Land Use and Travel Model Integration

Testing The PSRC Land Use Model Response to Transportation Strategies

Innovations in Travel Modeling
May 10-12, 2010
Presentation Overview

• Land Use Model Background
• Integration with Travel Model
• Transportation Scenarios Tested
• Results
• Future Directions
Land Use Model Background
PSRC Land Use Model - UrbanSim

• Micro-simulation of actions of actors on parcels and buildings:
  – Households and Workers
  – Jobs
  – Developers / Landowners

• Primary Inputs include:
  – Allowable development (comp plans)
  – Transportation system
  – Major planned developments (pipeline developments)
  – Regional economic forecasts

• Many operating assumptions:
  – Relocation rates
  – SQFT needed per job by sector
  – Construction costs
  – Vacancy rates

• Simulates each year from 2001-2040
Land Use Model Elements

- Land Development Models
  - Process Pipeline Events
  - Real Estate Price Model
  - Expected Sale Price Model
  - Development Proposal Choice Model
  - Building Construction Model

- Household Location Models
  - Household Transition Model
  - Household Relocation Model
  - Household Location Choice Model

- Employment Location Models
  - Employment Transition Model
  - Employment Relocation Model
  - Employment Location Choice Model

- Workplace Location Models
  - Economic Transition Model
  - Home-based Job Choice Model
  - Workplace Location Choice Model
Integration With Travel Model
PSRC Analysis Framework

Regional Economic Forecasts

Transport System

Travel Forecasts

Benefit-Cost Analysis

Air Quality Analysis

Land Use Forecasts

URBANSIM
Model Handshake – Current Setup

<table>
<thead>
<tr>
<th>Model Inputs and Integration</th>
<th>Analysis Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006 (base)</td>
</tr>
<tr>
<td>Travel Model Runs, using population and employment from:</td>
<td>2006 land use model run</td>
</tr>
</tbody>
</table>
Accessibility Measures – passed to UrbanSim

**Zone-based, measured to a downtown location**
- Generalized Cost to Seattle CBD, HBW AM SOV
- Generalized Cost to Bellevue CBD, HBW AM SOV

**Zone-based**
- Average Travel Time, Trip-weighted, AM, SOV, HBW
- Jobs within 30 minutes travel time, AM, SOV

**Person-based, Home to Work Zones**
- Network distance from Home to Work
- Log Sum, HBW AM from Home to Work
### Accessibility – Model Blocks

<table>
<thead>
<tr>
<th>Accessibility Measure</th>
<th>UrbanSim Models</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Real Estate Price(1)</td>
</tr>
<tr>
<td>Zone-Based, Origin Zone to Location</td>
<td></td>
</tr>
<tr>
<td>Generalized Cost HBW AM SOV to Seattle CBD</td>
<td>16</td>
</tr>
<tr>
<td>Generalized Cost HBW AM SOV to Bellevue CBD</td>
<td>--</td>
</tr>
<tr>
<td>Zone-Based, Origin Zone to All Other Zones</td>
<td></td>
</tr>
<tr>
<td>Average trip-weighted Travel Time, HBW AM SOV,</td>
<td>15</td>
</tr>
<tr>
<td>Jobs within 30 minutes time, AM SOV</td>
<td>12</td>
</tr>
<tr>
<td>Person-Based, Home to Work Zones</td>
<td></td>
</tr>
<tr>
<td>Network Distance from Home to Work</td>
<td>--</td>
</tr>
<tr>
<td>Logsum of HBW AM Trip</td>
<td>--</td>
</tr>
<tr>
<td>Grid Cell-based, Proximity to Roadways</td>
<td></td>
</tr>
<tr>
<td>Distance to Highway</td>
<td>4</td>
</tr>
<tr>
<td>Distance to Arterial</td>
<td>1</td>
</tr>
</tbody>
</table>

(1) – *Number of submodels that contain the measure in current specifications, there are 18 sub-models in the Real Estate Price Model, and 17 in the Employment Location Choice Model*
Relative Influence of Variables - WLCM

Workplace Location Choice Model

Utility

Adj. Likelihood ratio: 0.419

Estimated Parameters ($\beta$)

\[
\begin{align*}
\beta_{11} x_{11} & \quad \beta_{12} x_{12} & \quad \ldots & \quad \beta_{ik} x_{ik} + \\
\text{All variables (X) except one} & \text{held at median value} & \text{One variable:} & \text{Calc. $\Delta U$ for indication of influence} \\
\end{align*}
\]

Variable Levels:

- $hbw_{distance_{am}}$
- $logsum_{hbw_{am}}$
- $resdistr_{is_{wkdist}}$
- $resarea4_{wkarea2}$
- $resarea1_{wkarea2}$
- $home_{wkpl_{dist19}}$
- $edu_{x_{emp_{retail}}}$
- $edu_{x_{emp_{fires}}}$
- $edu_{x_{emp_{ed}}}$
- $edu_{x_{emp_{basic}}}$
Relative Influence of Variables - HLCM

Household Location Choice Model

Residential units

HLCM

-6 -4 -2 0 2 4 6 8 10
Utility

Adj. Likelihood ratio: 0.419
Sensitivity Tests

**Base Case Scenario**
- Transportation Networks (2020, 2040)
- Modest investments in roads and road-based transit
- Near-term voter-approved rail transit extensions
- Very limited tolling (two bridge crossings)
- No real growth in vehicle operating costs
- Modest real growth in parking costs

**Alternative Scenarios**
- Lower parking costs in selected neighborhoods (zones)
- Higher vehicle operating costs forecast
- Major extensions of rail transit
- Major investments in highway capacity
Alternatives

2020 Daily Parking Charges

Legend
Centers TAZs Parking Charges
Daily 2020
- $1.47 - $5.00
- $5.01 - $10.00
- $10.01 - $15.00
- $15.01 - $20.00
- $20.01 - $25.00
- $25.01 - $29.18

Legend
- Light Rail
- Commuter Rail
Expectations

- Short-run substitution will minimize the magnitude of cost changes reflected in long-run (location) choices.

