Assessing Reasonableness of Activity-based Model: Example of Work Activity Generation and Workers’ Travel Scheduling Models

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SCAG ABM Framework

1. Population Synthesis
   - 2.0 Preschool Arrangement
   - 2.1 Usual School Location
   - 2.2 Work Arrangement
   - 2.3 Usual Work Location
   - 2.4 Work Scheduling Flexibility

2. Long-term Choices
   - 3.1 Driver License
   - 3.2 Auto Availability

3. Mobility Choices

4. Generation-Allocation
   - Mandatory Activity Generation
     - 4.1.1 Frequency
     - 4.1.2 Start/End Time
     - 4.1.3 Trip Mode
   - Adult Mandatory Activities
     - 4.2.1 Frequency
     - 4.2.2 Start/End Time
     - 4.2.3 Allocation of Dropoff/Pickup
   - 4.3 Non-Mandatory Activity - Tour Generation
     - 4.3.1 Participation decision
     - 4.3.2 Time budget
     - 4.3.3 Non-Mandatory Time allocation
     - 4.3.4 Serve Passenger Activity Generation
     - 4.3.5 Tour Formation

5. Joint Activity Scheduling
   - 5.1 Primary purpose
   - 5.2 Start time
   - 5.3 Location
   - 5.4 Tour mode
   - 5.5 Duration of intermediate stop

6. Tour Scheduling
   - 6.1 Adult Mandatory Tour
     - 6.1.1 Tour Mode
     - 6.1.2 Stop purpose and duration
     - 6.1.3 Distance to stop
     - 6.1.4 Stop Location
     - 6.1.5 Departure, return time period
   - 6.2 Non-Mandatory Tour: Worker
     - 6.2.1 Tour window
     - 6.2.2 Primary destination
     - 6.2.3 Tour mode
     - 6.2.4 Stop purpose and duration
     - 6.2.5 Distance to stop
     - 6.2.6 Stop Location
   - 6.3 Non-Mandatory Tour: Non-worker
     - 6.3.1 Tour window
     - 6.3.2 Primary destination
     - 6.3.3 Tour mode
     - 6.3.4 Stop purpose and duration
     - 6.3.5 Distance to stop
     - 6.3.6 Stop Location
SCAG ABM Development Schedule

Stage 1: 2009-2013
- Framework Design
- Model Development

Stage 2: 2013-2015
- Model Enhancement
- Implementation
- Calibration & Validation
ABM Challenge to Planning Agency Modelers

- It’s new
- Framework is complicated
- Many sub-models
- Estimated by advanced techniques
- Output analysis

**Question:**
Do we fully understand our new model?
Model Assessment & Presentation Purpose

Model assessment procedure:
- Carried out in-house
- A self-learning procedure
- Assisted by consultants

Purpose of this presentation
- Introduce SCAG’s model assessment framework and procedure
Goals of Model Assessment

SCAG modelers should be able to:
- Fully understand each (sub)model,
- Analyze household survey,
- Re-estimate each model,
- Create model specification,
- Develop validation target, and
- Validate/Calibrate model
Model Assessment Procedure

Model Assessment

Review, Analysis
Revise

Specification
Communication

Target Data
Analysis

Model

Software

Validation
Model Assessment Tasks

- Analyze Household Survey
- Model Review
- Model Re-estimate
- Software Implementation
- Model Output Analysis
- Model Calibration & Validation
- 1-2 meetings each week
Example of Model Assessment
Work Activity Generation & Travel Scheduling Models

- Frequency
- Start/End time
- Tour duration
- Tour mode
- Stop purpose & duration
- Distance to stop
- Stop location
- Time period
1. Analyze Household Survey

- Analyze variables related to the model:
  - Individual attributes
  - Household attributes
  - Work characteristics
  - Land use & built environment
  - Accessibility

Example:
Workers’ Work Start, End time, Duration
Overall Worker’s Work Start Time and End Time by 30 Minutes
Overall Worker’s Work Start Time and End Time by 30 Minutes
IND1 Agriculture & Mining
(start/end early)

