Statewide Models
Statewide Model Topics

• Why do we need Statewide Models
• Statewide model theory and typical steps
• Similarities and differences with urban models
• Data needs and considerations
• Validation and reasonableness checking/transferability
• Interfacing statewide and urban models
• Shortcomings and areas for improvement
Topic – Why do we need Statewide Models

- Rationale
- Unique features
- Current implementation
- Context/unique issues
- Typical uses
- Examples of statewide models
- Potential for micro-simulation
- Documenting current practice

Source: TRB presentation on Wisconsin Statewide Model, WISDOT, Cambridge Systematics, Inc.
Rationale – Why Statewide Models?

- Consistency in statewide planning – policy issues
- Often motivated by specific project requirements
- Issues or projects affecting entire state or beyond single MPO
- Travel analyses for rural areas outside MPOs
- Forecasting MPO external trips
- Examining freight issues

Source: University of Connecticut, Connecticut Dept. of Transportation
Unique Features of Statewide Models

- **Geographic scale and resolution**
  - In-state traffic analysis zones
  - “Halo” or “border” set of detailed zones in adjacent state(s), where significant activity lies across the border
  - “External” zones for passenger travel at state line or halo border
  - Other states or groups of states for freight modeling (*see next example map*)

Source: Florida Department of Transportation, 2005 Statewide Model
Unique Features of Statewide Models (Cont’d)

- More aggregate than MPO models (networks/zones)

- Simplified approaches used at times (not necessarily recommended)
  - Three step structure
  - Synthetic or borrowed model structures and parameters

- Explicit treatment of visitors and long-distance travel

- Freight a larger emphasis

- Potential for inconsistencies with urban models

- Some linkages with land use and economic models

Source: Florida Department of Transportation, 2005 Statewide Model
Current Status of Statewide Models

- Operational (28)
- Dormant (3)
- No model (11)
- Developing (8)

Source: A. Horowitz, Statewide Travel Forecasting Models, NCHRP Synthesis 358 (2006), with recent updates
Context for statewide modeling

Statewide Models

Megascoopic

- Regional model of economic, trade, and land use trends
- Economic triggers for freight flows
- Accessibilities and transport costs

Macroscopic

- Urban travel models (tour-based or sequential)
- Transport costs, disutilities, and travel times
- Multimodal person and freight tours

Mesoscopic

- Dynamic traffic assignment to planning network
- Congestion indices, link and node delay
- Time-sliced demand flows by mode

Microscopic

- Detailed traffic analysis of key facilities and corridors

Source: Federal Highway Administration, Pilot Course on Statewide Travel Forecasting, 2007
Issues unique to statewide models

- Explicit linkages to economic models
- Scale issues
  - Modeling states at an urban scale
  - Expensive to build and maintain
- Need for interfaces with urban models
  - Consistency
  - Data exchange
- Lack of standard practice
- Unique components
  - Freight (commodities → vehicles)
  - Long distance travel
  - Economic impacts

Data and knowledge gaps

Source: Michigan Department of Transportation
Typical uses of Statewide Models

Most commonly cited
- Corridor planning (*including community bypasses*)
- Forecasting freight/truck flows
- External trip forecasts for MPO & regional models
- Expansion of MPO & regional models

Less common uses
- Air quality conformity analyses
- Freight and intermodal planning
- Traffic impact studies
- Economic development studies
- Long-term investment studies
- Emergency evacuation studies
- Multi-state corridors (*possibly with multi-state models*)

Source: Pennsylvania Department of Transportation, TRB presentation on 2006-2030 Statewide Model
## Louisiana’s and Virginia’s statewide models

<table>
<thead>
<tr>
<th>Market segments</th>
<th>2000 source &amp; estimation procedure</th>
<th>Forecast source &amp; estimation procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macro level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Interstate and interparish truck trip table</td>
<td>2000 macro zone level Transearch data, some matrix estimation</td>
<td>2030 macro zone forecast of 2000 Transearch data, interpolation and extrapolation to forecast other years</td>
</tr>
<tr>
<td>2. Long distance interstate business, tourist, and other auto trip tables</td>
<td>1995 American Travel Survey data, disaggregated from state and MSA to county level, and Fratar balanced to 2000 using household and employment growth</td>
<td>Fratar balance year 2000 county-level trip tables to forecast year using household and employment growth</td>
</tr>
<tr>
<td>3. Long distance intrastate business, tourist, and other auto trip tables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Short distance Interstate Louisiana HBW trip table</td>
<td>1990 Census county level JTW data, Fratar balanced to 2000 using household and employment growth</td>
<td></td>
</tr>
<tr>
<td><strong>Micro level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Short distance intraparish truck trip table</td>
<td>Synthesized from 2000 intraparish Transearch data</td>
<td>Fratar balance 2000 intraparish trip table to forecast year using household and employment growth</td>
</tr>
<tr>
<td>7. Short distance intrastate HBO and NHB trip tables</td>
<td>Urban model style household-based trip generation and gravity model distribution</td>
<td>Urban style household-based trip generation and distribution models, log-linear regression used to estimate external trip ends</td>
</tr>
</tbody>
</table>

Source: Virginia Department of Transportation
Microsimulation/Activity-based Approach

- Models dynamic evolution and actions of discrete agents across time and space

- Observe emergent behavior
  - Interaction
  - Cooperation
  - Coordination

- Primary emphasis on understanding the system

- Maybe forecast it

Source: Ohio Department of Transportation
Key Differences – Traditional vs Microsimulation

“Traditional models”
- Closed form equilibrium
- Well understood
- Typically deterministic
- Presumes central tendencies in underlying data
- Well-behaved
- “Manageable” variation
- Computationally efficient

Microsimulation
- Disequilibrium
- Large systems NWU
- Stochastic
- Diverse behavior
- Handles wide variances
- Accommodates weak to strong understanding
- Computationally heavy

Microsimulation Examples
- Ohio
- Oregon

Source: Ohio Department of Transportation
Statewide Model Current Practice

- Meetings of the TRB Subcommittee on Statewide Travel Forecasting Models

- *NCHRP Report 735: Long-Distance and Rural Transferable Parameters for Statewide Travel Forecasting Models*, 2012

- *NCHRP Validation and Sensitivity Considerations for Statewide Models*, September 2010


- *National Travel Demand Forecasting Model Phase I Final Scope*, 2008


- TRB Annual Meeting Sessions in 2004, 2006 and 2008; web page

- Statewide Travel Forecasting Models, *NCHRP Synthesis #358*, 2006

- Statewide Travel Demand Modeling: Peer Exchange, *Transportation Research Circular E-C075*, September

- *Guidebook on Statewide Travel Forecasting* and Irvine Conference, Transportation Research Circular E-C011, 1999
Topic – Statewide Model Theory

• Common themes in statewide model development

• Alternative structures
  ➢ Trip table estimation (2 step)
  ➢ Highway model structure (3 step)
  ➢ Fully multimodal (4 step)
  ➢ Beyond 4 step

• Deciding on best approach

• Data development challenges

Source: Massachusetts Highway Dept/Cambridge Systematics, Inc.
Common Themes in Review of Statewide Models

- Most statewide models use similar methodologies to metropolitan models, but there are many variations.

