Measuring Impacts on Demands for Transportation

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Presentation Overview

- Modelling Travel Demand and Land use Transportation Interaction
- Issues with modelling systems in using for predicting uncertain future
- Uncertain future and measurement
- Recent ongoing projects
Modelling Systems

- My group has been developing modelling system for travel demand and land use-transportation interaction modelling
  - Activity-based model for travel demand
  - Computational equilibrium model for land use-transportation interactions

- It is important to have such modelling systems that are based on sound theoretical foundations

- However, empirical version of the models need data:
  - Data are observations of reality
  - Data are measurements of demand and demand generating factors/variables
Activity-Based Travel Demand Model: CUSTOM

- Expected maximum utility of trip making choice
- Expected maximum utility of location choice

Time Allocation to previous activity Episode

Next Activity Type Choice

Potential Path Area: PPA

Mode & Destination location choice of next activity

Time budget left after travel time

Time Allocation to next activity Episode

Expected Maximum Utility of Daily Activity-Travel Scheduling

Mobility Tool Ownership Choices
Activity-Based Travel Demand Model: CUSTOM
Land Use Transportation Interaction Model: LUTIM
LUTIM-Sequence of Calculation
LUTIM - Production Consumption Relationship
LUTIM-Activity Transport Interactions
Modelling Systems

- Rich in theory
- Poor in Data:
  - We need real observations to estimate model parameters
    - This means models can reproduce what happened in the past
  - How about the uncertain future?
Potential Impacts of Transformative Transportation Technologies/Policy

- Increase VKT?
- Increased in number of trips?
- Reduced Transit Modal Share?
- Reduced Privacy?
- Better Land Use?
- Increased Social Equity?
- Reduced Car Ownership?
- Reduced Stress?
- Increased Safety?
- Reduced Emissions?
- And many more...!
Transformative and Automated Transportation: Impact Measurement Perspective
Uncertain Future

- Uncertainty:
  - Conventional ownership versus ridehail/rideshare service?
  - How much these services will cost?
  - Will AVs have a noticeable positive impact on traffic flow and by extension travel time?
  - Will people be willing to share AVs or are SOV trips going to continue to be the norm?
Problems:

- Massive set of potential impacts and large amount of uncertainty

- We have no way of predicting what will happen without prior observation:

- No guarantee that existing modelling systems will give accurate prediction of the future:
  - If models use only revealed information
Research Challenge

- New Modelling System or New Data?
- Answer:
  - Data: measurement of responses (people and firms) in contexts of new options, new technologies.
  - Policy sensitive model components of activity-based travel demand modelling system
  - Policy sensitive model components of land use transportation interaction modelling system
Projects on Measuring Demand Impacts

1. 2018 Experiment on Travel Mode Choice in Context of Shared and non-Shared AV (SAVER)- Adam Weiss & Faizus Salehin

2. 2019 Experiment on Willingness-to-pay for Automation- Kaili Wang & Faizus Salehin

3. 2019 Experiment on AV impacts on Vulnerable road users: People with vision impairment in an era of AV-Sina Azizisoldouz

4. 2019 Experiment on Travel Mode Choice in Context of Flexible mobility options (SPRINT)- Patrick Loa & Jason Hawkins
1. Mode Choice Impacts

- An SP-pivoted on-RP survey on travel mode choices of the residents of the GTHA in 2018.
- Sample size of 1617 (833 commuting and 784 non-commuting trips).
- Objective was to investigate mode switching behaviour.
- Survey includes measurements of:
  - Personal and household socio-economics variables
  - Chosen mode of latest commuting and non-commuting modes
  - SP experiment
  - Attitudes and perceptions towards AV options
1. Mode Choice Impacts

**Question 32:** Please select your preferred alternative

<table>
<thead>
<tr>
<th></th>
<th>Current mode - drive</th>
<th>Own your own AV and travel alone</th>
<th>Own your own AV and carpool</th>
<th>Hail an AV and travel alone</th>
<th>Hail an AV and carpool</th>
<th>Hail a conventional travel option (taxi/UBER) with a driver and travel alone</th>
<th>Hail a conventional travel option (taxi/UBER) with a driver and carpool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Time (minutes)</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Expected Detour Time (minutes)</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
<td>N/A</td>
<td>4</td>
<td>N/A</td>
<td>8</td>
</tr>
<tr>
<td>Expected Wait Time (minutes)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>8</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Travel Cost</td>
<td>$2.05</td>
<td>$0.95</td>
<td>$0.00</td>
<td>$1.09</td>
<td>$0.95</td>
<td>$1.64</td>
<td>$1.09</td>
</tr>
<tr>
<td>Parking Cost</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Additional Upfront Cost for Owning an AV (Relative to a Conventional Vehicle)</td>
<td>N/A</td>
<td>$7,500.00</td>
<td>$7,500.00</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Earning Potential</td>
<td>N/A</td>
<td>N/A</td>
<td>$0.61</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Number of Shared Riders</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
<td>N/A</td>
<td>2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Do You Know the Person You Are Carpooling With?</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Your Choice</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
1. Mode Choice Impacts

