CTR PROGRAM-BASED CONGESTION MITIGATION, WHAT TOOLS STILL WORK?

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Research Objectives

- Evaluate the effectiveness of CTR tools, employers’ perspective
- Examine Travel Mode Change Incentivized by CTR tools, employees’ perspective
Introduction

Policy

Data

Pre-analysis

Model

Results

Limitation

Prospect

Background

History

- From late 1980s, US Congress and EPA initiated CTR in selected states;
- Washington State initiated its CTR programs from 1991;
- At late 1990s, most participated states ceased CTR programs;
- Washington State implemented CTR programs for three decades.

Trend

- Decentralization (from Federal to States);
- Localized preferences (the needs from employers & employees);
- Technique-involved mobility services.
Background

Key to Success

- Rich choice set;
- Employee transportation coordinator (ETC);
- Collective bargain;
- Incentives and subsidies (both employer and employee).

Core Measurements

- Average Vehicle Ridership (AVR) /Vehicle Trip Rates (VTR)
- Vehicle Miles Traveled (VMT)
- Greenhouse Gas Emission (GHG)

CTR Policy Tools

- CTR program promotion/ collective bargain
- Alternative transportation modes
- Parking strategies
- Employee transit pass/subsidy
- Compressed work schedule
- Telework
- Flexible work schedule
- Employer provided vehicles
- Ride match/carpool/vanpool
- Short distance mobility services
Study 1: the effectiveness of CTR tools

>Question

- What CTR policy tools work?
- Which CTR policy tool is more efficient?

>Outcome Measurements

- **VTR**: The number of vehicle trips per employee on a worksite, in vehicles per person
- **VMT**: Vehicle miles traveled per employee in a worksite in miles

CTR in WA
## CTR in WA

<table>
<thead>
<tr>
<th>County</th>
<th># of Worksites</th>
<th>VTR</th>
<th>VMT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean S.D.</td>
<td>Min Max</td>
</tr>
<tr>
<td>Clark</td>
<td>5</td>
<td>0.87 0.11</td>
<td>0.69 0.95</td>
</tr>
<tr>
<td>King</td>
<td>341</td>
<td>0.59 0.28</td>
<td>0.07 0.98</td>
</tr>
<tr>
<td>Kitsap</td>
<td>28</td>
<td>0.84 0.11</td>
<td>0.46 0.96</td>
</tr>
<tr>
<td>Pierce</td>
<td>39</td>
<td>0.90 0.04</td>
<td>0.80 0.97</td>
</tr>
<tr>
<td>Snohomish</td>
<td>71</td>
<td>0.85 0.08</td>
<td>0.59 0.98</td>
</tr>
<tr>
<td>Spokane</td>
<td>41</td>
<td>0.85 0.09</td>
<td>0.58 0.94</td>
</tr>
<tr>
<td>Whatcom</td>
<td>13</td>
<td>-- -- --</td>
<td>-- -- --</td>
</tr>
<tr>
<td>Yakima</td>
<td>8</td>
<td>0.88 0.09</td>
<td>0.71 0.95</td>
</tr>
<tr>
<td>Total</td>
<td>546</td>
<td>0.69 0.26</td>
<td>0.07 0.98</td>
</tr>
</tbody>
</table>

## Variable

### 1. Random Effects

- **Company name**: The name of the company that the worksite belongs to
- **Zip code**: The zip code of the worksite

### 2. Independent Variables

#### Employer Features

- **Location (King County)**: If a worksite locates in King county, 1; else, 0
- **Size (# of employees)**: The total number of employees at a worksite
- **IT-related industry**: If the business is information services/software/technical, 1; else, 0
- **Gov. & Edu. related**: If the business is military, government, education, 1; else, 0
- **Manufacturing, transport and utility**: If the business is manufacturing, public utilities, construction, or transportation, 1; else, 0
- **Finance and professional service**: If the business is finance, insurance, real estate, professional/personal services, or retail/trade, 1; else, 0
- **Health care**: If the business is health care, 1; else, 0
- **Agriculture and fishing**: If the business is agriculture or fishing, 1; else, 0
### Marketing and Engagement