- The largest problems relate to issues of scale.

- Models from different states vary greatly in complexity, cost and development time.

- Models are most successful when addressing statewide priorities.

- There are major deficiencies in available data about long-distance and rural passenger travel… NCHRP Report 735 has helped

- Statewide models are more compatible with secondary freight data sources, such as the Commodity Flow Survey, than are metropolitan models.

- Interest is high among states in progress in deploying models.

Alternative Statewide Model Structures

- **Trip table estimation (2 step)**
  - Estimate initial “seed matrix”:
    - Roadside intercept surveys
    - American Travel Survey
    - National HH Travel Survey/Add-ons
    - Census Journey-to-Work flows
  - Matrix estimation program:
    - Inputs – seed matrix, highway network, traffic counts
    - Adjusts origin-destination flows between zones to optimize matching network traffic counts
  - Fratar factors applied to synthetic trip table in estimating future growth

- **Trip table estimation (2 step)**
  - **Pros:**
    - Limited need to prepare/ aggregate socioeconomic input data
    - Simplicity of model generally means short execution times
    - Forecasting needs are limited to zone or district growth factors
  - **Cons:**
    - Less explanatory power than most MPO/regional models
    - Fixed distribution pattern
    - Difficulties in assessing benefits of adding new roadway capacity
Alternative Statewide Model Structures (Cont’d)

• Highway model structure (3 step)
  ➢ Trip generation
  ➢ Trip distribution
  ➢ Highway assignment
• Mode choice excluded
  ➢ Either generate vehicle trips or
  ➢ Apply auto occupancy factors to person trip tables
• Pros
  ➢ Benefits of trip redistribution across range of alternatives
  ➢ Greater sensitivity to roadway capacity and congestion
• Cons
  ➢ Likely reliance on MPOs/others to provide socioeconomic input data
  ➢ Can’t fully test transportation strategies that would alter mode split

Source: Florida Dept. of Transportation/Cambridge Systematics, Inc.
Alternative Statewide Model Structures (Cont’d)

- **Freight considerations (3 step)**
  - Typical freight model steps:
    - Trip generation – tons by commodity group
    - Trip distribution
    - Mode choice – freight is apportioned to transport modes

- **Joint highway assignment (trucks and passenger trips)**

Source: Florida Dept. of Transportation/Cambridge Systematics, Inc.
Alternative Statewide Model Structures (Cont’d)

- Full multi-modal structure (4 step)
  - Trip generation
  - Trip distribution
  - Mode choice
  - Highway assignment
- More common with mega-regions
  - Focused on fixed guideway systems
  - Intercity rail is important component
- Pros
  - Potential to model new intercity rail, including high speed rail
  - Test greater range of potential transportation solutions
- Cons
  - Requires coding of transit networks and mode choice estimation
  - Modeling of air travel might be needed, especially if intercity rail is a completely new mode of travel

Source: California HSR Authority/Cambridge Systematics, Inc.
Beyond 4 Step

- **Potential components**
  - Implement destination choice
  - Tour-based/trip chains
  - Activity-based travel model
  - Activity micro-simulation
  - Traffic micro-simulation
  - Integration with land use models
  - Integration with economic models

- **Pros**
  - Ability to test a more complete set of transportation strategies and solutions

- **Cons**
  - Extensive data requirements
  - Cost to maintain
  - Complexity

Source: Oregon Dept. of Transportation/PB/University of Calgary
Deciding on Best Statewide Model Approach

- What are the motivations for building a statewide travel demand model?
- What are the emerging transportation and policy issues to address?
- How significant is the impact of through travel on your state?
- Do you have many multi-state MPOs?
- How reliable (and current) are your survey data?
- Does your state have major international ports or border crossings?

Source: Florida Department of Transportation/Cambridge Systematics, Inc.
Statewide Model Data Development Challenges

- **Primary data deficiencies**
  - Long distance travelers
  - Rural resident trip-making

- **Challenges in compiling required data**
  - Age of data
  - Confidentiality
  - Coordination with data providers
  - Proper level of geography
  - Sufficient sample size

- **Four categories of data for discussion**
  - Networks and zone system
  - Demographic and employment data
  - Freight and other economic data
  - NHTS and other behavioral data

Source: Florida Department of Transportation/Cambridge Systematics, Inc.
Data Challenges…what is “long distance?”

- >50 miles (American Traveler Survey)
- >100 miles (National Household Travel Survey)
- IE trips (several states)
- Trips made by residents for business/ personal business
- Recreational/tourist trips
Topic – Similarities & Differences with Urban Models

- Zone systems
- Networks
- Travel behavior assumptions
- Trip purposes/market segments
- Modal issues
- Truck forecasting

Source: Delaware Dept. of Transportation/WR&A, Inc.
Statewide vs. Urban Model Zone Systems

- Usually larger zones in statewide models than MPOs
- Block groups are good starting point for statewide model TAZs
- Block groups might need splitting along major transportation corridors
- In small states, MPO TAZs could equal SWM zones
- In most states, MPO TAZ equivalency tables will likely be needed/desirable
- FAF disaggregation approach used for statewide model TAZs
Statewide vs. Urban Model Networks

- Statewide model networks are sparse in comparison with MPO models

- At a minimum, statewide networks should include:
  - Limited access highways
  - Arterials
  - Major collectors

- For proper circulation patterns, lower class facilities might be added

- Outside state, a very sparse network is needed for major truck corridors

- Consistent level of detail for networks and zones

Source: Tennessee Dept. of Transportation/Cambridge Systematics, Inc.
Statewide vs. Urban Model Travel Behavior

- Understanding urban travel behavior
  - MPO models are usually developed with local household travel survey data
  - MPOs without recent HH survey data can borrow parameters from other MPO models or guidance documents such as NCHRP 716: Transferable Urban Travel Parameters

- Rural and long-distance travel behavior
  - A limited number of states have conducted statewide household travel surveys
  - American Travel Survey was designed to target long-distance trips but was discontinued long ago
  - National Household Travel Survey Add-ons can be structured for a sufficient sample of rural trip-makers
  - NCHRP 735: Rural and Long-Distance Travel Parameters recently published for use in statewide models

Map of 2009 Add-on Surveys, Source: FHWA
Statewide vs. Urban Model Trip Purposes

- Typical MPO trip purposes are usually collapsed into HBW, HBO/HBNW, and NHB for statewide models.