SP Modal Distribution (Commuting Trips)
1. Mode Choice Impacts

SP Modal Distribution (Non-Commuting Trips)
1. Mode Choice Impacts

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Aggregate Share of Attitudinal Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joining an AV Carshare Group</td>
<td>24.68% no interest, 15.99% somewhat uninterested, 22.87% somewhat uninterested, 26.71% somewhat uninterested, 9.75% uninterested</td>
</tr>
<tr>
<td>Owning Your Own AV</td>
<td>23.45% no interest, 14.71% somewhat uninterested, 18.82% somewhat uninterested, 28.04% somewhat uninterested, 14.98% uninterested</td>
</tr>
<tr>
<td>AV Taxi With a Backup Driver</td>
<td>15.72% no interest, 13.91% somewhat uninterested, 24.68% somewhat uninterested, 31.45% somewhat uninterested, 14.23% uninterested</td>
</tr>
<tr>
<td>AV Taxi No Backup Driver</td>
<td>30.70% no interest, 17.32% somewhat uninterested, 21.43% somewhat uninterested, 23.13% somewhat uninterested, 7.41% uninterested</td>
</tr>
</tbody>
</table>
1. Mode Choice Impacts

➢ On-Going Research:
  ✓ Joint RP-SP GEV mode choice modelling
  ✓ Structural Equation Modelling to identify latent constructs/traits that drive behaviour/habit/attitude
  ✓ Discrete mode choice model with latent perception/attitude variable
2. Willing-to-Pay for Automation

- A survey on vehicle choice.
- Survey question includes:
  - Personal and household information
  - Current car information
  - Contingent valuation of different features of automation
  - SP survey on new vehicle type choice
- Sample size: 238 individual distributed across the GTA
2. Willing-to-Pay for Automation

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver Assistance</td>
<td>$1,042</td>
<td>3080</td>
</tr>
<tr>
<td>Partial Automation</td>
<td>$1,667</td>
<td>3828</td>
</tr>
<tr>
<td>Conditional Automation</td>
<td>$2,197</td>
<td>5588</td>
</tr>
<tr>
<td>High Automation</td>
<td>$2,642</td>
<td>6027</td>
</tr>
<tr>
<td>Full Automation</td>
<td>$3,351</td>
<td>7593</td>
</tr>
</tbody>
</table>

- Direct question about how much you’d be willing to pay for?
- This will be compared against estimated willingness-to-pay based on SP data
## 2. Willing-to-Pay for Automation

<table>
<thead>
<tr>
<th></th>
<th>Private Conventional Vehicle</th>
<th>Private Autonomous Vehicle</th>
<th>Autonomous vehicle sharing membership</th>
<th>Private vehicle + Autonomous vehicle sharing membership</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Automation level</strong></td>
<td>No Automation</td>
<td>Conditional Automation</td>
<td>Conditional Automation</td>
<td>Conditional Automation Full Automation</td>
</tr>
<tr>
<td><strong>Additional cost</strong></td>
<td>No additional cost</td>
<td>$8000 higher</td>
<td>N/A</td>
<td>$1000 higher N/A</td>
</tr>
<tr>
<td><strong>Driving rate</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>$15 per hr</td>
<td>N/A $25 per hr</td>
</tr>
<tr>
<td><strong>Driving cost</strong></td>
<td>$40 per 100km</td>
<td>$40 per 100km</td>
<td>N/A</td>
<td>$30 per 100 km N/A</td>
</tr>
<tr>
<td><strong>Membership application fee</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>$150</td>
<td>N/A $0</td>
</tr>
<tr>
<td><strong>Monthly parking + insurance</strong></td>
<td>$450</td>
<td>$450</td>
<td>N/A</td>
<td>$230 N/A</td>
</tr>
<tr>
<td><strong>Monthly subscription fee</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>$10</td>
<td>N/A $0</td>
</tr>
<tr>
<td><strong>Monthly mileage limit</strong></td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>4400 km</td>
<td>Unlimited 1350 km</td>
</tr>
<tr>
<td><strong>General traffic condition</strong></td>
<td>Below Speed Limit</td>
<td>Below Speed Limit</td>
<td>Stop and go</td>
<td>Stop and go</td>
</tr>
</tbody>
</table>
2. Willing-to-Pay for Automation

