Incorporating Discrete Characteristics and Network Relationships of Parking into SF-CHAMP Travel Model

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Why Model Parking?

- Test effects of varying parking supply and pricing
- Test smart parking (reduced search time)
- People often don’t park in destination zone
Outline

(1) Background & Goals
(2) Parking in Existing SF-CHAMP
(3) New Data
(4) Parking Enhancements to SF-CHAMP
(5) Results
(6) Next Steps

Source: chelseagirlphotos, Flickr
SF-CHAMP Parking Enhancement Goals

(1) Separate treatments of on- and off-street parking
(2) Model parking price and availability variations across time of day
(3) Relate parking search time to available spaces
(4) Represent parking explicitly in the roadway network
(5) Capture the trade off between parking search time, cost, and walk time
Parking in Existing SF-CHAMP

Model Inputs
- TAZ Data
  - Parking subsidy and capacity, Area Type
- Initial Trip Tables
- Road Network
- Transit Network

Initial Road Assignment
- Transit Skimming
  - Work Loc & Destination Choice
    - Terminal time per OD-pair
  - TAZ-based parking time, costs
  - TAZ-based parking time, costs
- Full-Day Tour Generation
- Intermediate Stop Choice
- Trip Mode Choice
  - TAZ-based parking time, costs
- Final Road Assignment
  - Transit Assignment

Model Outputs
- Roadway Skims
- Transit Skims
- Person Trip Tables
- Loaded Road Network

Model Inputs
- Person Trip Tables
- Loaded Road Network

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Parking in Existing SF-CHAMP

1) pctPaying
2) totalParking
3) parkCostWorkHourly and parkCostOtherHourly
4) areatype
Parking in Existing SF-CHAMP

\[ U_{DA} = C_{IVTW_{walk}t_{terminal}} + C_{park, inclow}D_{inclow}c_{park,DA} + C_{park, incmed}D_{incmed}c_{park,DA} + C_{park, inchi}D_{inchi}c_{park,DA} + C_{pkind}a_{dtaz} + 
\ldots (other components of utility) \ldots \]
### New Data: 2006 Stated Preference Survey on Parking

<table>
<thead>
<tr>
<th>Search Time</th>
<th>Low Price Level</th>
<th>High Price Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pay $0.50 to $1.00 more per hour to find a parking space in less than 5 minutes but may require me to walk 2 to 3 blocks from my parking space to my destination</td>
<td>Pay $1.50 to $2.00 more per hour to find a parking space immediately but may require me to walk 2 to 3 blocks from my parking space to my destination</td>
</tr>
<tr>
<td>Walk Distance</td>
<td>Pay $0.50 to $1.00 more per hour to park within 1 to 2 blocks of my destination but may require me to drive around for more than 5 minutes searching for a parking space</td>
<td>Pay $1.50 to $2.00 more per hour to park right in front of my destination but may require me to drive around for more than 5 minutes searching for a parking space</td>
</tr>
</tbody>
</table>
Discrete Choice Model Estimation Results

Significant Variables:
- trip purpose
- frequency of parking
- frequency of transit use
- number of household vehicles
- weekdays or weekends
- disability limiting physical movement
## Discrete Choice Model Estimation Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Value</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative 1</strong></td>
<td>0.00</td>
<td></td>
<td>fixed</td>
</tr>
<tr>
<td><strong>Alternative 2</strong></td>
<td>0.06</td>
<td>0.72</td>
<td>0.48</td>
</tr>
<tr>
<td><strong>Cost (&quot;Additional Dollars/hour&quot;)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. times park per week</td>
<td>0.44</td>
<td>2.11</td>
<td>0.03</td>
</tr>
<tr>
<td>Trip purpose: errand</td>
<td>-5.44</td>
<td>-5.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: shopping</td>
<td>-4.84</td>
<td>-3.98</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: work</td>
<td>-5.80</td>
<td>-4.29</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: work-based errand</td>
<td>-5.45</td>
<td>-2.88</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Search Time (&quot;Minutes&quot;)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical disability</td>
<td>0.14</td>
<td>6.18</td>
<td>0.00</td>
</tr>
<tr>
<td>No. times park per week</td>
<td>0.18</td>
<td>2.41</td>
<td>0.01</td>
</tr>
<tr>
<td>Trip purpose: errand</td>
<td>-1.69</td>
<td>-4.40</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: shopping</td>
<td>-1.56</td>
<td>-3.63</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: work</td>
<td>-1.87</td>
<td>-3.91</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: work-based errand</td>
<td>-1.56</td>
<td>-2.35</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Walking Distance (&quot;Blocks&quot;)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical disability</td>
<td>-0.20</td>
<td>-4.37</td>
<td>0.00</td>
</tr>
<tr>
<td>No. times park per week</td>
<td>0.32</td>
<td>2.09</td>
<td>0.03</td>
</tr>
<tr>
<td>Trip purpose: errand</td>
<td>-3.01</td>
<td>-3.79</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: shopping</td>
<td>-2.69</td>
<td>-3.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: work</td>
<td>-3.23</td>
<td>-3.26</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip purpose: work-based errand</td>
<td>-2.75</td>
<td>-1.99</td>
<td>0.05</td>
</tr>
</tbody>
</table>

n= 5187, $\rho^2 = 0.165$, adjusted $\rho^2 = 0.160$
### Discrete Choice Model Estimation Results