- Long-distance purposes:
  - Business
  - Tourist
  - Personal business

- Trucks:
  - Commodity group is often surrogate for trip purpose

- External trips:
  - External generally means trip from outside state
  - Might exclude “halo” area surrounding state boundary

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>FL 2000</th>
<th>IN</th>
<th>LA</th>
<th>MA</th>
<th>MS</th>
<th>RI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-based Work</td>
<td>19.14%</td>
<td>19.95%</td>
<td>19.00%</td>
<td>18.41%</td>
<td>16.06%</td>
<td>20.00%</td>
</tr>
<tr>
<td>Home-based Nonwork</td>
<td>55.47%</td>
<td>52.08%</td>
<td>47.70%</td>
<td>52.06%</td>
<td>49.17%</td>
<td>57.00%</td>
</tr>
<tr>
<td>Home-based Other</td>
<td>27.92%</td>
<td>52.08%</td>
<td>47.70%</td>
<td>19.38%</td>
<td>49.17%</td>
<td>57.00%</td>
</tr>
<tr>
<td>Home-based Shop</td>
<td>15.76%</td>
<td>–</td>
<td>–</td>
<td>11.73%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Home-based Social/Recreation</td>
<td>11.79%</td>
<td>–</td>
<td>–</td>
<td>13.95%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Home-base Recreation/Shop</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Home-based School</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>7.00%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Nonhome-based</td>
<td>25.39%</td>
<td>26.86%</td>
<td>31.00%</td>
<td>24.68%</td>
<td>32.89%</td>
<td>23.00%</td>
</tr>
<tr>
<td>Nonhome-based Work</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>10.27%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Nonhome-based Nonwork</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>14.41%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Other</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Truck</td>
<td>–</td>
<td>–</td>
<td>1.70%</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Long-Distance</strong></td>
<td>0.00%</td>
<td>1.11%</td>
<td>0.60%</td>
<td>4.17%</td>
<td>0.22%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Long-Distance Business</td>
<td>–</td>
<td>–</td>
<td>0.20%</td>
<td>2.84%</td>
<td>0.11%</td>
<td>–</td>
</tr>
<tr>
<td>Long-Distance Personal Business</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Long-Distance Tourist</td>
<td>–</td>
<td>–</td>
<td>0.10%</td>
<td>0.27%</td>
<td>0.00%</td>
<td>–</td>
</tr>
<tr>
<td>Long-Distance Work</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.05%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Long-Distance Nonwork/Other</td>
<td>–</td>
<td>–</td>
<td>0.30%</td>
<td>–</td>
<td>0.11%</td>
<td>–</td>
</tr>
</tbody>
</table>
### Number of person trips

<table>
<thead>
<tr>
<th>Mode</th>
<th>Pleasure</th>
<th>Business</th>
<th>Personal business</th>
<th>Other</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal vehicle</td>
<td>12185</td>
<td>5708</td>
<td>3120</td>
<td>789</td>
<td>21802</td>
<td>90.8</td>
</tr>
<tr>
<td>Commercial air</td>
<td>1012</td>
<td>746</td>
<td>151</td>
<td>24</td>
<td>1933</td>
<td>8</td>
</tr>
<tr>
<td>Train</td>
<td>74</td>
<td>150</td>
<td>14</td>
<td>0</td>
<td>238</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>12</td>
<td>23</td>
<td>0.1</td>
</tr>
<tr>
<td>Ship</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>13294</td>
<td>6606</td>
<td>3290</td>
<td>825</td>
<td>24015</td>
<td>100</td>
</tr>
<tr>
<td><strong>Percent</strong></td>
<td>55.4</td>
<td>27.5</td>
<td>13.7</td>
<td>3.4</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

### Percent by trip purpose

<table>
<thead>
<tr>
<th>Mode</th>
<th>Pleasure</th>
<th>Business</th>
<th>Personal business</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal vehicle</td>
<td>91.7</td>
<td>86.4</td>
<td>94.8</td>
<td>95.6</td>
</tr>
<tr>
<td>Commercial air</td>
<td>7.6</td>
<td>11.3</td>
<td>4.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Train</td>
<td>0.6</td>
<td>2.3</td>
<td>0.4</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Ship</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Statewide vs. Urban Model Modal Issues

- Most statewide models are limited to highway trips
- Modeling of local bus routes is likely overkill
- Mode choice is usually just a conversion from person trips to vehicle trips via auto occupancy rates
- Transit components of statewide models are more common in regions with history of fixed guideway transit
- Transit model is needed to test options such as high speed/intercity rail

<table>
<thead>
<tr>
<th>Primary mode of transport</th>
<th>Primary mode of transport</th>
<th>Survey and year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ATS 95</td>
<td>NHTS 01</td>
</tr>
<tr>
<td>Personal vehicle</td>
<td>81</td>
<td>89</td>
</tr>
<tr>
<td>Commercial air</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Bus</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Train</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Other</td>
<td>0.5</td>
<td>0.9</td>
</tr>
</tbody>
</table>
Statewide vs. Urban Model Modal Issues (Cont’d)

Mode by Trip Purpose

Mode by Distance (miles)
Statewide vs. Urban Model Modal Issues (Cont’d)

- Most statewide assignment models separate trucks from passenger cars
  - Preloading process commonly used for trucks
  - Takes into account more limited route options for truck travel

Source: Ohio Dept. of Transportation
Statewide vs. Urban Model Truck Forecasting

**Urban models**
- Freight movements are partially “external” to model (truncated at external zone)
- More general categories of truck/commercial trips used
- Strong reliance on Quick Response Freight Manual

**Statewide models**
- Rooted in commodity flows
- Often use econometric approaches to modeling
- Generally model entire length of freight travel

Source: TRB Electronic Circular E-C075: Statewide Travel Demand Modeling – A Peer Exchange
Topic – Data Needs and Considerations

- Impact of model complexity on data needs
- Overview of data sources
- Long-Distance travel > different focus than MPO/regional models
  - Sources
  - NHTS
  - Weight calculation
  - Pitfalls
  - Key statistics
  - European surveys
  - Lessons learned

<table>
<thead>
<tr>
<th>Mode</th>
<th>Business</th>
<th>Standard Error</th>
<th>Commute</th>
<th>Standard Error</th>
<th>Pleasure</th>
<th>Standard Error</th>
<th>Personal Business</th>
<th>Standard Error</th>
<th>Other</th>
<th>Standard Error</th>
<th>Total</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>85.8</td>
<td>2.22</td>
<td>40.4</td>
<td>10.76</td>
<td>69.9</td>
<td>1.73</td>
<td>43.9</td>
<td>3.05</td>
<td>54.8</td>
<td>14.32</td>
<td>70.1</td>
<td>1.38</td>
</tr>
<tr>
<td>Bus</td>
<td>4.0</td>
<td>1.19</td>
<td>13.1</td>
<td>6.81</td>
<td>22.8</td>
<td>1.64</td>
<td>51.7</td>
<td>3.30</td>
<td>14.3</td>
<td>7.83</td>
<td>20.1</td>
<td>1.05</td>
</tr>
<tr>
<td>Train</td>
<td>7.7</td>
<td>1.70</td>
<td>46.5</td>
<td>13.55</td>
<td>5.6</td>
<td>0.78</td>
<td>3.2</td>
<td>1.24</td>
<td>1.3</td>
<td>1.33</td>
<td>7.7</td>
<td>0.96</td>
</tr>
<tr>
<td>Other</td>
<td>2.4</td>
<td>1.32</td>
<td>0.0</td>
<td>0.00</td>
<td>0.0</td>
<td>0.41</td>
<td>1.2</td>
<td>0.41</td>
<td>23.6</td>
<td>14.00</td>
<td>2.1</td>
<td>0.52</td>
</tr>
<tr>
<td>Total</td>
<td>31.1</td>
<td>1.16</td>
<td>4.4</td>
<td>0.92</td>
<td>50.6</td>
<td>1.28</td>
<td>12.8</td>
<td>0.77</td>
<td>1.1</td>
<td>0.27</td>
<td>100.0</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**NOTES:** Only trips in which the transportation mode and trip purpose could be identified are included. Underlined estimates are based on a small sample size (<30) or a coefficient of variation greater than 30% and are not reliable. On this table, differences are measured in columns instead of rows. The difference between shaded cells in the same column are not statistically significant, except for Commuting where Air is different from Bus while Air and Train are different from Other Modes, Personal Business where Air and Bus are different from Train and Other, and for Other trip purposes where Air is different from Bus and Train, and Train is different from Other Modes. **SOURCE:** U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, Federal Highway Administration, National Household Travel Survey, long-distance file, 2001 (Washington, DC).
Impact of Model Complexity on Data Needs