Start Early
End Early
IND2 Construction & Utility
(start early, some workers end early)
IND3 Manufacturing & Warehousing
(some start/end early)
IND5 Information & Business Service
(some start/end a little late)
IND6 Education & Health/Social Services
(start/end a little early)
IND8 Arts/Entertainment, Food Service/Hospitality

(More Significant Start/End Late)

Start Late

End Late
IND9 Public Administration
(Start/End a little early)
Part-Time Workers
(Start late, end early)
Work Duration by Start Time
(Start early, long hours)

Before 5:30 AM

Longer Work Duration
5:30-6:00 AM

(long hours, but shorter than half hour ago)
6:00-6:30 AM

(long hours, but shorter than half hour ago)
6:30 - 7:00 AM

6:30-7:00 AM

[Bar chart showing data distribution from 6:30 to 7:00 AM]
7:00 - 7:30 AM
8:00 - 8:30 AM

8:00-8:30 AM
8:30 - 9:00
(moving to shorter hours)

8:30-9:00 AM
9:00 - 9:30 AM

9:00-9:30 AM

Bar chart showing data distribution from 0 to 12.
9:30 - 10:00
(shorter)

9:30-10:00 AM
10:00 - 10:30 AM

(uniform)
10:30 - 11:00 AM
11:00 - 11:30 AM
11:30 - 12:00

11:30AM-12:00 PM

[Bar chart showing data distribution between 11:30AM and 12:00PM]
12:00 - 12:30 PM
1:00 - 1:30 PM

1:30-1:30 PM

Graph showing data distribution between 1:30 PM and 1:30 PM.
1:30 - 2:00 PM

1:30-2:00 PM

<2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 >12
After 2:00 PM
Start Time

(PTW tends to starts later than FTW)
Work Duration
Work Duration by Start Time

Shorter Work Hours if Start Later

- FT worker
- PT worker
End Time
(similar distribution, STDEV is larger for PTW)
Other Examples

Worker’s Trip Scheduling
Examples

- Worker’s Tour by Time Window

**Workers’ Trips and Scheduling for Mandatory Tours (MILS)**

### Already Known

- 3. Work start time, end time
- 4. Total MTO activity time (all purposes)
- 5. Total activity time and purpose (MV)
- 6. Time budget for each MTO activity

### Need to Know

- Number (frequency) of intermediate stops by outbound tour and inbound tour (half tour)
- Stop activity purpose and activity duration
- On-time tour: Not sure if it’s important, but will check when

### Work Tour Intermediate Stops

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
<th>Duration</th>
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<tbody>
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</tbody>
</table>

### Outbound 1 Int. Stop

- 3. (same) vs 2
- 4. (same) vs 3

### Outbound 2+ Int. Stop

- 3. (same) vs 2

### Outbound 1 Int. Stop - Duration

- 3. (same) vs 2

### Inbound 1 Int. Stop

- 3. (same) vs 2

### Inbound 2 Int. Stop

- 3. (same) vs 2

### Inbound 3 Int. Stop

- 3. (same) vs 2

### Inbound 1 Int. Stop - Duration

- 3. (same) vs 2

### Inbound 2 Int. Stop - Duration

- 3. (same) vs 2

### Comparison - Purpose

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Activity Duration</th>
<th>Travel Access Time</th>
</tr>
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<tbody>
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### Comparison - Activity Duration

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
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### Comparison - Travel Access Time

<table>
<thead>
<tr>
<th>Access Time</th>
<th>Travel Distance</th>
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</table>

### Outbound Tour by Work Arrival Time

- People are more likely to have intermediate stops if arriving at work after 5:30 AM.

### Outbound Tour by Work Duration

- Pattern is not clear.

### Inbound Tour by Work Departure Time

- Leaves work later; less intermediate stops for inbound.

