Park-and-Ride User Behavior in the Twin Cities

Alex Webb

**Project Title:**

Impact of Transitways on Travel on Parallel and Adjacent Roads

**Research Objective:**

Estimate a utility function representing the significance and magnitude of parameters for different factors affecting the attractiveness of park-and-ride facilities.
Metro Transit 2016 On-Board Survey

• Origin-Destination Survey
• 5+ minutes to complete
• Administered April 2016-February 2017
• 30,491 total survey responses

Data Collected:
• Home
• Origin/Destination
• Boarding/alighting
• Trip purpose
• Fare type
• Transit route(s)
• Demographics
Park-and-Ride User Summary

- N = 1,895 users
- Destination
  - 86% went to work
  - 8% went to school
  - 6% other
- Route Surveyed On
  - 65% express bus
  - 20% LRT
  - 10% Northstar
  - 5% local bus
  - <1% Red Line
- Transfers
  - 77.4% had zero transfers
  - 21% had one transfers
  - 1.6% had two or more transfers

What we want to do:

1,895 users \times \text{111 park-and-ride facilities} = 210,345 \text{ total paths}
Travel Path Components

- Home coordinates \(\rightarrow\) park-and-ride coordinates
- OSMnx python package (Prof. Geoff Boeing, USC)

\[
Travel Time = \sum_{i}^{P} \frac{\text{Length}_i}{\text{Speed Limit}_i}
\]

for road segments \(l\) in path \(P\)

- Speed Limit: motorway = 55 mph, other* = 30 mph

*tertiary, residential, secondary, primary, tertiary link, trunk link, motorway link, road, primary link, trunk, unclassified
Driving Path

Distance: 3.35 miles  
Time: 5.7 minutes

Distance: 3.4 miles  
Time: 8 minutes

Schedule-Based Transit Path

Southdale Transit Center

Distance

Stop: York Ave. S  
Time: 8:15 AM  
Route: 6

Stop: Transit Center Gate B  
Time: 8:24 AM  
Route: 515

Stop: Transit Center Gate B  
Time: 8:34 AM  
Route: 515
**Example Path**

**User ID:** 10554  
**PNR ID:** 99  
**Destination ID:** 342

**Departure Time:** 11:00 am

1. Leave PNR at 11:11 am  
2. Walk for 1.6 minutes  
3. 8853307-DEC15-MVS-BUS-Weekday-01,2  
   **11:13 am**  
4. ...  
5. 8853307-DEC15-MVS-BUS-Weekday-01,62  
   **11:54 am**  
6. Walk for 5.5 minutes  
7. Arrive at destination at 11:59 am  

**48 minutes total**
Transit Departure/Arrival Time

- Survey records first boarding as "8:00 AM – 9:00 AM"
- Find fastest path within 2-hour window

![Time Schedule Diagram]

### Multinomial Logit Model

<table>
<thead>
<tr>
<th>User</th>
<th>PNR Alternatives</th>
<th>Choice</th>
<th>Driving time</th>
<th>Transit time</th>
<th>Service type</th>
<th>...</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Yes</td>
<td>6</td>
<td>15</td>
<td>Bus</td>
<td>...</td>
<td>25-34</td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>No</td>
<td>15</td>
<td>21</td>
<td>LRT</td>
<td>...</td>
<td>25-34</td>
</tr>
<tr>
<td>1</td>
<td>C</td>
<td>No</td>
<td>40</td>
<td>5</td>
<td>Bus</td>
<td>...</td>
<td>25-34</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>No</td>
<td>14</td>
<td>10</td>
<td>Bus</td>
<td>...</td>
<td>55-64</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>Yes</td>
<td>20</td>
<td>9</td>
<td>Bus</td>
<td>...</td>
<td>55-64</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Choice = f(Transit time, driving time, service type, ... , age)
All Variables Considered

- Driving time
- In-transit time
- Wait time
- Walk time
- # transfers
- Distance ratio
- Average headway
- # Routes available
- Path overlap
- Lot Capacity
- Transitway (binary)
- Structured (binary)
- # Amenities
- Age
- Income
- Gender
- Disability status

Distance Ratio

Path Overlap

1. Path size factor $p_{S_{mn}}$ is based on the length $L_s$ of subroute $s_i$, and the total number $N_{sw}$ of unique full routes using leg $a$:

$$p_{S_{mn}} = \frac{1}{L_s} \sum_{i \in m} \frac{l_i}{N_{sw}}$$

Hoogendoorn-Lanser and Bovy (2007)
### Model Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficient</th>
<th>z-score</th>
<th>In-car time equivalence (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-car time</td>
<td>-0.38</td>
<td>-27.51</td>
<td>1.0</td>
</tr>
<tr>
<td>In-transit time</td>
<td>-0.08</td>
<td>-9.98</td>
<td>0.2</td>
</tr>
<tr>
<td>Transfers</td>
<td>-1.61</td>
<td>-8.25</td>
<td>4.2</td>
</tr>
<tr>
<td>Avg. headway</td>
<td>-0.01</td>
<td>-5.63</td>
<td>0.04</td>
</tr>
<tr>
<td>Distance ratio</td>
<td>-3.84</td>
<td>-6.96</td>
<td>10.1</td>
</tr>
<tr>
<td>Lot capacity</td>
<td>0.002</td>
<td>18.70</td>
<td>0.005</td>
</tr>
<tr>
<td>Transitway</td>
<td>1.131</td>
<td>9.91</td>
<td>3</td>
</tr>
<tr>
<td># Routes available</td>
<td>-0.11</td>
<td>-5.35</td>
<td>0.3</td>
</tr>
<tr>
<td>Path size</td>
<td>0.58</td>
<td>2.60</td>
<td>-</td>
</tr>
</tbody>
</table>

No. Observations: 1183  
Pseudo R-sq.: 0.594  
Predictive Ability: 64%
Conclusions

1. Strong preference for shorter driving time to reach PNR
2. PNR users willing to drive 3 minutes further to reach a Transitway
3. PNR users value smaller distance ratio

Applications

• Demand Forecasting

• Situating a PNR facility
  • Maximize the sum of commuter utility functions