- **Trip table estimation (2 step)** – highway network, zone system, trip table

- **Highway model structure (3 step)** – 2 step plus behavioral data for trip rates, friction factors, auto occupancy rates

- **Freight considerations (3 step)** – 3 step plus commodity flows, economic data, tonnages by mode, truck counts

- **Full multi-modal structure (4 step)** – 3 step plus transit networks and paths, logit mode choice model

- **Beyond 4 Step** – synthetic household generation, operational characteristics, etc.

Source: Georgia DOT/Cambridge Systematics, Inc.
Statewide Model Data Sources A-Z

- American Travel Survey (ATS)
- Bureau of Economic Analysis (BEA)
- Census Journey-to-Work (JTW) data
- Census Public Use Microsample (PUMS)
- Census Transportation Planning Package (CTPP)
- Claritas
- Commodity Flow Survey (CFS)

Source: U.S. Census Bureau
Statewide Model Data Sources (Cont’d)

- Dun & Bradstreet (D&B) employment data
- Employment Security data (ES-202)
- Freight Analysis Framework (FAF)
- Highway Performance Monitoring System (HPMS)
- InfoUSA employment data
- Metropolitan Planning Organizations (MPO)
- NCHRP 365 Manual
- National Highway Planning Network (NHPN)

Source: FAF2 Provisional Commodity Origin-Destination Estimates Revised Methodology Report, Battelle/FHWA
Statewide Model Data Sources (Cont’d)

- National Household Travel Survey (NHTS)
- Origin-destination surveys
- Regional Economic Models, Inc. (REMI)
- State Departments of Transportation
- TRANSEARCH data
- Vehicle Use and Identification Survey (VIUS)
- Woods & Poole employment forecasts

**FIGURE 2: Mode Share for Personal Vehicle and Air at Various Trip Lengths**

Source: Bureau of Transportation Statistics, NHTS
Data Sources on Long-Distance Travel

- Census Journey-to-Work data
- Long distance component:
  - American Travel Survey (77, 95)
  - National Household Travel Survey (01)
  - Ohio statewide surveys (02-04)
  - Michigan statewide survey (04-05)
  - California (10-12)
- Surveys focused on long distance
  - Oregon (96-98, 07-08)
- Others
  - BTS Omnibus surveys
  - Tourism surveys
  - European practice
  - NCHRP Report 735
NHTS and Long-Distance Travel

- Evolution of U.S. national surveys
  - NPTS (69, 77, 83, 90, 95)
  - ATS (77, 95)

- 2001 NHTS – Total of 60,282 long distance person trips
  - Data collected March 01 to May 02
  - 22,204 (37 percent) before 9/11
  - 38,078 (63 percent) afterwards

- Long distance trip is longer than 50 miles one-way (vs. 100 miles in 1995 ATS)

- 28-day retrospective survey (including travel day)

- Not your typical travelers
  - Low frequency
  - Distinct segment of the population

### TABLE 1: Annual Long-Distance Trips by Mode

<table>
<thead>
<tr>
<th>Transportation mode</th>
<th>Trips (millions)</th>
<th>Standard error</th>
<th>% of total trips</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal vehicle</td>
<td>2,336.1</td>
<td>36.89</td>
<td>89.5</td>
<td>0.33</td>
</tr>
<tr>
<td>Air</td>
<td>193.3</td>
<td>6.28</td>
<td>7.4</td>
<td>0.26</td>
</tr>
<tr>
<td>Bus</td>
<td>55.4</td>
<td>3.45</td>
<td>2.1</td>
<td>0.13</td>
</tr>
<tr>
<td>Train</td>
<td>21.1</td>
<td>2.88</td>
<td>0.8</td>
<td>0.11</td>
</tr>
<tr>
<td>Other</td>
<td>5.8</td>
<td>1.45</td>
<td>0.2</td>
<td>0.06</td>
</tr>
<tr>
<td>Total</td>
<td>2,611.7</td>
<td>37.70</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

NOTES: Totals may not add due to rounding. Only trips in which the transportation mode could be identified are included.

Weight Calculation for Long-Distance Travelers

- **Use to ensure valid population-level estimates**
  - Accounts for non-response, under-coverage, multiple phones, etc.

- **Multi-stage process**
  - Match national margins
  - Adjust for data splitting (force $\sum \text{expfac} = 277,208,169$)
  - Raking (match independent controls): race, ethnicity, race by month, ethnicity by month, sex by age, census region, MSA status, month by day of week
  - Trim outlier expansion factors: max expfac = $4 \times \text{mean}$
  - Replication (correct for sampling error)

- **At least two passes through the data**
Key Statistics for Long-Distance Travel

- Incidence & frequency (trip rates)
- Mode of travel
- Trip duration
- Trip purpose
- Party size
- Place/type of stay

<table>
<thead>
<tr>
<th>Lodging at farthest destination</th>
<th>NHTS observations</th>
<th>Per-</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw</td>
<td>Weighted</td>
<td>cent</td>
</tr>
<tr>
<td>Did not stay overnight</td>
<td>9,901</td>
<td>1,476,180,913</td>
<td>53.7</td>
</tr>
<tr>
<td>Friend or relative's home</td>
<td>3,300</td>
<td>528,190,020</td>
<td>19.2</td>
</tr>
<tr>
<td>Hotel, motel, bed &amp; breakfast, resort</td>
<td>3,049</td>
<td>463,335,160</td>
<td>16.8</td>
</tr>
<tr>
<td>Camper, trailer, tent or other recreational vehicle</td>
<td>637</td>
<td>87,821,810</td>
<td>3.2</td>
</tr>
<tr>
<td>Owned cabin, condominium, vacation home, timeshare</td>
<td>554</td>
<td>78,526,719</td>
<td>2.9</td>
</tr>
<tr>
<td>Rented cabin, condominium or vacation home</td>
<td>432</td>
<td>61,616,966</td>
<td>2.2</td>
</tr>
<tr>
<td>Overnight in automobile, plane, ship, train, etc.</td>
<td>116</td>
<td>16,599,669</td>
<td>0.6</td>
</tr>
<tr>
<td>Dormitory, youth hostel</td>
<td>81</td>
<td>13,850,288</td>
<td>0.5</td>
</tr>
<tr>
<td>Military housing</td>
<td>37</td>
<td>6,980,894</td>
<td>0.3</td>
</tr>
<tr>
<td>Other</td>
<td>52</td>
<td>8,830,037</td>
<td>0.3</td>
</tr>
<tr>
<td>Corporate owned housing</td>
<td>26</td>
<td>5,723,523</td>
<td>0.2</td>
</tr>
<tr>
<td>Conference center for participants only</td>
<td>16</td>
<td>2,188,649</td>
<td>0.1</td>
</tr>
<tr>
<td>YMCA</td>
<td>2</td>
<td>241,128</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>18,203</td>
<td>2,750,085,777</td>
<td>100</td>
</tr>
</tbody>
</table>
Topic – Validation & Reasonableness Checking/Transferability

