SCAG ABM Model Improvement and Validation:
Sub-model Re-estimation, Calibration, and Validation

Raghu Sidharthan
Sara Khoeini
Bayarmaa Aleksandr

SCAG Modeling Taskforce Meeting
January 25, 2023
Outline

• Overview of the project
• Model refinements
• Calibration and validation updates
• Conclusion and next steps
Overview of the project

• Objective: get the SCAG ABM ready for the 2024 RTP/SCS

• Contract period: June 2021 to June 2024

• Major Tasks
  • Model improvements: Sub-model refinements & New sub-model development
  • Base year model calibration and validation
  • Peer review meeting
  • Modeling support for RTP/SCS 2024
Model refinements

- Sub-model estimation from local data
- New sub-model implementation
- Run time improvements
Model estimation

• Mandatory destination choice models
  • Work location
  • University location
  • School location

• Discretionary task frequency model

• Mode choice model
Model estimation

- Discretionary task frequency model

Subject to constraints:
N1 ≤ 1, N2 ≤ 1, N3 ≤ 1, N4 ≤ 1, N5 ≤ 2, N6 ≤ 1
N1+N2+N3+N4+N5+N6 ≤ 4

These criteria yield a total of 73 alternatives

Figure 1: Model Structure
Model estimation

• Discretionary task frequency model
  • Data used in estimation
    • 2012 California Household Survey
    • Model accessibilities
    • Land-use and built environment variables
    • Outputs of upstream activity/travel decisions
  • Multinomial logit model (MNL)
  • Estimated in ALOGIT software
  • R used to create estimation dataset and ALOGIT script
New sub-model implementation

- Trip Departure Time Choice
- In-home/Out-of-home choice for non-mandatory activities
New sub-model implementation

- Trip Departure Time Choice
  - Activity duration allocation within a tour based on observed data
  - Affects only tours with more than one activity in a segment.
  - Results in more realistic trip departure times
**Trip Departure Time Choice**

<table>
<thead>
<tr>
<th>Time</th>
<th>6:00 AM</th>
<th>7:00 AM</th>
<th>8:00 AM</th>
<th>9:00 AM</th>
<th>10:00 AM</th>
<th>11:00 AM</th>
<th>12:00 PM</th>
<th>1:00 PM</th>
<th>2:00 PM</th>
<th>3:00 PM</th>
<th>4:00 PM</th>
<th>5:00 PM</th>
<th>6:00 PM</th>
<th>7:00 PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Mandatory Tour**
- **Individual Non-mandatory Tour**
- **Individual Non-mandatory Tour with multiple activities**
- **Mandatory Tour with multiple non-mandatory activities**
### Trip Departure Time Choice

| M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM | AN | AO | AP | AQ | AR | AS | AT | AU | AV | AW | AX | AY | AZ | BA | BB | BC | BD | BE | BF | BG | BH | BI | BJ | BK | BL | BM | BN | BO | BP | BQ | BR |
| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22| 23| 24| 25| 26| 27| 28| 29| 30| 31| 32| 33| 34| 35| 36| 37| 38| 39| 40| 41| 42| 43| 44| 45| 46| 47| 48| 49| 50| 51| 52| 53| 54| 55| 56| 57| 58| 59| 60| 61| 62| 63| 64| 65| 66| 67| 68| 69|
| 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22| 23| 24| 25| 26| 27| 28| 29| 30| 31| 32| 33| 34| 35| 36| 37| 38| 39| 40| 41| 42| 43| 44| 45| 46| 47| 48| 49| 50| 51| 52| 53| 54| 55| 56| 57| 58| 59| 60| 61| 62| 63| 64| 65| 66| 67| 68| 69|

- **Mandatory Tour**
- **Individual Non-mandatory Tour**
- **Individual Non-mandatory Tour with multiple activities**
- **Mandatory Tour with multiple non-mandatory activities**
New sub-model implementation

• In-home/Out-of-home choice for non-mandatory activities
  • Motivated by increasing non-mandatory activities being done remotely
  • Policy driven as opposed to Behaviorally Driven
Run time improvements

- Accessibility Manager Runtime improvements
  - Java code improvements
  - Upgraded version of Java (Java 18)
  - Writing the outputs to binary format directly

<table>
<thead>
<tr>
<th>Component</th>
<th>SCAG ABM RTP 2020</th>
<th>SCAG ABM RTP 2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility manager</td>
<td>2:21:36</td>
<td>2:02:37</td>
</tr>
<tr>
<td>Binary conversion</td>
<td>1:36:33</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3:58:09</td>
<td>2:02:37</td>
</tr>
</tbody>
</table>
Calibration and Validation Targets from SCAG

• Calibration Sources
  - California HH Travel Survey (Reweighted for the new base year)
  - NHTS 2017
  - ACS/IPUMS 2019
  - LEHD 2018
  - DMV 2019
  - CTPP 2012-2016

