Statewide Multi-Modal Freight Model

presented to
MTF Freight Modeling Session

presented by
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June 19, 2013

Outline

• Supply Chain and Logistics Models
  – Model steps
  – Integration into statewide model (FSUTMS)
  – Simulating shipments at a statewide level

• Project status and remaining work

• Freight Forecasting Framework
  – Regional truck touring models
  – Integration with supply chain model
**Motivation for the Model**

Enhance Florida’s statewide freight forecasting capabilities
- Represent supply chains and distribution channels
- Include 4 modes and inter-modal connections
- Provide policy sensitivity for buyer and supplier firm choices

**AND**
Provide a framework to support enhancements to regional freight forecasting
- Represent pick-up and delivery systems in regional areas
- Account for empty trucks and non-freight carrying trucks
- Provide sensitivity for firm logistics choices

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**Model Structure Overview**

- Passenger Model
- National Supply Chain Model (Firms, Shipments, Modes)
- Regional Model
- Conversion to modal trip tables
- National/Statewide Networks
- Regional Truck Touring Model
- Regional Networks

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Florida Statewide Model

Regional Model

National Supply Chain Model (Firms, Shipments, Modes)

Conversion to modal trip tables

National/Statewide Networks

Regional Truck Touring Model

Regional Networks

Regional Networks
Statewide Model Framework

- **Firm Synthesis**: Synthesizes a list of businesses in Florida, the rest of the US, and an international sample.
- **Supplier Selection**: Connects suppliers to buyers based on the commodities produced by the supplier and consumed by the buyer.
- **Goods Demand**: Distributes commodity flows amongst the paired suppliers and buyers.
- **Distribution Channel**: For each buyer/supplier pair, selects whether shipments are direct or involve intermediate handling (intermodal, distribution center).
- **Shipment Size**: For each buyer/supplier pair, converts an annual commodity flow to shipments by size and frequency.
- **Mode and Transfers**: Identifies the mode for each leg of the trip from supplier to buyer and the transfer locations.
- **Network Assignment**: Assign the trips to the multi-modal networks based on the mode(s) and transfer locations.

Firms and Commodity Flow Data

- Individual firms are synthesized in each traffic analysis zone (TAZ) based on employment data for each industry (County Business Patterns, InfoUSA, QCEW, and other local data).
- TAZs provide detailed spatial resolution, particularly in metropolitan areas, for firm locations and shipment origins and destinations.
- Across the whole of Florida, the TAZs provide a significant level of detail.
- FAF commodity flow data, a model input, uses large FAF zones. This is disaggregated down to TAZs based on the firm allocations and economic (input/output) data.
Transportation Networks

• Model covers all of Florida and includes transportation networks across the USA and internationally
• Uses newest multi-modal transportation networks: highway, rail, seaports and waterways, airports, and intermodal connections
• Uses network information to understand transportation costs (including storage costs during transshipment), capacities, and resulting travel times
• Model outputs vehicle and commodity flows on networks and through intermodal/distribution centers

Modeling a Shipment Into Florida

Mode: Air, Rail, Water

Shipment size: >10,000 lbs. Actual Weight: 20,000 lbs.
Annual Frequency: 6
Probability of delivery occurring on an average day: 0.8

Distribution Center
One Distribution Center or Consolidation Center

Sold in FAF3 zone 4BC2
524-1125 (Pharmaceutical preparation manufacturers)
Modeling a Shipment Leaving Florida

Mode: Air, Rail, V

Mode Shares in Florida

Mode Share by Value in 2007

- Truck
- Rail
- Multiple modes & mail
- Other and unknown
- Water
- Pipeline
- Air (include truck-air)

0%
20%
40%
60%
80%
100%

Within Florida
Florida to External
External to Florida

Total

7/2/2013
Freight Flows in Florida

Freight Flows Between Florida FAF Zones (2007)

<table>
<thead>
<tr>
<th>Top Commodities (by Weight)</th>
<th>Top Commodities (by Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel 21%</td>
<td>Machinery 17%</td>
</tr>
<tr>
<td>Nonmetal min. prods. 17%</td>
<td>Electronics 9%</td>
</tr>
<tr>
<td>Waste/scrap 9%</td>
<td>Mixed freight 8%</td>
</tr>
<tr>
<td>Gasoline 7%</td>
<td>Motorized vehicles 6%</td>
</tr>
<tr>
<td>Natural sands 6%</td>
<td>Gasoline 6%</td>
</tr>
<tr>
<td>Nonmetallic minerals 3%</td>
<td>Pharmaceuticals 6%</td>
</tr>
<tr>
<td>Logs 3%</td>
<td>Articles-base metal 4%</td>
</tr>
<tr>
<td>Other ag prod. 3%</td>
<td>Misc. mfg. prod. 4%</td>
</tr>
<tr>
<td>Other foodstuffs 3%</td>
<td>Other foodstuffs 3%</td>
</tr>
<tr>
<td>Cereal grains 3%</td>
<td>Precision instruments 3%</td>
</tr>
</tbody>
</table>