• Likely range of values for SWMs
• *NCHRP Report 735: Long-Distance and Rural Transferable Parameters*
• SWM reasonableness comparisons
  ➢ Trip generation
    □ Aggregate trip rates
    □ Trip purpose percentages
  ➢ Trip distribution
    □ Average trip lengths
    □ Percent intrazonal trips
    □ Analyze district-to-district trip movements
  ➢ Mode choice
    □ Average auto occupancy rates
    □ Assess reasonableness of mode shares (for multimodal models)
  ➢ Trip assignment
    □ Root mean square error
    □ Volume-over-count ratios

Source: Florida Dept. of Transportation/Cambridge Systematics, Inc.
Likely Range of Values for Statewide Models

- **Varies significantly**
  - Size of state
  - Density of development
- **Network links per TAZ**
- **Population per TAZ**

- **Model checks against Census**
  - Persons per household
  - Employees per household
  - Autos per household

### Statewide Model Results

<table>
<thead>
<tr>
<th></th>
<th>AL</th>
<th>AZ</th>
<th>DE</th>
<th>FL 2000</th>
<th>IN</th>
<th>KY</th>
<th>LA</th>
<th>MD</th>
<th>MA</th>
<th>MS</th>
<th>MO</th>
<th>NJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Zones</td>
<td>1,081</td>
<td>1,073</td>
<td>908</td>
<td>4,000</td>
<td>4,720</td>
<td>4,753</td>
<td>1,313</td>
<td>1,739</td>
<td>3,069</td>
<td>3,305</td>
<td>2,392</td>
<td>2,813</td>
</tr>
<tr>
<td>Number of Links</td>
<td>4,607</td>
<td>6,412</td>
<td>10,047</td>
<td>-</td>
<td>34,500</td>
<td>77,272</td>
<td>-</td>
<td>167,150</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>44,000</td>
</tr>
<tr>
<td>Ratio of Links per Zone</td>
<td>4.26</td>
<td>5.98</td>
<td>11.06</td>
<td>-</td>
<td>7.31</td>
<td>16.26</td>
<td>-</td>
<td>96.12</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.64</td>
</tr>
<tr>
<td>Persons per Household or DU</td>
<td>2.26</td>
<td>2.26</td>
<td>2.28</td>
<td>2.19</td>
<td>2.4</td>
<td>2.31</td>
<td>2.42</td>
<td>2.47</td>
<td>2.42</td>
<td>2.45</td>
<td>2.29</td>
<td>2.54</td>
</tr>
<tr>
<td>Employment/Population</td>
<td>0.43</td>
<td>0.43</td>
<td>0.49</td>
<td>0.44</td>
<td>0.49</td>
<td>0.45</td>
<td>0.42</td>
<td>0.5</td>
<td>0.5</td>
<td>0.42</td>
<td>0.48</td>
<td>0.47</td>
</tr>
<tr>
<td>Autos/Household or DU</td>
<td>1.6</td>
<td>1.19</td>
<td>1.5</td>
<td>1.38</td>
<td>1.68</td>
<td>1.57</td>
<td>1.4</td>
<td>1.56</td>
<td>1.44</td>
<td>1.56</td>
<td>1.56</td>
<td>1.48</td>
</tr>
<tr>
<td>Population/TAZ**</td>
<td>4,113</td>
<td>5,611</td>
<td>863</td>
<td>3,995</td>
<td>1,288</td>
<td>850</td>
<td>3,403</td>
<td>3,045</td>
<td>2,068</td>
<td>860</td>
<td>2,339</td>
<td>2,991</td>
</tr>
</tbody>
</table>

NCHRP Report 735: Long-Distance & Rural Transferable Parameters for Statewide Models

- Differences in rural and long-distance travel
- Statewide model statistics on rural and long-distance travel
- Transferability of rural and long-distance model parameters
- Consideration of other trip characteristics
- Developed recommended transferable model parameters
  - 1995 ATS, 2001 NHTS, 2009 NHTS, Statewide Surveys, GPS Surveys

Figure 1. Vehicle Trips and VMT by Trip Length
Statewide Model Reasonableness – Trip Generation

- **Aggregate trip rates**
  - Provided for only a few statewide models
  - Differs little from urban & regional models

<table>
<thead>
<tr>
<th>Person Trips/TAZ</th>
<th>Statewide Model Results</th>
<th>Guidance Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AZ</td>
<td>CA</td>
</tr>
<tr>
<td>Person Trips/TAZ</td>
<td>27,213</td>
<td>-</td>
</tr>
<tr>
<td>Person Trips/Person</td>
<td>4.85</td>
<td>1.95</td>
</tr>
<tr>
<td>Person Trips/Household (DU)***</td>
<td>10.95</td>
<td>5.41</td>
</tr>
<tr>
<td>HBW Person Trips/Household</td>
<td>1.32</td>
<td>-</td>
</tr>
<tr>
<td>Person Trips/Employee</td>
<td>11.36</td>
<td>4.41</td>
</tr>
</tbody>
</table>


* As documented in 2008 Model Calibration and Validation Standards Final Report for Florida DOT (results from models throughout the US)

**NCHRP Report 365 Travel Estimation Techniques for Urban Planning, 1998 (trips/HH)
Statewide Model Reasonableness – Trip Generation

- Trip purpose percentages
  - Less trip purposes than found in typical urban & regional models
  - Percentages by purpose not that different from urban & regional models as long distance trips are overshadowed by others