### Inbound Tour by Work Departure Time

- Longer work hours, less intermediate stops for inbound.
Examples

- Worker’s Non-Mandatory Tour

M6 Worker’s Non-Mandatory Tour and Trip
Hsiu-Ting Hu
Feb. 10, 2015
Examples
- Worker’s Intermediate Stops
Examples
- Household Activity Generation

M4.2.1 – M4.2.4
Non-Mandatory Household Activity Generation

AAM Flowchart

1. Models Included
   - Model 4.2.1: Out-of-Home Non-Mandatory Activity Participation
   - Model 4.2.2: Activity Duration Allocation
   - Model 4.2.3: Out-of-Home Non-Mandatory Activity Generation
   - Model 4.2.4: In-House Activity Participation

2. Model 4.2.1: Out-of-Home Non-Mandatory Activity Participation
   - The model predicts activities by person within a household. Participants in any one of five non-mandatory activities may choose to participate. They may choose to participate in another activity, and at least one person in the household participates. The model uses loo probabilities to predict activities for each person in a household.

3. Introduction
   - This model predicts activities by person within a household. Participants in any one of five non-mandatory activities may choose to participate. They may choose to participate in another activity, and at least one person in the household participates. The model uses loo probabilities to predict activities for each person in a household.

4. Data Analysis
   - Using HBS data, analyze percentage of households that make at least one use of non-home for non-mandatory activities.
   - Remove all households with problematic trip duration and activity duration data.
   - Total 13,373 households.

5. Overall
   - 61% of households made at least one trip (of homes) with non-mandatory activities.
   - Calculations were performed by region.
   - 39% of the households in the region (with problematic trips) were removed from the analysis.
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6. Other Variables
   - No significant pattern for employment density (total and at least one), household density (in 10 miles), and average number of persons in a household.

7. Model Test for Joint Effect – V1
   - The model predicts the time spent in non-mandatory activities for each person in a household.

8. Model Test for Joint Effect – V2
   - The model predicts the time spent in non-mandatory activities for each person in a household.

9. Model Test for Joint Effect – V3
   - The model predicts the time spent in non-mandatory activities for each person in a household.

10. Summary
    - Households that participate in a non-mandatory activity tend to have a significant effect on the activity being predicted.
    - The model is consistent with data analysis.
    - When service is included, the model can be combined.
    - Local employment density (at 3 miles) performs better than accessibility.

11. Model 4.2.2: Activity Duration Allocation
    - This model predicts the time spent in each activity for each person in a household.
    - The model is consistent with data analysis.
    - The model predicts the time spent in each activity for each person in a household.

12. Household Income
    - Higher income = higher percentage

13. Household with Mandatory Activity
    - Used by the model
    - No income for the mandatory activity
    - Pattern is used for mandatory activity duration, does not include other variables.

14. Analysis with Multiple Variables
    - Using regression to examine how variables are associated with non-home OHM activity time
    - Longer trips = lower percentage
    - Higher income = higher percentage (consistent with prior analysis)
2. Model Review

Review model estimated by consultants

Based on HTS analysis, examine the reasonableness of:

- Model assumption
- Variable definition
- Explanatory variables
3. Model Re-estimate

Based on model review, enhance/re-estimate a model if needed.

- **Consultants:**
  - Provide training
  - Provide estimation data and script

- **Staff:**
  - Revise estimation data
  - Re-estimate the model
4. Software Implementation

- Prepare model specification to software developer
- Feedback from software developer
- Staff learn software coding
- Model output analysis
5. Model Validation

- Staff create validation target
  - Household Survey
  - ACS
  - Other data – CTPP, ATUS, ...
- Model calibration / validation
We started the assessment procedure in Aug, 2014.
About 80% of models have been reviewed and re-estimated.
All completed by SCAG staff.
A painful procedure, but worth it.
Understand the model much better.
Conclude

- The model assessment is a useful procedure for agency staff for ABM development.
- Greatly enhance the understanding of this complicated model.
Thank you

Question?

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