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promoting efforts</td>
<td>The number of activities in distributing CTR information to affected employees on a worksite</td>
</tr>
<tr>
<td>Collective bargaining</td>
<td>If a CTR program involves employees for collective bargaining, 1; else 0</td>
</tr>
</tbody>
</table>

### Access to Alternative Transportation Modes and Facilities

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit access</td>
<td>If a station/bus stop locates within 3 blocks from a worksite, 1; else, 0</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>If sidewalks or pedestrian trails are accessible to employees, 1; else, 0</td>
</tr>
<tr>
<td>Amenities</td>
<td>If amenities, such as shopping malls, restaurants, and banks, are located within 3 blocks, 1; else, 0</td>
</tr>
</tbody>
</table>

### Monetary Incentives

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit pass</td>
<td>The average monetary cost of a transit pass that an employee received, in $ per month</td>
</tr>
<tr>
<td>Transit subsidy</td>
<td>The average monetary cost that assigned as transit subsidy to an employee, in $ per month</td>
</tr>
<tr>
<td>Carsharing subsidy</td>
<td>The average monetary cost that assigned as car sharing subsidy to an employee, in $ per month</td>
</tr>
<tr>
<td>Bike/walk subsidy</td>
<td>The average monetary cost that assigned as walk/bike subsidy to an employee, in $</td>
</tr>
<tr>
<td>Tax credit received</td>
<td>If the employer receives a tax credit or grant for the CTR program, 1; else, 0</td>
</tr>
</tbody>
</table>
### Variable

#### Alternative Work Schedule

<table>
<thead>
<tr>
<th>Alternative Work Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed workweek</td>
<td>If a compressed schedule (typically ten hours per day and four days per week) is offered, 1; else, 0</td>
</tr>
<tr>
<td>Flexible work hours</td>
<td>If employees can decide their starting and ending hours, 1; else, 0</td>
</tr>
<tr>
<td>Telecommuting</td>
<td>If employees working from home, a telework center, or a satellite office is allowed, 1; else, 0</td>
</tr>
</tbody>
</table>

#### Site Services

<table>
<thead>
<tr>
<th>Site Services</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking fees</td>
<td>If parking is free for ridesharing and not free for driving alone, 1; else, 0</td>
</tr>
<tr>
<td>Employer-provided vehicles</td>
<td>If the employer provides vehicles for employees, 1; else, 0</td>
</tr>
<tr>
<td>Short-distance mobility service</td>
<td>If the employer provides mobility services for close destinations (e.g., bus stop), 1; else, 0</td>
</tr>
<tr>
<td>Emergency ride</td>
<td>If the employer provides emergency rides, 1; else, 0</td>
</tr>
<tr>
<td>Ride match</td>
<td>If the employer/ETC helps match carpoolers, 1; else, 0</td>
</tr>
<tr>
<td>Rental car</td>
<td>If the worksite has rental cars, 1; else, 0</td>
</tr>
<tr>
<td>ETC worksites</td>
<td>The number of worksites that an ETC is managing</td>
</tr>
</tbody>
</table>

---

### Generalized Linear Mixed Model (GLMM)

- **Linear mixed model**
  \[ Y_{N\times 1} = X_{N\times p}\beta_{p\times 1} + Z_{N\times q}y_{q\times 1} + \varepsilon_{N\times 1} \]
  \[ y \sim N(0, \sigma^2) \text{ and } \varepsilon \sim N(0, \sigma^2) \]

- **Linear predictor**
  \[ \eta = X\beta + Z\gamma \]

- **A link function** \( g(\cdot) \) and a response function \( h(\cdot) \)
  \[ g(\cdot) = h^{-1}(\cdot) \]
  \[ g(E(Y)) = \eta \]
  \[ E(Y) = h(\eta) \]