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Statewide Model Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FL</td>
</tr>
<tr>
<td></td>
<td>AL</td>
</tr>
<tr>
<td>Home-based Work</td>
<td>19.19%</td>
</tr>
<tr>
<td>Home-based Nonwork</td>
<td>46.22%</td>
</tr>
<tr>
<td>Home-based Other</td>
<td>-</td>
</tr>
<tr>
<td>Home-based Shop</td>
<td>-</td>
</tr>
<tr>
<td>Home-based Social/Recreation</td>
<td>-</td>
</tr>
<tr>
<td>Home-based School</td>
<td>-</td>
</tr>
<tr>
<td>Nonhome-Based</td>
<td>-</td>
</tr>
<tr>
<td>Nonhome-based Work</td>
<td>-</td>
</tr>
<tr>
<td>Nonhome-based Nonwork</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>21.80%</td>
</tr>
<tr>
<td>Truck</td>
<td>7.79%</td>
</tr>
<tr>
<td>Long-Distance</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Business</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Tourist</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Work</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Nonwork/Other</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Business</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Tourist</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Other</td>
<td>-</td>
</tr>
<tr>
<td>External</td>
<td>0.75%</td>
</tr>
</tbody>
</table>

Statewide Model Reasonableness – Trip Distribution

- **Average trip lengths (minutes)**
  - Vary by state
  - Not that different from MPO short distance purposes
  - However, long-distance purposes exceed maximum trip lengths found in urban & regional models

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>AZ</th>
<th>FL 2000</th>
<th>LA</th>
<th>MA</th>
<th>RI</th>
<th>TX</th>
<th>UT</th>
<th>VA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Home-based Work</strong></td>
<td>26.1</td>
<td>18.38</td>
<td>17.3</td>
<td>23.05</td>
<td>21.59</td>
<td>16</td>
<td>17.79</td>
<td>14.6</td>
</tr>
<tr>
<td><strong>Home-based Other/Nonwork</strong></td>
<td>20.2</td>
<td>16.22</td>
<td>12.2</td>
<td>14.57</td>
<td>15.64</td>
<td>9.06</td>
<td>12.98</td>
<td>10.8</td>
</tr>
<tr>
<td>Home-based Shop</td>
<td>-</td>
<td>16.77</td>
<td>-</td>
<td>15.06</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Home-based Social/Recreation</td>
<td>-</td>
<td>15.55</td>
<td>-</td>
<td>16.19</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Home-based School</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>13.93</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Nonhome-based</strong></td>
<td>18.6</td>
<td>13.06</td>
<td>9.3</td>
<td>-</td>
<td>14.45</td>
<td>9.68</td>
<td>12.37</td>
<td>23.17</td>
</tr>
<tr>
<td>Nonhome-based Work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>17.91</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nonhome-based Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.62</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10.83</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Business</td>
<td>174</td>
<td>134.67</td>
<td>166</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>127.13</td>
</tr>
<tr>
<td>Long-Distance Personal Business</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>124.58</td>
</tr>
<tr>
<td>Long-Distance Tourist</td>
<td>-</td>
<td>-</td>
<td>172</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>126.67</td>
</tr>
<tr>
<td>Long-Distance Work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>200.82</td>
<td>89.54</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Nonwork/Other</td>
<td>-</td>
<td>-</td>
<td>164</td>
<td>-</td>
<td>-</td>
<td>199.71</td>
<td>81.73</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Business</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>51.26</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>55.49</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Short Distance</td>
<td>-</td>
<td>42.82</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Long Distance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>125.75</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Statewide Model Reasonableness – Trip Distribution

- **Percent intrazonal trips**
  - Considerably higher than urban & regional models
  - Result of larger TAZs found in statewide models

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>FL 2000</th>
<th>MA</th>
<th>PA</th>
<th>UT</th>
<th>WI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-Based Work</td>
<td>9.4%</td>
<td>6.3%</td>
<td>-</td>
<td>5.5%</td>
<td>29.2%</td>
</tr>
<tr>
<td>Home-Based Nonwork</td>
<td>17.4%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Home-Based Shop</td>
<td>15.6%</td>
<td>16.5%</td>
<td>-</td>
<td>-</td>
<td>41.0%</td>
</tr>
<tr>
<td>Home-Based Social/Recreation</td>
<td>37.3%</td>
<td>15.3%</td>
<td>-</td>
<td>1.6%</td>
<td>37.4%</td>
</tr>
<tr>
<td>Home-Based School</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>51.5%</td>
</tr>
<tr>
<td>Home-Based Other</td>
<td>25.2%</td>
<td>17.0%</td>
<td>-</td>
<td>8.5%</td>
<td>53.6%</td>
</tr>
<tr>
<td>Nonhome-Based</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8.3%</td>
<td>54.4%</td>
</tr>
<tr>
<td>Nonhome-Based Work</td>
<td>-</td>
<td>18.4%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nonhome-Based Other</td>
<td>-</td>
<td>19.2%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>19.9%</strong></td>
<td>-</td>
<td><strong>37.7%</strong></td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Statewide Model Reasonableness – Mode Choice

- **Average auto occupancy rates**
  - Similar to urban & regional models for short-distance trips
  - Much higher for long-distance trips unique to statewide models

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>AZ</th>
<th>CA</th>
<th>FL 2000</th>
<th>KY</th>
<th>LA</th>
<th>MS</th>
<th>RI</th>
<th>TX</th>
<th>UT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-based Work</td>
<td>1.19</td>
<td>-</td>
<td>1.1</td>
<td>-</td>
<td>1.15</td>
<td>1.1</td>
<td>1.12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Home-based Nonwork</td>
<td>-</td>
<td>1.19</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Home-based Other</td>
<td>1.8</td>
<td>1.54</td>
<td>1.7</td>
<td>-</td>
<td>1.78</td>
<td>1.65</td>
<td>1.56</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Home-based Shop</td>
<td>-</td>
<td>-</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Home-based Social/Recreation</td>
<td>-</td>
<td>1.49</td>
<td>1.94</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nonhome-based</td>
<td>1.67</td>
<td>-</td>
<td>1.71</td>
<td>-</td>
<td>1.79</td>
<td>1.56</td>
<td>1.56</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nonhome-based Work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.33</td>
<td>-</td>
</tr>
<tr>
<td>Non-home-based Non-Work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.06</td>
</tr>
<tr>
<td>Long-Distance Business</td>
<td>1.65</td>
<td>1.19</td>
<td>-</td>
<td>1.8</td>
<td>1.86</td>
<td>1.39</td>
<td>-</td>
<td>-</td>
<td>1.82</td>
</tr>
<tr>
<td>Long-Distance Tourist</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.31</td>
<td>3.44</td>
<td>2.55</td>
<td>-</td>
<td>-</td>
<td>2.69</td>
</tr>
<tr>
<td>Long-Distance Work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.43</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Rec</td>
<td>-</td>
<td>1.73</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Long-Distance Nonwork/Other</td>
<td>-</td>
<td>1.31</td>
<td>-</td>
<td>-</td>
<td>2.64</td>
<td>2.05</td>
<td>-</td>
<td>-</td>
<td>2.69</td>
</tr>
<tr>
<td>Internal-External Business</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Tourist</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.55</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Internal-External Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.26</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

## Statewide Model Reasonableness – Trip Assignment

### Percent root mean square error
- Not commonly reported for statewide models
- Areawide RMSE similar to urban & regional models
- RMSE for low volume roadways, of which there are plenty in statewide models, generally fails to meet urban model accuracy standards
- Volume groups vary among models