• Highway and Transit Validation Sources
  - PEMS
  - StreetLight/Replica
  - Caltrans Traffic Counts (All Vehicles and Trucks)
  - SCAG’s 2017 Screenline Vehicle Classification (One Day Field Counts)
Calibration and Validation Process

- Developing R scripts to compare model outputs to target metrics
- Adjust model coefficients so that the model outputs are close enough to the target metrics
- Check the model highway and transit assignments compared to validation targets for finetuning the calibration
SCAG ABM System
Calibrated Model Outputs

Work Duration by Income

![Graph showing work duration by income and model outputs.](chart.png)
Calibrated Model Outputs

Work Location

<table>
<thead>
<tr>
<th>Source</th>
<th>WeightedLength</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEHD2018</td>
<td>20.1</td>
</tr>
<tr>
<td>CHTS2019</td>
<td>13.0</td>
</tr>
<tr>
<td>NHTS17</td>
<td>13.2</td>
</tr>
<tr>
<td>Average</td>
<td>15.4</td>
</tr>
<tr>
<td>Model</td>
<td>15.9</td>
</tr>
</tbody>
</table>

![Graph showing work location data](graph.png)
Calibrated Model Outputs

Work Location – County to County Flow

<table>
<thead>
<tr>
<th>Final Targets</th>
<th>IM</th>
<th>LA</th>
<th>OR</th>
<th>RIV</th>
<th>SBD</th>
<th>VN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HomeCounty</strong></td>
<td>IM</td>
<td>LA</td>
<td>OR</td>
<td>RIV</td>
<td>SBD</td>
<td>VN</td>
</tr>
<tr>
<td>IM</td>
<td>0.91</td>
<td>0.02</td>
<td>0.01</td>
<td>0.05</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>LA</td>
<td>0.00</td>
<td>0.91</td>
<td>0.06</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>OR</td>
<td>0.00</td>
<td>0.16</td>
<td>0.81</td>
<td>0.02</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>RIV</td>
<td>0.00</td>
<td>0.08</td>
<td>0.10</td>
<td>0.66</td>
<td>0.13</td>
<td>0.00</td>
</tr>
<tr>
<td>SBD</td>
<td>0.00</td>
<td>0.19</td>
<td>0.06</td>
<td>0.09</td>
<td>0.66</td>
<td>0.00</td>
</tr>
<tr>
<td>VN</td>
<td>0.00</td>
<td>0.24</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0.74</td>
</tr>
</tbody>
</table>

**Target is a combination of CA HH travel survey, LODES19, CTPP12-16, IPUMS19, LEHD19**

<table>
<thead>
<tr>
<th>Model</th>
<th>IM</th>
<th>LA</th>
<th>OR</th>
<th>RIV</th>
<th>SBD</th>
<th>VN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HomeCounty</strong></td>
<td>IM</td>
<td>LA</td>
<td>OR</td>
<td>RIV</td>
<td>SBD</td>
<td>VN</td>
</tr>
<tr>
<td>IM</td>
<td>0.90</td>
<td>0.00</td>
<td>0.00</td>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>LA</td>
<td>0.00</td>
<td>0.90</td>
<td>0.05</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>OR</td>
<td>0.00</td>
<td>0.13</td>
<td>0.79</td>
<td>0.05</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>RIV</td>
<td>0.00</td>
<td>0.07</td>
<td>0.09</td>
<td>0.69</td>
<td>0.14</td>
<td>0.00</td>
</tr>
<tr>
<td>SBD</td>
<td>0.00</td>
<td>0.18</td>
<td>0.05</td>
<td>0.10</td>
<td>0.67</td>
<td>0.00</td>
</tr>
<tr>
<td>VN</td>
<td>0.01</td>
<td>0.24</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>0.75</td>
</tr>
</tbody>
</table>
Calibrated Model Outputs

Driver’s License
Calibrated Model Outputs

Daily Activity Pattern

Share of Mandatory pattern by person types

Share of Non-Mandatory pattern by person types

Share of At-home pattern by person types

Source:
- SURVEY
- MODEL
Calibrated Model Outputs

Work Tour Time of Day for Full-time Workers
Calibrated Model Outputs

Trip Mode Share

Graph showing the share of different modes of transportation (SOV, HOV2, HOV3, HCV, Transit, Walk, Bike, Taxi, School Bus) with bars representing the target and model outputs.
Addition of New Transportation Modes

• TNC
  • Replaces the old taxi mode
  • Private and shared TNC will be modeled together

• Micro-mobility
  • Performs as a new access mode to transit in the model

Impacts of the carsharing, old taxi trips, and micro-mobility trips (not to access transit) will be calculated off-model due to very small portions.
Conclusion and Next Steps

- Model refinement task is completed
- First round of calibration has been completed based on calibration targets
- The second round of calibration will consider both the validation results as well as calibration targets.
- The following documents will be reported in preparation for the Peer-review meeting:
  - SCAG ABM Model Validation Report
  - SCAG ABM Model Specification Report
  - SCAG ABM Sensitivity Report
  - SCAG ABM Software and User guide