Advanced Goods Movement Model Framework

presented to

Florida Model Task Force Meeting

presented by

Maren Outwater

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Overview

- Advances in Freight Forecasting
  - Supply Chain Models
  - Tour-based Models
  - Hybrid Models
- FHWA Research on a Freight Forecasting Framework
- Recommendations for a Goods Movement Framework
  - Statewide/National
  - Regional/Urban

Advanced Freight Forecasting Methods

- **Supply Chain Models**
  - **Tend to be National in scope**
  - **Some examples at State and Regional levels**
- **Tour-based Models**
  - **Tend to be Regional in scope**
  - **Some examples at State and National levels**
- **Hybrid Models**
  - **Combined supply chain and tour-based models**
  - **Tend to be for Regional planning purposes, but with a National component**

U.S. FAME Framework

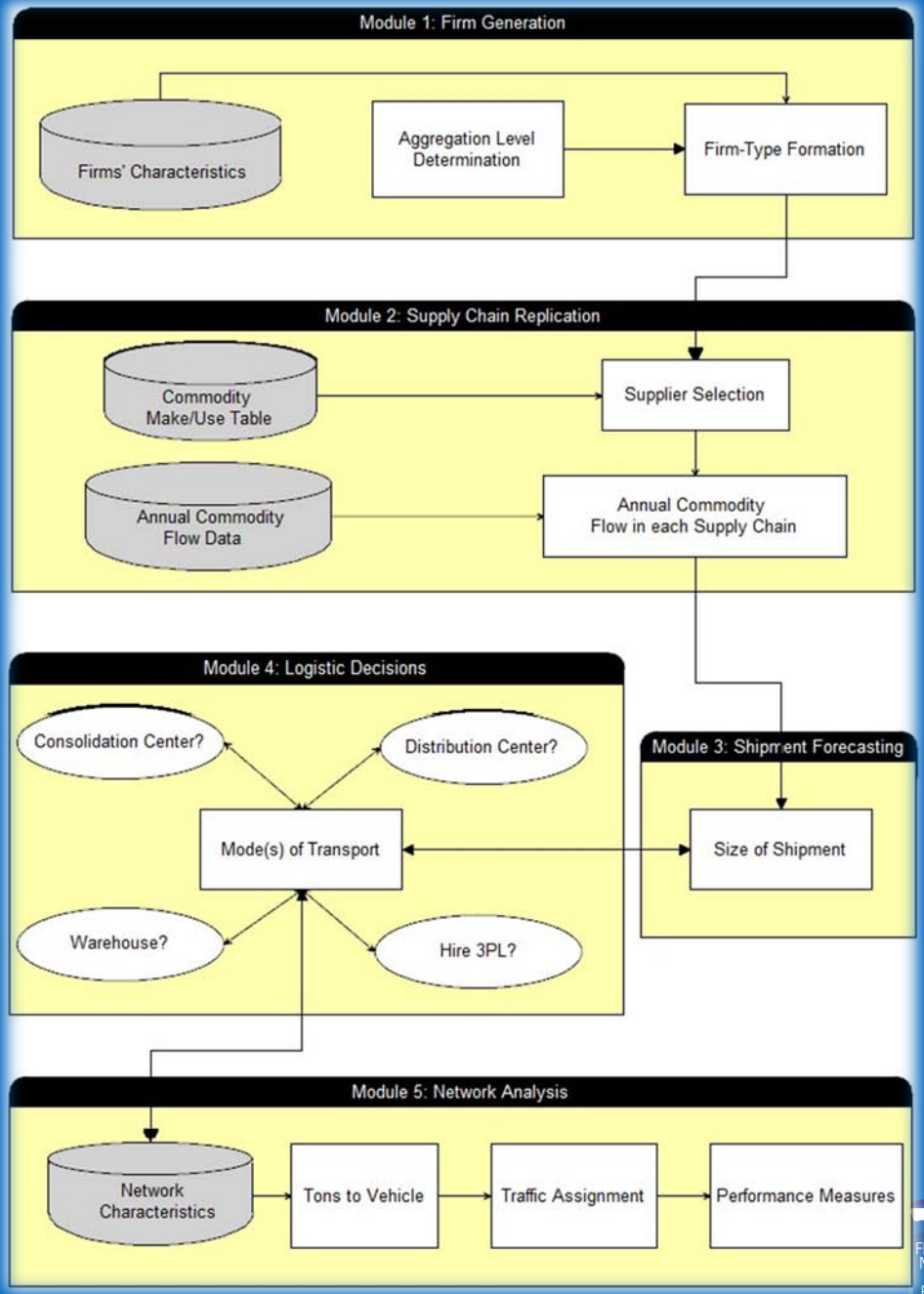
FAME

FREIGHT

ACTIVITY

MICROSIMULATION

ESTIMATOR



Freight Activity Microsimulation Estimator (FAME)

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.