- 58% buying a private conventional vehicle only
- 22% buying a private autonomous vehicle only
- 10% joining autonomous vehicles sharing program
- 11% buying a private vehicle and joining autonomous vehicles sharing program
2. Willing-to-Pay for Automation

➢ On-going research:
  ✓ Econometric modelling of vehicle choice to estimate willingness-to-pay

  ✓ Comparing estimated values against elicited values
3. Impacts on Vulnerable Users

- Understanding the impact of connected and automated vehicles for pedestrians with sight loss
- A behavioural survey on perception and potential impact of AV/CAV on pedestrian with sight loss
- Sample size: 406

- Survey includes measurements of:
  - Personal attributes
  - Perception and Attitude towards AV/CAV
  - Opinion about possible policy options
3. Impacts on Vulnerable Users

Trust to CAV versus preference for using CAV
3. Impacts on Vulnerable Users

Preference for using CAV versus level of trust and employment status
3. Impacts on Vulnerable Users

Preference for using CAV versus level of trust and age categories
3. Impacts on Vulnerable Users

Preference for using CAV versus level of trust and sight loss experiences
3. Impacts on Vulnerable Users

- On-going research:
  - Statistical analysis of factors influencing perceptions/opinions towards AV/CAV
  - Policy options to mitigate negative impacts
4. Mode choice in Flexible/New Mobility Context

- An SP-pivoted on-RP mode choice experiment to capture tradeoff involved in mode choices in context of TNC service options in the City of Toronto.
- Sample size: 800+
- Survey includes measurements of:
  - Personal and household socio-economics variables
  - Chosen mode of latest commuting and non-commuting modes
  - SP experiment
  - Attitudes and perceptions towards TNC services
### 4. Mode choice in Flexible/New Mobility Context

| Question 41: Please choose the alternative that you would prefer to use for your typical commuting trip. |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Drive yourself | Driven by someone you know | Public Transit | Exclusive Ride Hailing | Shared Ride Hailing | Taxi | Bicycling | Walking |
| Travel Time (mins) | 6 | 6 | 29 | 6 | 7 | 6 | 6 | 14 |
| Travel Cost ($) | $0.22 | $0.11 | $3.10 | $1.94 | $1.30 | $7.39 | - | - |
| Waiting Time (mins) | - | - | 7.5 | 2 | 5 | 2 | - | - |
| Walking Time (mins) | - | - | 5 | - | - | - | - | - |
| Parking Cost ($) | $15 | - | - | - | - | - | - | - |
| Other Passengers | - | - | - | - | 1 | - | - | - |
| Delay Time (mins) | - | - | 1 | - | 4 | - | - | - |
| Level of Crowding | - | - | Moderately crowded (50% chance of getting a seat) | - | - | - | - | - |
| Frequency of Delays over 5 mins | - | - | Once a month | - | - | - | - | - |

Your Choice: Drive yourself

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*UTTRI*
4. Mode choice in Flexible/New Mobility Context

If Ride Hailing Services were not Available, How Would You Have Made This Trip? [n=403]

- I would have driven a car
- I would have gotten a ride from someone
- I would have used a taxi
- I would have walked or biked
- I would have used public transit
- I would have used a van or shuttle service
- I would not have made this trip at all
4. Mode choice in Flexible/New Mobility Context

Please Indicate the Statement(s) that Best describe Why You Used a Ride Hailing Service for This Trip [n=403]

- I was travelling with luggage bags and or boxes
- To avoid drinking and driving
- Difficulty finding parking
- Parking cost
- Reliability of service
- Safety
- Comfort
- Ease of hailing service
- Faster travel time
- Shorter waiting time
- Cost
- Ease of payment
4. Mode choice in Flexible/New Mobility Context
4. Mode choice in Flexible/New Mobility Context

Please Select the Important Factor That Influenced Your First-Time Use of Ride Hailing Services [n=723]

- Heard from a friend who has used this service
- Heard from a co-worker who has used this service
- Heard from a relative who has used this service
- Learned from newspapers
- Learned from the Internet
- I have never used this service
- Not applicable
4. Mode choice in Flexible/New Mobility Context

- Drive Yourself (AD): 215
- Public Transit (PT): 315
- Taxi (TAXI): 7
- Driven by Someone You Know (AP): 37
- Exclusive Ride Hailing (ERH): 12
- Shared Ride Hailing (SRH): 7
- Walking (WALK): 42
- Bicycling (BIKE): 8
4. Mode choice in Flexible/New Mobility Context

➢ On-Going Research:
  ✓ Joint RP-SP GEV mode choice modelling
  ✓ Structural Equation Modelling to identify latent constructs/traits that drive behaviour/habit/attitude
  ✓ Discrete mode choice model with latent perception/attitude variable
Q&A

Thank you for listening