Freight Flows to and from Florida

Commodity Flows from Florida

<table>
<thead>
<tr>
<th>Top Commodities (by Weight)</th>
<th>Top Commodities (by Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizers 15%</td>
<td>Electronics 13%</td>
</tr>
<tr>
<td>Other foodstuffs 10%</td>
<td>Precision instruments 9%</td>
</tr>
<tr>
<td>Cereal grains 9%</td>
<td>Pharmaceuticals 8%</td>
</tr>
<tr>
<td>Newspapers/paper 7%</td>
<td>Textiles/leather 7%</td>
</tr>
<tr>
<td>Waste/scrap 6%</td>
<td>Motorized vehicles 7%</td>
</tr>
<tr>
<td>Other ag prod. 5%</td>
<td>Misc. mfg. prod. 6%</td>
</tr>
<tr>
<td>Basic chemicals 5%</td>
<td>Machinery 6%</td>
</tr>
<tr>
<td>Nonmetallic minerals 5%</td>
<td>Other foodstuffs 4%</td>
</tr>
<tr>
<td>Wood products 4%</td>
<td>Mixed freight 4%</td>
</tr>
<tr>
<td>Nonmetal min. prods. 3%</td>
<td>Transport equip. 3%</td>
</tr>
</tbody>
</table>

Commodity Flows to Florida

<table>
<thead>
<tr>
<th>Top Commodities (by Weight)</th>
<th>Top Commodities (by Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal 18%</td>
<td>Electronics 14%</td>
</tr>
<tr>
<td>Coal-n.e.c. 14%</td>
<td>Motorized vehicles 10%</td>
</tr>
<tr>
<td>Gasoline 9%</td>
<td>Textiles/leather 7%</td>
</tr>
<tr>
<td>Other foodstuffs 5%</td>
<td>Misc. mfg. prod. 7%</td>
</tr>
<tr>
<td>Fertilizers 4%</td>
<td>Pharmaceuticals 6%</td>
</tr>
<tr>
<td>Fuel oils 4%</td>
<td>Machinery 5%</td>
</tr>
<tr>
<td>Nonmetal min. prods. 4%</td>
<td>Mixed freight 5%</td>
</tr>
<tr>
<td>Wood products 3%</td>
<td>Precision instruments 4%</td>
</tr>
<tr>
<td>Basic chemicals 3%</td>
<td>Plastics/rubber 4%</td>
</tr>
<tr>
<td>Newspapers/paper 2%</td>
<td>Other foodstuffs 3%</td>
</tr>
</tbody>
</table>

Note: Including Total flows
Source: FAF3
Freight Flows by Mode to and from Florida

Freight Flows into Florida

Commodities by Mode (Weight in Kttons in 2007)

Florida to Houston

Freight Flows into Florida (2007)

Commodities by Mode (Weight in Kttons in 2007)

Houston to Florida

Freight Flows by Mode to and from Florida

Commodities by Mode (Weight in Kttons in 2007)
Gasoline imports arrive at ports and are mainly distributed in the region close to the port, with relatively small amounts trucked to other regions.

Freight Forecast Growth (2007 to 2040)

- FHWA’s FAF includes forecasts out to 2040
- High growth forecast in outbound flow from Florida
Statewide Policy Sensitivity

- Changes in land use and economy
  - Spatial distribution of employment and mix of industries
- Changes in transportation supply
  - Major highway network changes
  - Changes to rail capacity
  - Intermodal facility capacity changes, including deep water ports and airports
- Changes in distribution center network
  - New facilities (with regional significance)
- Changes in commodity flow origins and destinations outside Florida

Project Status and Next Steps

- Developed data inputs and assumptions
- Developed multimodal networks (rail, air, water, truck)
- Integrated supply chain models with FSUTMS passenger travel models
- Developed validation data by mode
- Calibration and validation of freight models underway
- Scheduled to complete in October 2013
Regional Model Framework

- Shipment Flows (from Statewide Model)
- Vehicle and Tour Pattern Choice
- Number of Tours and Stops in each Tour
- Stop Sequence and Stop Duration
- Tour Start Time and output of Trip List

Truck Touring Models

- Implemented in Chicago region for CMAP as part of FHWA project
- Model links shipment deliveries and pick-ups together into truck tours
- Tours built for different truck types and for different patterns: single stop, single loops, several returns to warehouse
- Output is a trip schedule similar to that from an activity-based model of personal travel
Regional Policy Sensitivity

- **Regional model input** is the output from the statewide model, so statewide model’s sensitivity feeds through to regional model
- Local (more detailed) distribution of employment and land use affects local truck travel patterns
- Local changes in transportation supply, non-truck traffic growth causing congestion, and resulting truck travel times
- Local policies such as truck routes, truck prohibitions, delivery windows, and size limits can be modeled

Connections to the Statewide Model

- Statewide model is designed to be integrated with regional models
- Statewide model develops shipment paths including transfer locations and modes, and intercity truck movements
- Statewide model outputs include a list of regional shipment pick-ups and deliveries that must be met in a given day: that can then be microsimulated in the regional model
- Possible modes of operation
  - Integrate complete statewide model with regional model and run models sequentially
  - Provide an extract from the statewide model of regional shipment demand and run the regional model separately
Regional Model Implementation

- Data needs: establishment surveys and truck surveys (travel behavior inventory) to support regional model development and calibration
- Pilot a regional truck model in partnership with an MPO/District, integrated within their regional model
- Consider further regional implementations

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