<table>
<thead>
<tr>
<th>Trip Category</th>
<th>Value of Search Time ($/hour)</th>
<th>Value of Walk Distance ($/block)</th>
<th>Value of Walk Time ($/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip purpose: errand</td>
<td>16.49</td>
<td>0.49</td>
<td>13.45</td>
</tr>
<tr>
<td>Trip purpose: shopping</td>
<td>17.13</td>
<td>0.48</td>
<td>13.21</td>
</tr>
<tr>
<td>Trip purpose: work</td>
<td>17.63</td>
<td>0.50</td>
<td>13.74</td>
</tr>
<tr>
<td>Trip purpose: work-based errand</td>
<td>14.46</td>
<td>0.42</td>
<td>11.57</td>
</tr>
</tbody>
</table>

Assuming parking duration of 1 hour
New Data: Parking Inventory
New Data: Parking Inventory
New Data: Parking Inventory

TazData in Enhanced Parking Model

Total Parking Per Square Mile

- 0
- 1 - 5,789
- 5,790 - 8,884
- 8,885 - 14,010
- 14,020 - 20,380
- 20,390 - 27,470
- 27,480 - 39,710
- 39,720 - 59,090
- 59,100 - 99,080
- 99,090 - 173,000
- 173,100 - 338,000

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SF-CHAMP Enhanced Parking Model

**Model Inputs**
- TAZ Data
  - Parking subsidy and capacity, Area Type
- Initial Trip Tables
  - Split by reserved and unreserved parking
- Road Network
  - Parking capacity, cost (on- and off-street)
- Transit Network

**Multiple Iterations**
- Parking General Cost
- Initial Road Assignment
- Transit Skimming
- Roadway Skimming
  - Terminal time per OD-pair
- Work Loc & Destination Choice
- Skim-based parking time, costs
- Full-Day Tour Generation
- Tour Mode Choice
- Skim-based parking time, costs
- Intermediate Stop Choice
- Trip Mode Choice
  - Skim-based parking time, costs
- Final Road Assignment
- Transit Assignment

**Model Outputs**
- Roadway Skims
  - Parking costs, travel times for unreserved
- Transit Skims
- Person Trip Tables
  - Split by reserved and unreserved parking
- Loaded Road Network
Deciding Who Pays

<table>
<thead>
<tr>
<th>Reserved Parking</th>
<th>Unreserved Parking</th>
</tr>
</thead>
<tbody>
<tr>
<td>• To home</td>
<td>All others</td>
</tr>
<tr>
<td>• Some work and school trips</td>
<td></td>
</tr>
<tr>
<td>• Disabled placard holders</td>
<td></td>
</tr>
</tbody>
</table>
Deciding Who Pays

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>• To home</td>
<td></td>
</tr>
<tr>
<td>• Some work and school trips</td>
<td></td>
</tr>
<tr>
<td>• Disabled placard holders</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>56%</td>
</tr>
<tr>
<td>All others</td>
<td></td>
</tr>
</tbody>
</table>
Network Representation: Offstreet

Reserved

Unreserved
Network Representation: Offstreet

Reserved

Unreserved
Network Representation: Onstreet

Reserved

Unreserved

- Roadway
- TAZ Boundary
- TAZ Centroid
- Centroid Connector

- Roadway
- TAZ Boundary
- TAZ Centroid
- Parking Link
- Roadway to Parking
- Parking to Walkable TAZs
## Generalized Cost

\[ GC = \beta_{\text{Cost}} C + \beta_{\text{Search}} S + \beta_{\text{Dist}} D \]

<table>
<thead>
<tr>
<th>Mode</th>
<th>( \beta_{\text{Cost}} ) (Utility/$)</th>
<th>( \beta_{\text{Search}} ) (Utility/Minute)</th>
<th>( \beta_{\text{Dist}} ) (Utility/Mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Alone</td>
<td>-3.908</td>
<td>-1.100</td>
<td>-25.904</td>
</tr>
<tr>
<td>Shared Ride 2</td>
<td>-3.722</td>
<td>-1.031</td>
<td>-24.450</td>
</tr>
<tr>
<td>Shared Ride 3+</td>
<td>-3.643</td>
<td>-1.002</td>
<td>-23.844</td>
</tr>
</tbody>
</table>
Search Time for Parking Links

- On-Street Search Time
- Off-Street Search Time
- Off-Street Smart Search Time

Volume/Capacity

Search Time (minutes)

0.85
Results

AM Walk Volumes

Offstreet to TAZ
- 5 - 36
- 37 - 82
- 83 - 145
- 146 - 269
- 270 - 686

Onstreet to TAZ
- 5 - 36
- 37 - 82
- 83 - 145
- 146 - 269
- 270 - 686

TAZ Boundary
Results

V/C for Offstreet:
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 1.40

V/C for Free Unreserved:
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
Performance: Run time

- Iteration 1: Parking HwyAssign (12.5 hours), Baseline HwyAssign (3.0 hours)
- Iteration 2: Parking HwyAssign (9.0 hours), Baseline HwyAssign (3.5 hours)
- Iteration 3: Parking HwyAssign (9.0 hours), Baseline HwyAssign (9.5 hours)
Performance:
Final Roadway Assignment Convergence
Discussion

- Next Steps
  - Duration issue
  - Better estimates of free unreserved inventory
  - Better estimates of parking walkshed
- Validation
  - Reserved vs unreserved parking
  - Parking search time
  - Parking occupancy
Questions?

Or advice & input:

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