- **Generalized linear mixed model**
  \[ Y = h(\eta) + \varepsilon \]
### Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>VTR</th>
<th>VMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location (King County)</td>
<td>-0.145 (*** &lt;0.001</td>
<td>-18.15%</td>
</tr>
<tr>
<td>Size (# of employees)</td>
<td>-0.009 (*) 0.027</td>
<td>-0.83%</td>
</tr>
<tr>
<td>IT-related industry</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Gov. &amp; Edu. related</td>
<td>0.11 (**) 0.001</td>
<td>12.50%</td>
</tr>
<tr>
<td>Manufacturing, transport and utility</td>
<td>0.097 (**) 0.003</td>
<td>18.44%</td>
</tr>
<tr>
<td>Finance and professional service</td>
<td>0.058 (*) 0.048</td>
<td>0.26%</td>
</tr>
<tr>
<td>Health care</td>
<td>0.129 (** &lt;0.001</td>
<td>10.54%</td>
</tr>
<tr>
<td>Agriculture and fishing</td>
<td>0.082 (**) 0.010</td>
<td>3.99%</td>
</tr>
<tr>
<td>Marketing and Engagement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promoting efforts</td>
<td>-0.008 0.108</td>
<td>-0.052</td>
</tr>
<tr>
<td>Collective bargaining</td>
<td>-0.058 (*) 0.020</td>
<td>-2.21%</td>
</tr>
<tr>
<td>Access to Alternative Transportation Modes and Amenities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit access</td>
<td>-0.011 0.714</td>
<td>-1.283 (*) 0.046</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>-0.092 (.) 0.085</td>
<td>-12.03%</td>
</tr>
<tr>
<td>Amenities</td>
<td>-0.007 0.827</td>
<td>-0.938 0.208</td>
</tr>
</tbody>
</table>

### Monetary Incentives

<table>
<thead>
<tr>
<th>Variables</th>
<th>VTR</th>
<th>VMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit pass</td>
<td>-0.001 (** &lt;0.001</td>
<td>-3.15%</td>
</tr>
<tr>
<td>Transit subsidy</td>
<td>0.002 (*) 0.094</td>
<td>0.73%</td>
</tr>
<tr>
<td>Carsharing subsidy</td>
<td>0.001 0.383</td>
<td>0.040 (*) 0.033</td>
</tr>
<tr>
<td>Bike/walk subsidy</td>
<td>-0.006 (*) 0.015</td>
<td>-0.65%</td>
</tr>
<tr>
<td>Tax credit received</td>
<td>0.016 0.341</td>
<td>0.691 (.) 0.080</td>
</tr>
<tr>
<td>Alternative Work Hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressed workweek</td>
<td>-0.038 (*) 0.043</td>
<td>-0.91%</td>
</tr>
<tr>
<td>Flexible work hours</td>
<td>-0.026 0.244</td>
<td>-0.054</td>
</tr>
<tr>
<td>Telecommuting</td>
<td>-0.016 0.422</td>
<td>0.102</td>
</tr>
<tr>
<td>Site Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking fee</td>
<td>-0.028 0.364</td>
<td>0.132</td>
</tr>
<tr>
<td>Employer-provided vehicles</td>
<td>0.040 (*) 0.025</td>
<td>6.17%</td>
</tr>
<tr>
<td>Short-distance mobility services</td>
<td>0.038 0.137</td>
<td>0.843</td>
</tr>
<tr>
<td>Emergency rides</td>
<td>0.066 (**) 0.009</td>
<td>1.35%</td>
</tr>
<tr>
<td>Ride match</td>
<td>0.003 0.915</td>
<td>-0.852</td>
</tr>
<tr>
<td>Rental cars</td>
<td>-0.013 0.500</td>
<td>-0.546</td>
</tr>
<tr>
<td>CTR-affected worksites</td>
<td>0.004 0.308</td>
<td>0.081</td>
</tr>
</tbody>
</table>
Results on VTR

- Companies in King County have a lower VTR.
- Larger employers with more employees suggest a lower level of VTR.
- Employees in IT-related industries have the lowest VTR in comparison with the other industries.
- The process of collective bargain shows a negative association with VTR.
- Sites with good access to pedestrian facilities suggest a negative correlation with VTR.
- Providing transit passes encourages employees to drive less while providing transit subsidies encourages employees to drive more.
- A compressed workweek suggests a negative association with VTR.
- Both employer-provided vehicles and emergency rides suggest positive associations with VTR.
Results on VMT

- Employees working in King County tend to have a higher VMT.
- Employees working in manufacturing, transportation, and utility industries commute for longer distances than employees in the IT industry.
- VMT shows a positive association with collective bargaining.
- VMT suggests a negative association with distributing transit passes to employees.