### Statewide Model Results

<table>
<thead>
<tr>
<th>Range</th>
<th>AL</th>
<th>AZ</th>
<th>FL 2000</th>
<th>IN</th>
<th>TN</th>
<th>TX</th>
<th>UT</th>
<th>WI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5,000</td>
<td>141.8</td>
<td>103.6</td>
<td>60.9</td>
<td>42.29-99.06</td>
<td>27.2-21.8</td>
<td>90-290</td>
<td>57-147</td>
<td>80.61</td>
</tr>
<tr>
<td>5,000 - 10,000</td>
<td>80.7</td>
<td>56.9</td>
<td>43.4</td>
<td>35.52-42.97</td>
<td>15.9</td>
<td>70</td>
<td>53-76</td>
<td>32</td>
</tr>
<tr>
<td>10,000 - 20,000</td>
<td>65.5-82.4</td>
<td>36.7</td>
<td>32.7</td>
<td>31.33-35.6</td>
<td>25.4-35.5</td>
<td>61.0****</td>
<td>81.0</td>
<td>22.3</td>
</tr>
<tr>
<td>20,000 - 30,000</td>
<td>57.1</td>
<td>27.5******</td>
<td>25.9</td>
<td>29.34</td>
<td>20.2</td>
<td>40.0****</td>
<td>45</td>
<td>19.33</td>
</tr>
<tr>
<td>30,000 - 40,000</td>
<td>36.2*****</td>
<td>-</td>
<td>21.4</td>
<td>21.93</td>
<td>18.2</td>
<td>40.0****</td>
<td>36</td>
<td>13.62</td>
</tr>
<tr>
<td>40,000 - 50,000</td>
<td>-</td>
<td>-</td>
<td>17.4</td>
<td>15.74</td>
<td>8.8</td>
<td>-</td>
<td>36</td>
<td>13.91</td>
</tr>
<tr>
<td>50,000 - 60,000</td>
<td>-</td>
<td>-</td>
<td>14.5</td>
<td>5.1******</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>&gt; 60,000</td>
<td>-</td>
<td>-</td>
<td>10.9-13.22</td>
<td>14.9</td>
<td>14.6</td>
<td>-</td>
<td>-</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>82.2</td>
<td>56</td>
<td>32.6</td>
<td>39.42</td>
<td>-</td>
<td>90</td>
<td>49</td>
<td>39.21</td>
</tr>
</tbody>
</table>

### Guidance Documents

<table>
<thead>
<tr>
<th>Statewide Model Results</th>
<th>FDOT Acceptable*</th>
<th>FDOT Preferable*</th>
<th>Oregon DOT**</th>
<th>Michigan***</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5,000</td>
<td>100</td>
<td>45</td>
<td>115.76</td>
<td>50-200%</td>
</tr>
<tr>
<td>5,000 - 10,000</td>
<td>45</td>
<td>35</td>
<td>43.14</td>
<td>25%</td>
</tr>
<tr>
<td>10,000 - 20,000</td>
<td>30.0-35.0</td>
<td>25.0-27.0</td>
<td>28.73</td>
<td>20%</td>
</tr>
<tr>
<td>20,000 - 30,000</td>
<td>27</td>
<td>15</td>
<td>25.84</td>
<td>20%</td>
</tr>
<tr>
<td>30,000 - 40,000</td>
<td>25</td>
<td>15</td>
<td>30.25</td>
<td>15%</td>
</tr>
<tr>
<td>40,000 - 50,000</td>
<td>25</td>
<td>15</td>
<td>30.25</td>
<td>15%</td>
</tr>
<tr>
<td>50,000 - 60,000</td>
<td>20</td>
<td>10</td>
<td>30.25</td>
<td>10%</td>
</tr>
<tr>
<td>&gt; 60,000</td>
<td>19</td>
<td>10</td>
<td>19.2</td>
<td>10%</td>
</tr>
</tbody>
</table>

*10,000-25,000 and 25,000+ ranges used in Texas model reference

**25,000+ range used in Alabama model reference

***50,000+ range used in Tennessee model reference

Statewide Model Reasonableness – Trip Assignment

- Percent root mean square error (cont’d)

Statewide Model RMSE Distribution by State

Statewide Model Reasonableness – Trip Assignment

- **Volume-over-count ratios**
  - Similar to urban & regional models
  - Infrequently summarized by urban vs. rural area type
  - This limits ability to fully assess model accuracy

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>AL</th>
<th>FL 2000</th>
<th>MA</th>
<th>MI</th>
<th>TX</th>
<th>WI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
<td>0.84</td>
<td>0.94</td>
</tr>
<tr>
<td>Freeway</td>
<td>1.01</td>
<td>0.98</td>
<td>1.01</td>
<td>-</td>
<td>-</td>
<td>1.08</td>
</tr>
<tr>
<td>Expressway</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.05</td>
</tr>
<tr>
<td>US Highway</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.03</td>
<td>-</td>
</tr>
<tr>
<td>State Highway</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.55</td>
<td>-</td>
</tr>
<tr>
<td>Arterials</td>
<td>-</td>
<td>-</td>
<td>0.97</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>1.05</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.99</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>-</td>
<td>1.01</td>
<td>-</td>
<td>0.99</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>0.94</td>
<td>1.03</td>
<td>-</td>
<td>1.03</td>
<td>-</td>
<td>1.06</td>
</tr>
<tr>
<td>Collector</td>
<td>0.87</td>
<td>1.01</td>
<td>0.97</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Major Collector</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.88</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Minor Collector</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.95</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Statewide-Urban Model Interface

Run the statewide model

Run the urban model

Synthetic matrix estimation

Convergence?

n

 targets and constraints

estimators

link flows

data

y
Data Sharing with Urban and Statewide Models

- **Pros of data sharing**
  - Minimizes cost of data development/review
  - Achieves greater consistency with regional planning efforts

- **Cons of data sharing**
  - Requires continuous coordination to maintain consistency with land use forecasts and status of planned projects
  - Methodologies, such as network coding and socioeconomic forecasting, will vary throughout statewide model

Source: Florida Department of Transportation
Statewide Model Independent of MPO Data/Process

• **Pros**
  - Model updates can be made more expeditiously
  - Common methodologies can be employed throughout the model
    - Unified land use forecasting model
    - Common set of network attributes
    - Matrix estimation alternative
  - Set of forecasts independent from local politics

• **Cons**
  - Could result in inconsistencies with regional planning
  - Results could be unrealistic

Source: Florida Department of Transportation
Additional Considerations on External Trips

- In addition to using statewide models to forecast external trip control totals for urban and regional models...

  - Use statewide model as source for E-I/I-E and E-E trip tables
    - Would require disaggregation of statewide trip table to represent internal urban/regional model TAZs
    - Would require aggregation of statewide trip table to represent external urban/regional model TAZs
    - Would require adjustments to account for statewide model assignment errors at external crossings for urban/regional models

Source: Tennessee Department of Transportation/Cambridge Systematics, Inc.

