Advanced Freight Forecasting Models

Prepared for:
Innovations in Travel Modeling Workshop

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3 Types Emerging

1. **Supply Chain Models**
   - Tend to be National in scope
   - Some examples at State and Regional levels

2. **Tour-based Models**
   - Tend to be Regional in scope
   - Some examples at State and National levels

3. **Hybrid Models**
   - Combined supply chain and tour-based models
   - For Regional or Statewide planning purposes, but with a National component
Supply Chain Models
U.S. FAME Framework

FAME
Freight
Activity
Microsimulation
Estimator
1. All the firms in the study area are recognized and their basic characteristics are identified.

2. Based on each firm’s characteristics, the types and amounts of incoming and outgoing goods are determined, and the design of the supply chains is replicated.

3. The shipment sizes are defined based on the acquired information on the firms’ characteristics and the way that they trade commodities between each other.

4. Shipping decisions such as shipping mode, haul time, shipping cost, warehousing, etc. are made.

5. The impact of the goods movements on transportation network is investigated.
Norway and Sweden National Freight Models

- Similar (but separate) models for each country
- Logistics costs for each leg of production-consumption (PC) flow are simulated on a firm-to-firm level
- Feedback allows logistics choices to impact economic (trade) patterns
Tour-based Models
Tour-based Models

- Tour-based models include model components for
  - tour generation
  - vehicle-type models
  - trip purpose models
  - time of day models
  - stop location models
  - stop duration models

- Primarily based on tour characteristics of truck trips and not commodity

- Focus on truck trips, so they are not multimodal
<table>
<thead>
<tr>
<th>Tour-based Truck Model</th>
<th>Truck Surveys</th>
<th>How Tours are Constructed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas</td>
<td>Estimated from Commercial Vehicle Surveys in 2005-2006</td>
<td>Daily patterns for trucks, stops chosen then linked</td>
</tr>
<tr>
<td>Ohio</td>
<td>Estimated from ODOT surveys in 2003-2004</td>
<td>Daily patterns for workers, incremental tours</td>
</tr>
<tr>
<td>Calgary</td>
<td>Estimated from Commercial Vehicle Surveys in 2000</td>
<td>Daily tours for workers, incremental tours</td>
</tr>
<tr>
<td>Denver</td>
<td>Estimated from DRCOG Surveys in 1998</td>
<td>Daily patterns for trucks, incremental tours</td>
</tr>
</tbody>
</table>
Hybrid Supply Chain and Tour-based Models
Firm Synthesis

- Firms are synthesized for the entire U.S. with a high level of industrial sector detail, and across several employment categories.
- Spatial resolution is more detailed than is used nationally (counties are smaller than FAF zones).

Legend:
- 1 Dot = 3
- Over_1000_Emp
- 1 Dot = 100
- Under_1000_Emp
Supplier Selection Results

- The model builds 2.8 million buyer-supplier pairs with one of the pair in the Chicago region.
- The distance distribution of buyer-supplier pairs reflects the spatial distribution of commodity flows.

**Distance Distribution of Buyer-Supplier Pairs**

Includes pairs with one or more firms in the Chicago region.

- Peak at <100 miles is within region travel.
- Peak at 600-800 miles is largely to/from east coast (NYC, NJ, PA, DC), and also Texas cities.
- Peak at 1700-1800 miles is Chicago to/from Los Angeles.
Direct distribution channels and channels involving a single type of stop are evenly split and account for almost all of the shipments.
Shipment Size and Frequency Models

- Small shipments (<1,000 lb) make up the largest proportion of shipments
- There is relatively little variation between the commodities: a slightly higher proportion of food shipments are small
- Annual shipment frequency is calculated by dividing the annual flow for each supplier-buyer pair by the shipment size
Mode and Transfer Results

- Within Chicago movement is all via truck

- Longer movements include significant intermodal elements, including conversion between (for example) FTL and LTL
Mode: Air, Rail, Water, Truck?

Mode: Truck

Buyer at Chicago county 17031 Food manufacturing

Assume last transfer facility always locate in Chicago

Shipment size: 1K ~ 10K lbs
Actual Weight: 5,500 lbs
Annual Frequency: 167

Seller at FAF3 zone 34 Petroleum and coal products manufacturing

Distribution Channel: One of Distribution Center, Warehouse, or Consolidation Center used

Annual Tons: 464 T
Commodity: Plastics and Rubber
Daily Shipments and Warehouse Selection

- Convert annual to daily shipments
- Assign shipments to a warehouse/distribution center
- Identify warehouse/distribution center locations from the synthesized business establishments
Vehicle Choice/Tour Pattern Results

- Results produce the majority of tours using smaller 2 axle trucks
- There are slightly fewer peddling tours than direct tours
Number of Tour and Stops

- The model allocates most shipments to single tour patterns
- Larger shipments are most likely to be in multiple tour patterns
- There is a long tail of tours with many stops
The model predicts that stops will generally be short on peddling tours and long on direct tours.
Advanced freight forecasting practice is still emerging

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Chain</td>
<td>• Representation of complex relationships between suppliers, shippers,</td>
<td>• Variability in relationships makes generalization difficult;</td>
</tr>
<tr>
<td></td>
<td>transshipment points, and consumers;</td>
<td>• Supporting data difficult to obtain;</td>
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<tr>
<td></td>
<td>• Good at representing economic drivers and commodity demand systems</td>
<td>• Missing service-purpose movements</td>
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<tr>
<td>Tour-Based</td>
<td>• Good at representing service vehicle movements and local deliveries in</td>
<td>• Misses inter-city shipments and ties to economic and commodity demand</td>
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<tr>
<td></td>
<td>urbanized areas</td>
<td>demand systems</td>
</tr>
<tr>
<td>Hybrid</td>
<td>• Combines the best of both model types</td>
<td>• Comprehensive data difficult to obtain</td>
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