- Some modest correlation between a composite measure of zonal accessibility and the outputs of the land use model (population, households, employment, work trip locations).

- Higher transportation costs should result in lower site values, and vice versa.

- A resorting by willingness to pay for sites may dominate the location choices.
### Selected Travel Model Statistics

<table>
<thead>
<tr>
<th>Selected Measures - Travel Model</th>
<th>Base Scenario</th>
<th>Lower Parking Costs</th>
<th>Higher Vehicle Operating Costs</th>
<th>Rail Transit Extension</th>
<th>Highway Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Vehicle Trips</td>
<td>12,207,370</td>
<td>12,282,986</td>
<td>11,871,396</td>
<td>12,211,586</td>
<td>12,261,469</td>
</tr>
<tr>
<td>Daily Transit Trips</td>
<td>818,805</td>
<td>772,862</td>
<td>832,134</td>
<td>841,256</td>
<td>814,995</td>
</tr>
<tr>
<td>Daily Walk and Bike Trips</td>
<td>2,272,961</td>
<td>2,258,358</td>
<td>2,560,918</td>
<td>2,257,955</td>
<td>2,201,591</td>
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<tr>
<td>Daily VMT</td>
<td>105,976,212</td>
<td>106,312,470</td>
<td>94,195,933</td>
<td>106,185,529</td>
<td>109,787,866</td>
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<tr>
<td>Daily Average Vehicle Speeds</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>40</td>
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<tr>
<td>Trip Lengths</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HBW</td>
<td>13.0</td>
<td>12.9</td>
<td>12.4</td>
<td>13.0</td>
<td>13.1</td>
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<tr>
<td>HBShop</td>
<td>4.5</td>
<td>4.5</td>
<td>3.9</td>
<td>4.5</td>
<td>4.7</td>
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<tr>
<td>HBOther</td>
<td>5.6</td>
<td>5.6</td>
<td>4.9</td>
<td>5.7</td>
<td>5.9</td>
</tr>
</tbody>
</table>
HBW Average Trip Lengths

<table>
<thead>
<tr>
<th>Year</th>
<th>Base Alternative</th>
<th>Remove Parking Surcharges</th>
<th>High Operating Cost</th>
<th>Expanded Light Rail Transit</th>
<th>Expanded Roadway Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>12.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>12.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>12.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2035</td>
<td>12.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2040</td>
<td>12.8</td>
<td></td>
<td></td>
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</tbody>
</table>
Changes in Access Costs – AM Productions

Access Improvement
- A drop in generalized costs of auto travel
- Trip weighted average from each zone to all other zones
Changes in Access Costs – AM Attractions

Access Improvement
- A drop in generalized costs of auto travel
- Trip weighted average from each zone to all other zones
Lower Parking Charges

**Workplace Location Choice**

- Trip attractions increase in zones with lower parking costs
- Income sensitivity

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**Change in Low Income Attractions**

![Graph showing change in low income attractions vs change in generalised costs]

**Change in High Income Attractions**

![Graph showing change in high income attractions vs change in generalised costs]
Rail Transit Extensions

Transit Scenario: AM Trip Productions

Change in Generalized Costs
Change in HBW Trips

Change in Population and Employment
red-gains, blue-losses
Increased Highway Capacity

Highway Scenario: AM Trip Attractions

Change in Generalized Costs vs. Change in HBW Trips

Change in Population:
- Blue: gains
- Red: losses
Findings

Land Use Response to Transportation Scenarios

- A modest response is in line with theoretical expectations.
- Accessibility measures from the travel model do change across scenarios and reflect route and destination choices (and to a more limited degree mode choice).
- Short-run substitution and activity sorting across sites likely limits the effects on development capital.
- The influence of access on site values is probably a central feature in proper simulations. We have not explicitly evaluated site values.
Some Additional Tests

Influence of Developer Models

• Hypothesis – development dynamics may impose constraints that limit the influence of accessibility on location choices

• Test 1:
  – higher threshold vacancy rates for multi-family developments
  – higher redevelopment threshold (improvement value/total value)

• Test 2: changes as per Test 1 above plus 100% household relocation rates (tested for a single year)
Test 1: Highway Example

Highway Capacity Scenario

• Test 1:
  – higher threshold vacancy rates for multi-family developments
  – higher redevelopment threshold (improvement value/total value)

• Greater degree of household response to accessibility
Test 2: Highway Example

Highway Capacity Scenario

- Test 2: changes as per Test 1 above plus 100% household relocation rates (tested for a single year)

- Compared Highway Scenario with 100% household relocation rate with the same scenario with default location rate – single year analysis

- Greater degree of household response to accessibility
Future Directions
Future Directions

Accessibilities Variables
• Revisit the zonal composite variables used in the real estate price and employment location choice models
• Changes to real estate price model to more fully reflect scale of demand and accessibility
• A revised zone structure (from 938 to over 3,500) should reduce aggregation problems
• Activity-based travel model development will open up numerous opportunities for disaggregate access measures

Revisit Integration Structure
• Frequency of travel model runs (currently every 10 forecast years)
• Activity-based model development will necessitate a different approach (interaction between long-run and short-run choices)
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Maren L. Outwater, Resource Systems Group Inc