Conclusions

- When rewarding employees for their pro-environmental behavior, distributing transit passes is the preferred strategy.
- Free employer-provided goods, such as transit subsidies, vehicles, and emergency rides, are not recommended.
- Governmental agencies should lead other employers to better advertise CTR programs and engage employees for collective bargaining.
Study 2: travel mode change incentivized by CTR

>Background

- Some employees are loyal to driving alone, while others are open to using alternative travel modes.
- Travel mode change may happen when individuals are provided with multiple choices and incentivized with TDM tools.

>Outcome Measurement: Travel Mode Compatibility

- **No Change**: employees driving alone to access workplaces in the week
  - Driving alone always
- **Change to alternative travel modes**: employees driving alone for some days while using alternative modes for the other days within the week
  - Driving alone to carpooling
  - Driving alone to riding transit
  - Driving alone to telecommuting
  - Driving alone to walking and biking
Variable

Employee Attitudinal Factor

<table>
<thead>
<tr>
<th>Why not drive alone?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>incentive</td>
<td>If the employee does not drive because of receiving incentives, subsidies, or</td>
</tr>
<tr>
<td></td>
<td>free services, 1; else, 0</td>
</tr>
<tr>
<td>health</td>
<td>If the employee does not drive for personal health or well-being, 1; else, 0</td>
</tr>
<tr>
<td>parking</td>
<td>If the employee does not drive for the cost of parking or the lack of parking,</td>
</tr>
<tr>
<td></td>
<td>1; else, 0</td>
</tr>
<tr>
<td>time</td>
<td>If the employee does not drive for saving time by using HOV lanes, 1; else, 0</td>
</tr>
<tr>
<td>convenience</td>
<td>If the employee does not drive because of teleworking, 1; else, 0</td>
</tr>
<tr>
<td>physical constraints</td>
<td>If the employee does not drive because driving myself is not an option, 1; else, 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Why drive alone?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>convenience</td>
<td>If the employee drives alone for the convenience of having the car or the</td>
</tr>
<tr>
<td></td>
<td>inconvenience of alternative modes, 1; else, 0</td>
</tr>
<tr>
<td>information</td>
<td>If the employee drives alone for lacking information on alternative modes, 1;</td>
</tr>
<tr>
<td></td>
<td>else, 0</td>
</tr>
<tr>
<td>job requirement</td>
<td>If the employee drives alone for the requirement of the job, 1; else, 0</td>
</tr>
<tr>
<td>distance</td>
<td>If the employee drives alone because the commuting distance is too long, 1;</td>
</tr>
<tr>
<td></td>
<td>else, 0</td>
</tr>
<tr>
<td>family obligation</td>
<td>If the employee drives alone for family care or other similar obligations, 1;</td>
</tr>
<tr>
<td></td>
<td>else, 0</td>
</tr>
<tr>
<td>safety</td>
<td>If the employee drives alone because bicycling or walking isn’t safe, 1; else, 0</td>
</tr>
</tbody>
</table>

CTR tools and Employer Features...
**Mixed Multinomial Logit Model (MMNL)**

**Utility Function**

\[ U_i = \beta_0 + \beta_j X_j + \gamma_k Z_k + \epsilon_i \]

**Probability Function**

\[ P(Y = i) = \frac{e^{U_i}}{1 + \sum_{i=1}^{N-1} e^{U_i}}, \text{where } i = 1, 2, \ldots, N - 1 \]

\[ P(Y = N) = \frac{1}{1 + \sum_{i=1}^{N-1} e^{U_i}} \]

\[ \ln \left( \frac{P(Y = i)}{P(Y = N)} \right) = U_i = \beta_0 + \beta_j X_j + \gamma_k Z_k + \epsilon_i \]
### Introduction

