle MPH were used to represent induced travel (Robert Cervero, 2003).
• **TOD**: Increase residential densities by 10, 20, and 50 percent
  – random household selection from least dense to transit station zones

• **VMT Fee scenario**: Add 10, 20, 30, 40, and 50 cents to the current auto operating cost
Percentage Change in Daily 2010 VMT
## DRS Sensitivity Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>$50K</td>
<td>Restricts DRS participation to individuals with income below a specified income level.</td>
</tr>
<tr>
<td></td>
<td>$100K</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$150K</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$500K</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>20%</td>
<td>The share of those who actually use DRS relative to those who could use it but do not.</td>
</tr>
<tr>
<td></td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Trip Length</td>
<td>30 mi.</td>
<td>The minimum trip length (miles) to participate in DRS.</td>
</tr>
<tr>
<td></td>
<td>20 mi.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 mi.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 mi.</td>
<td></td>
</tr>
<tr>
<td>Proximity</td>
<td>2.5 mi.</td>
<td>The maximum distance (miles) between the origin locations to participate in DRS.</td>
</tr>
<tr>
<td></td>
<td>5 mi.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 mi.</td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>15 min.</td>
<td>The maximum time (minutes) a DRS participant is willing to wait or reschedule a departure time.</td>
</tr>
<tr>
<td></td>
<td>30 min.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 min.</td>
<td></td>
</tr>
</tbody>
</table>
DRS Sensitivity Analysis (DRS trips)

Total ride-sharable trips

Thousands

- 14,000
- 12,000
- 10,000
- 8,000
- 6,000
- 4,000
- 2,000
- 0

inc50k  inc100k  inc150k  BASE (inc200k)  inc250k  participate20  participate40  BASE (participate60)  participate80  participate100  timediff15  timediff30  BASE (time diff 60 min)  triplength30  triplength20  triplength10  BASE (trip length 2.5)  BASE (proximity 2)  proximity2  proximity10
## Dynamic Ridesharing Scenario

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>$200K</td>
</tr>
<tr>
<td>Participation</td>
<td>80%</td>
</tr>
<tr>
<td>Trip Length</td>
<td>2.5 mi.</td>
</tr>
<tr>
<td>Proximity</td>
<td>1 mi.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>60 min.</td>
</tr>
</tbody>
</table>
Percentage Change in VMT for DRS, TOD, and VMT Fee Scenarios

- Base Case
- TOD (10%)
- TOD (50%)
- VMT Fee (+10)
- VMT Fee (+50)

Scenarios

Percentage Change in VMT

- DRS (SR)
- DRS (LR)
Conclusion

• These results suggest a significant market for DRS that is regionally ubiquitous.

• Moreover, significant reductions in VMT maybe possible, with and without TOD and VMT fees, even when induced travel effects of DRS services are considered.

• Future research should examine incentives that may be required to encourage those who could use DRS to actually use it.
For any question, please contact:

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