<table>
<thead>
<tr>
<th>#</th>
<th>Location</th>
<th>Total Volume</th>
<th>SWM-MPO</th>
<th>Total Volume</th>
<th>SWM-MPO</th>
<th>Total Volume</th>
<th>SWM-MPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SWM (Arkansas State Line)</td>
<td>60,875</td>
<td>-4,142</td>
<td>63,004</td>
<td>-10,734</td>
<td>71,465</td>
<td>-24,218</td>
</tr>
<tr>
<td>2</td>
<td>Memphis MPO Model St Line</td>
<td>65,017</td>
<td>-142</td>
<td>73,738</td>
<td>-10,734</td>
<td>95,683</td>
<td>-24,218</td>
</tr>
<tr>
<td>3</td>
<td>Memphis MPO Model East</td>
<td>37,837</td>
<td>-40</td>
<td>44,023</td>
<td>-2,766</td>
<td>64,246</td>
<td>49,186</td>
</tr>
<tr>
<td>4</td>
<td>SWM (Memphis East)</td>
<td>37,537</td>
<td>-280</td>
<td>39,418</td>
<td>-4,605</td>
<td>58,116</td>
<td>-5,100</td>
</tr>
<tr>
<td>5</td>
<td>SWM (Jackson West)</td>
<td>37,547</td>
<td>-290</td>
<td>39,418</td>
<td>-4,605</td>
<td>58,116</td>
<td>-5,100</td>
</tr>
<tr>
<td>6</td>
<td>Jackson West</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>53,240</td>
<td>4,906</td>
</tr>
<tr>
<td>7</td>
<td>Jackson East</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>49,186</td>
<td>n/a</td>
</tr>
<tr>
<td>8</td>
<td>SWM (Jackson East)</td>
<td>33,007</td>
<td>n/a</td>
<td>34,927</td>
<td>n/a</td>
<td>42,673</td>
<td>-6,513</td>
</tr>
<tr>
<td>9</td>
<td>SWM (Nashville West)</td>
<td>40,926</td>
<td>112</td>
<td>43,855</td>
<td>945</td>
<td>56,253</td>
<td>290</td>
</tr>
<tr>
<td>10</td>
<td>Nashville West</td>
<td>40,814</td>
<td>112</td>
<td>44,800</td>
<td>945</td>
<td>55,963</td>
<td>290</td>
</tr>
<tr>
<td>11</td>
<td>Nashville East</td>
<td>52,185</td>
<td>-2,288</td>
<td>58,072</td>
<td>-971</td>
<td>74,558</td>
<td>506</td>
</tr>
<tr>
<td>12</td>
<td>SWM (Nashville East)</td>
<td>49,897</td>
<td>-2,288</td>
<td>57,101</td>
<td>-971</td>
<td>75,064</td>
<td>506</td>
</tr>
<tr>
<td>13</td>
<td>SWM (Knoxville West)</td>
<td>45,229</td>
<td>48,059</td>
<td>64,003</td>
<td>n/a</td>
<td>75,064</td>
<td>506</td>
</tr>
</tbody>
</table>
Other Potential Uses in Urban and Regional Models

- In addition to using statewide models as a source for external trips in urban and regional models...

  - Time-of-day estimate (assuming statewide time-of-day capabilities)
  - Vehicle class definitions (most statewide models load truck trips as a separate trip purpose/pre-load)
  - External transit trips (assuming statewide multi-modal capabilities)

Source: Tennessee Department of Transportation/Cambridge Systematics, Inc.
Topic – Statewide Model Shortcomings & Areas to Improve

- Travel behavior data on visitors and long-distance trip makers
- Trip generation rates and other model parameters for rural residents
- Origin-destination data at state line external zones
- Consistency between network and zone system
- Daily and seasonal variability
- Other shortcomings

Source: USDOT, Bureau of Transportation Statistics, American Travel Survey
Topology

Mindset: Boundaries → Behavioral
American Long Distance Personal Travel Program

- American Long-Distance Personal Travel Data & Modeling Program *identified*
- Goal is to support data on long distance personal travel:
  - Collection, Synthesis, Analysis
- Coverage areas:
  - Within, into, and out of U.S.
- Carry out design and application of models
- FHWA national origin-destination matrix by mode
  - Study recently *completed*
- FHWA Exploratory Advanced Research Program
  - Design of new approach for long-distance travel survey approach/instrument and model framework *underway*

Source: Oak Ridge National Laboratory, University of Maryland
Rural Trip Rates and Other Model Parameters

- Most household travel surveys focus on urban trip-making

- Rural sample from National Household Travel Survey

- NHTS Add-On surveys for specific states
  - e.g., Florida Add-on targeted a sample of rural residents

Source: Florida Dept. of Transportation/Cambridge Systematics, Inc.
Origin-Destination Data at State Line External Zones

- State line crossings analogous to MPO external zones

- Likewise, IE/EE split is needed (through trips)

- Unlike MPO models, need trip patterns to major internal destinations

- Also helpful to know trip purposes and vehicle classes (HOV, truck, etc.)

- Some potential for anonymous cellular data but long tracking distances could be challenging

- GPS data for truck travel (ATRI)

Source: Georgia DOT, Cambridge Systematics, Inc.
Consistency Between Network and Zone System

- Statewide model transportation networks are typically too dense (rarely too sparse)

- Statewide zone systems to support dense networks = long run times

- Resulting statewide model zones often too large for corridor validation

- Nested zone structures might hold promise

Source: Ohio Department of Transportation
Daily and Seasonal Variability

- Statewide models usually represent something akin to AADT (MPO models more likely to reflect peak conditions)
- Peak seasons could vary across the state
- Major roadways outside MPO areas might even experience peak traffic conditions during weekends
- Normalizing required

Source: New Jersey Institute of Technology

<table>
<thead>
<tr>
<th></th>
<th>RT-HIS</th>
<th>NPTA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekday</td>
<td>Weekend</td>
</tr>
<tr>
<td>Sample Size (Number of Households)</td>
<td>4,541</td>
<td>275</td>
</tr>
<tr>
<td>Estimated Mean (Number of Trips per HH)</td>
<td>8.80</td>
<td>7.71</td>
</tr>
<tr>
<td>Difference between Weekend and Weekday</td>
<td>0.4%</td>
<td></td>
</tr>
</tbody>
</table>

Source: New Jersey Institute of Technology
Other Potential Shortcomings of Statewide Models

- **High cost of maintenance**
  - Might require personnel with broader skills (GIS, econometric/freight models, decision support systems)
  - Ongoing data collection (beyond typical MPO needs)

- **Vague or poorly defined goals and objectives** (unlike MPO models, not statutorily required)

- **Often developed with single purpose in mind** (e.g., conduct statewide plan)

Source: Tennessee Department of Transportation
MiniQuiz 3

• Source(s) for Long-Distance Travel Survey Data
  A. Select statewide household surveys
  B. 2001 NHTS
  C. 1995 ATS
  D. All of the above

• Best source(s) for Rural Travel Survey Data
  A. 2009 NHTS and select statewide household surveys
  B. 2001 NHTS
  C. 1995 ATS
  D. All of the above