### Policy

### Data

### Pre-analysis

### Model

### Results

### Limitation

### Prospect

<table>
<thead>
<tr>
<th>Variable</th>
<th>DA - Car sharing</th>
<th>DA - Public transport</th>
<th>DA - Telework</th>
<th>DA - Walk &amp; Bike</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTR tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collective bargaining</td>
<td>-0.17</td>
<td>0.85</td>
<td>0.13</td>
<td>1.14</td>
</tr>
<tr>
<td>Promoting efforts</td>
<td>0.01</td>
<td>1.01</td>
<td>-0.05</td>
<td>0.95</td>
</tr>
<tr>
<td>Transit access</td>
<td>-0.27</td>
<td>0.76</td>
<td>1.84*</td>
<td>6.29</td>
</tr>
<tr>
<td>Amenities</td>
<td>0.03</td>
<td>1.03</td>
<td>1.18*</td>
<td>3.25</td>
</tr>
<tr>
<td>Transit pass</td>
<td>0.08</td>
<td>1.09</td>
<td>0.64*</td>
<td>1.90</td>
</tr>
<tr>
<td>Transit subsidy</td>
<td>0.17</td>
<td>1.18</td>
<td>-0.3</td>
<td>0.74</td>
</tr>
<tr>
<td>Car-sharing subsidy</td>
<td>0.03</td>
<td>1.03</td>
<td>-0.16</td>
<td>0.86</td>
</tr>
<tr>
<td>Bike/Walk subsidy</td>
<td>0.14</td>
<td>1.15</td>
<td>-0.4</td>
<td>0.67</td>
</tr>
<tr>
<td>Compressed workweek</td>
<td>-0.45*</td>
<td>0.64</td>
<td>0.38</td>
<td>1.46</td>
</tr>
<tr>
<td>Flexible work hours</td>
<td>0.18</td>
<td>1.20</td>
<td>0.58*</td>
<td>1.79</td>
</tr>
<tr>
<td>Parking fees</td>
<td>0.64**</td>
<td>1.91</td>
<td>2.14***</td>
<td>8.53</td>
</tr>
<tr>
<td>Employer-provided Vehicle</td>
<td>-0.19</td>
<td>0.82</td>
<td>0.35</td>
<td>1.42</td>
</tr>
<tr>
<td>Short-distance mobility service</td>
<td>0.60*</td>
<td>1.82</td>
<td>-0.25</td>
<td>0.78</td>
</tr>
<tr>
<td>Emergency ride</td>
<td>-0.29</td>
<td>0.75</td>
<td>-0.16</td>
<td>0.85</td>
</tr>
<tr>
<td>Ride match</td>
<td>0.11</td>
<td>1.12</td>
<td>0.28</td>
<td>1.33</td>
</tr>
<tr>
<td>Rental car</td>
<td>0.19</td>
<td>1.21</td>
<td>0.48*</td>
<td>1.62</td>
</tr>
<tr>
<td>ETC time</td>
<td>0.01</td>
<td>1.01</td>
<td>0.01</td>
<td>1.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>DA - Car sharing</th>
<th>DA - Public transport</th>
<th>DA - Telework</th>
<th>DA - Walk &amp; Bike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why don't drive alone?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incentive</td>
<td>0.48***</td>
<td>1.62</td>
<td>2.20***</td>
<td>8.98</td>
</tr>
<tr>
<td>Health</td>
<td>0.93***</td>
<td>2.54</td>
<td>1.11***</td>
<td>3.04</td>
</tr>
<tr>
<td>Parking</td>
<td>0.80***</td>
<td>2.23</td>
<td>1.20***</td>
<td>3.31</td>
</tr>
<tr>
<td>Time</td>
<td>1.50***</td>
<td>4.50</td>
<td>-0.22</td>
<td>0.80</td>
</tr>
<tr>
<td>Convenience</td>
<td>-2.05***</td>
<td>0.13</td>
<td>-1.78***</td>
<td>0.17</td>
</tr>
<tr>
<td>Physical constraints</td>
<td>-0.70**</td>
<td>0.50</td>
<td>-0.36</td>
<td>0.70</td>
</tr>
</tbody>
</table>