Source: Amir Samimi, Abolfazl (Kouros) Mohammadian and Kazuya Kawamura

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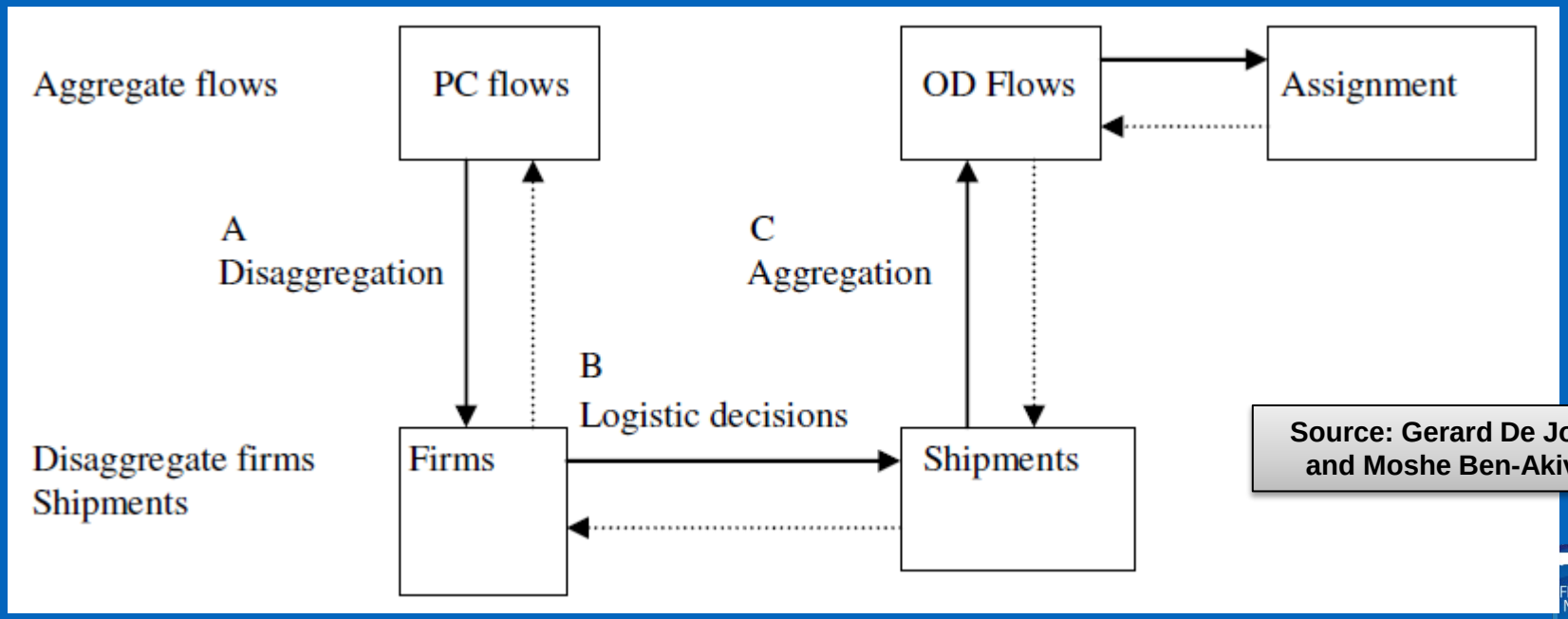
Norway and Sweden National Freight Models

