Modeling Travel Behavior in Support of Sustainable Transportation

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My motivation 1: More Complex Travel Patterns

- decentralization of residential, commercial and work places.
- more leisure time and more travel for non-work purposes.
- more flexibility in work hour.
- increasing participation of women in the work force.
- the introduction of information and communication technologies that enables substitute travel for all purposes.
My Motivation 2: New Needs

- New Policies/Travel demand management
  - Congestion pricing, parking restrictions, HOV.
- Response to ITS
- Land use and growth management
- Air Quality requirements:
  - Speed/acceleration profile
  - Cold/hot starts
  - Vehicle type
  - Off network activity
Planning for Sustainable Transportation

- Externalities
  - Land use
  - Economic growth
  - Equity

- Measures

- Evaluation

- MPO – coordinated planning
  - Political consideration
  - Managing transition

- Policy Making

- Modeling
  - Response to Policies
Problems with Current Modeling for Sustainable Transportation

- Non-motorized modes
- Policy measures
- Assumption of fix demand
- Biased towards highways
- Output for air quality modeling
- Dynamic models
- Integration with land-use models
- Behavioral models
Need of Behavioral Models

Aggregate problems

Individual Behavior

Policy
Main Approaches

- Aggregate/Four step models
- Disaggregate/Random Utility Models
- Simulation/Decision Rules
- Insight from Behavioral Science
- Activity based models
- Specific modeling responses
- Scenario analysis
Basics of Activity-Based Travel Theory

- Travel demand is derived from demand for activities.
- People face time and space constraints that limit their activity schedule choice.
- Activity and travel scheduling decisions are made in the context of a broader framework:
  - Conditioned by outcome of longer term processes.
  - Scheduling process interacts with the transportation system.
Representing Activity/Travel Behavior

**Schedule**

**Tours**

**Trips**

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>W</td>
</tr>
<tr>
<td>H</td>
<td>S</td>
</tr>
<tr>
<td>H</td>
<td>D</td>
</tr>
<tr>
<td>H</td>
<td>D</td>
</tr>
</tbody>
</table>

**H:** Home  
**W:** Work  
**S:** Shop  
**D:** Dinner out
Complex Responses to Policies (e.g., peak-period toll)

Pre-Toll Schedule

Potential Responses to Toll

(a) Change Mode & Pattern

(b) Change Time & Pattern

(c) Work at Home

= Peak Period
Extending the Framework

Urban development

Household decisions

- Residential choice
- Kids arranges
- Parking Transit
- Work place
- Auto ownership
- Shopping behavior

Activity participation (location, sequence, scheduling, mode)

Driver's decisions (route, parking)

Transportation system performance

ABA
## Portland Policy Scenarios

<table>
<thead>
<tr>
<th>Policy</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pricing of Automobile Travel.</td>
<td>- Long-term parking cost is doubled in central city.</td>
</tr>
<tr>
<td></td>
<td>- SOV toll of one dollar is imposed for a.m. and p.m. peak period travel within the metropolitan area.</td>
</tr>
<tr>
<td>2. Telecommuting Incentives.</td>
<td>- Double the current share of work-at-home activity.</td>
</tr>
<tr>
<td>3. Transit Improvements.</td>
<td>- Bus fare is halved for travel within the metropolitan area for all time periods.</td>
</tr>
<tr>
<td></td>
<td>- Increase bus service resulting in reduced bus waiting time by half for travel within the metropolitan area for all time periods.</td>
</tr>
<tr>
<td>4. Combination.</td>
<td>- Combination of Policies 1, 2, and 3.</td>
</tr>
</tbody>
</table>
## Comparison of Emissions for Base and Combined Scenarios

### A.M. Peak Period

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Base</th>
<th>Combined</th>
<th>Difference</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMT</td>
<td>6,078 K</td>
<td>5,905 K</td>
<td>-173 K</td>
<td>-2.84%</td>
</tr>
<tr>
<td>Total Hours</td>
<td>542,700</td>
<td>529,100</td>
<td>-13,600</td>
<td>-2.50%</td>
</tr>
<tr>
<td>Total Trips</td>
<td>658,950</td>
<td>639,850</td>
<td>-19,100</td>
<td>-2.90%</td>
</tr>
<tr>
<td>Cold Trips</td>
<td>472,100</td>
<td>455,900</td>
<td>-16,200</td>
<td>-3.43%</td>
</tr>
<tr>
<td>VOC (tons)</td>
<td>12.34</td>
<td>11.99</td>
<td>-0.35</td>
<td>-2.81%</td>
</tr>
<tr>
<td>CO (tons)</td>
<td>77.87</td>
<td>75.66</td>
<td>-2.21</td>
<td>-2.84%</td>
</tr>
<tr>
<td>Nox (tons)</td>
<td>12.20</td>
<td>11.86</td>
<td>-0.34</td>
<td>-2.77%</td>
</tr>
</tbody>
</table>
Tel Aviv Congestion Pricing Model

- Stated Preference questionnaire
- Revealed Tour data
- Various response options:
  - Pay congestion toll
  - Change mode
  - Change time of day
  - Chance destination
  - Cancel activity
הgowש באזאואר 3 (מרכז ת”א) הוא החמור ביותר

כבישים מסוד 8

כבישים מסוד 2

כבישים מסוד 4

כבישים מסוד 16 - איילון

מוריית סיפות באזואר 3 - מרץ 2007
כביש 1

ו מזרח

ו מערב
כביש 412
נפוע
דרומ
נפוע
מחלף ראשון
ז Manitement, Quality and Projects
### Three contradicting predictions from behavioral science

<table>
<thead>
<tr>
<th>Theory</th>
<th>Authors</th>
<th>Predicted behavior</th>
<th>Empirical evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Stove</td>
<td>Denrell &amp; March, 2001</td>
<td>Drivers exhibit risk aversion</td>
<td>Abdel Aty et al., 1997</td>
</tr>
<tr>
<td>Prospect Theory</td>
<td>Kahneman &amp; Tversky, 1979; 1992</td>
<td>Drivers exhibit risk seeking (travel time framed as loss)</td>
<td>Katsikopoulos et al., 2002</td>
</tr>
</tbody>
</table>