| Why drive alone?                |                  |                        |               |                  |
| Convenience                     | -0.60***         | 0.55                   | -0.72***      | 0.49             |
| Information                     | -1.07***         | 0.34                   | -1.22***      | 0.29             |
| Job requirement                 | -0.09            | 0.91                   | 0.00          | 1.00             |
| Distance                        | -0.78***         | 0.46                   | -1.50***      | 0.22             |
| Family obligation               | -0.03            | 0.97                   | -0.13         | 0.88             |
| Safety                          | -0.41***         | 0.66                   | -1.48***      | 0.23             |
### Results

- 46% of employees have a lower level of car dependence, and are subject to the occasional use of carsharing (10%), telecommuting (3%), riding public transit (29%), and walking and biking (4%);
- Employees in the IT-industry are more likely to change from driving alone to telecommuting;
- Employees in the IT-industry are more likely to change driving alone to riding transit in comparison with employees in manufacturing and health care;
- Employees in the IT-industry are more likely to change driving alone to walking and biking in comparison with employees in finance and professional service;
Results

- Employees who actively bargaining for CTR policies are more likely to change from drive alone to telecommute;
- Promoting transit access encourages the travel mode change towards riding transit, while discourages the change towards telecommuting;
- Providing transit pass does promote the travel mode change towards riding transit;
- Providing carsharing subsidy discourages the travel mode change towards telecommuting;
- Compressed workweek is positively associated with the travel mode change towards telecommuting, while negatively associated with the change towards to carsharing, walking and biking;
- Flexible work hours are positively associated with the travel mode change towards telecommuting, walking and biking;

Results

- Parking fee is an effective tool to promote the travel mode change from driving alone to all alternative modes;
- Employer-provided vehicles and short-distance mobility services both are negatively associated with the travel mode change towards telecommuting;
- The availability of rental cars on worksites is negatively associated with the travel mode change towards walking and biking;
- Attitudinal factors confirm the self-selection effect in making travel mode choices.
- In general, employees may choose alternative travel modes for incentives, health, time availability, or saving parking fees, while not for convenience or physical constraints;
- Employees who always drive show a high level of loyalty to driving, and the reasons are many, such as safety, family obligation, convenience, commuting distance, and job requirement.
Conclusions

- There is a great proportion of employees are apt to use alternative travel modes beyond driving alone;
- Promoting transit access and providing transit pass are effective tools in encouraging transit use;
- IT-industry employees have more choices and greater flexibility in choosing travel modes;
- Parking scheme is an effective tool in incentivizing travel mode change;
- Alternative work hours, such as compressed workweek, flexible work hours, all encourage the travel mode change towards telecommuting;
- Attitudinal factors play a key role in explaining travel mode choices.

Implications

- Promote transit access and provide transit pass to employees;
- Optimaly use parking schemes (employers won't favor);
- Increase working schedule flexibilities, especially alternative workhour policies, which have great potential to reduce traffic and mitigate congestion in the future;
- Stop providing or optimally regulate free rides to employees, such as employer provided-vehicles, emergency rides, and transit/carsharing subsidies;
- The joint effect of different TDM tools cannot be ignored, and the interplayed relationship among different tools needs to be carefully considered.
Limitations

General issue
- Generalizability or research significance (Despite CTR is no longer popular, it can be treated as a package of TDM tools)

The 1st study
- Fail to include factors related to household location choice, and the VMT model involves internal validity issues

The 2nd study
- Employees’ SES factors, home locations’ BE factors;
- Limit to King County;

Future Research

CTR Tools’ Evaluation (Internal, Item Response Theory-IRT)
- The Difficulty of CTR in Practice (Capacity, Difficulty, and Discrimination)

GHG Reduction Simulation
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