- 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

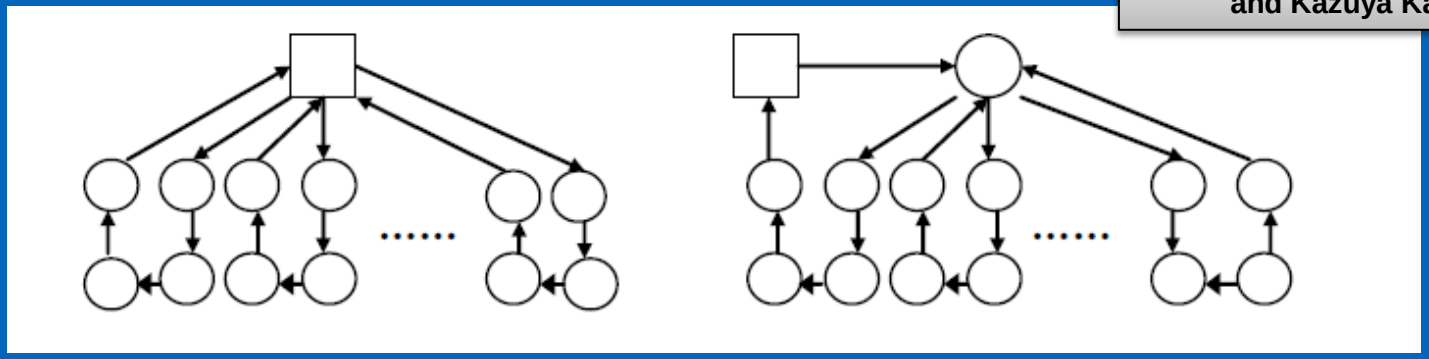


Source: Gerard De Jong and Moshe Ben-Akiva

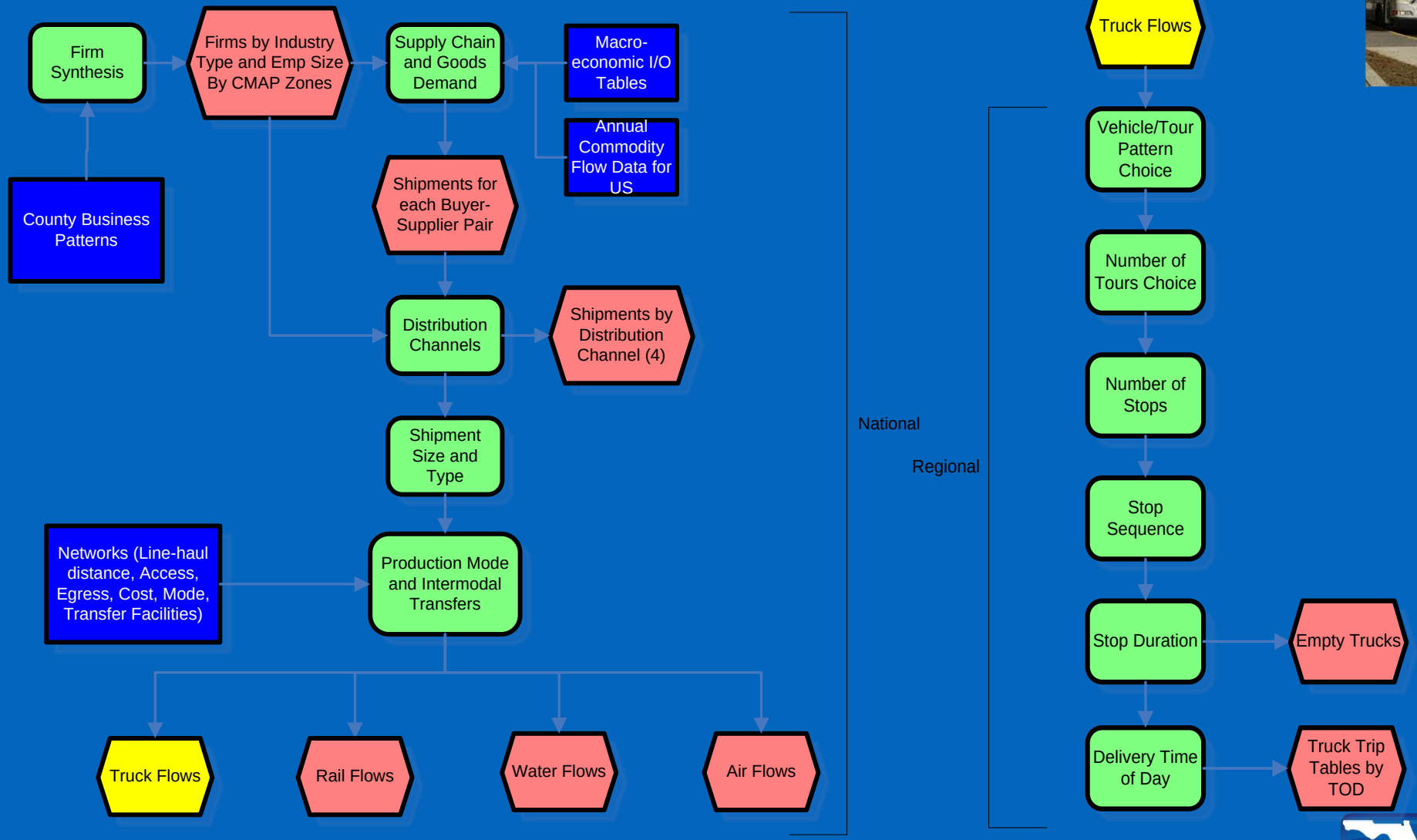
Texas Urban Commercial Vehicle Model

- Data are from the Texas Commercial Vehicle Surveys in San Antonio, Amarillo Valley, Lubbock and Austin during 2005 and 2006, which included 13,802 trips made by 1,711 commercial vehicles
- Models daily tour choice with a joint discrete choice model
- Each tour is defined as the entire trip chain in a given day
- Schedule choices for each tour are classified into 8 classes defined by: vehicle type, departure time, and trip chaining pattern/topology

Source: Minyan Ruan, Jie (Jane) Lin and Kazuya Kawamura



FHWA Freight Forecasting Framework



Summary of Advance Forecasting Methods

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

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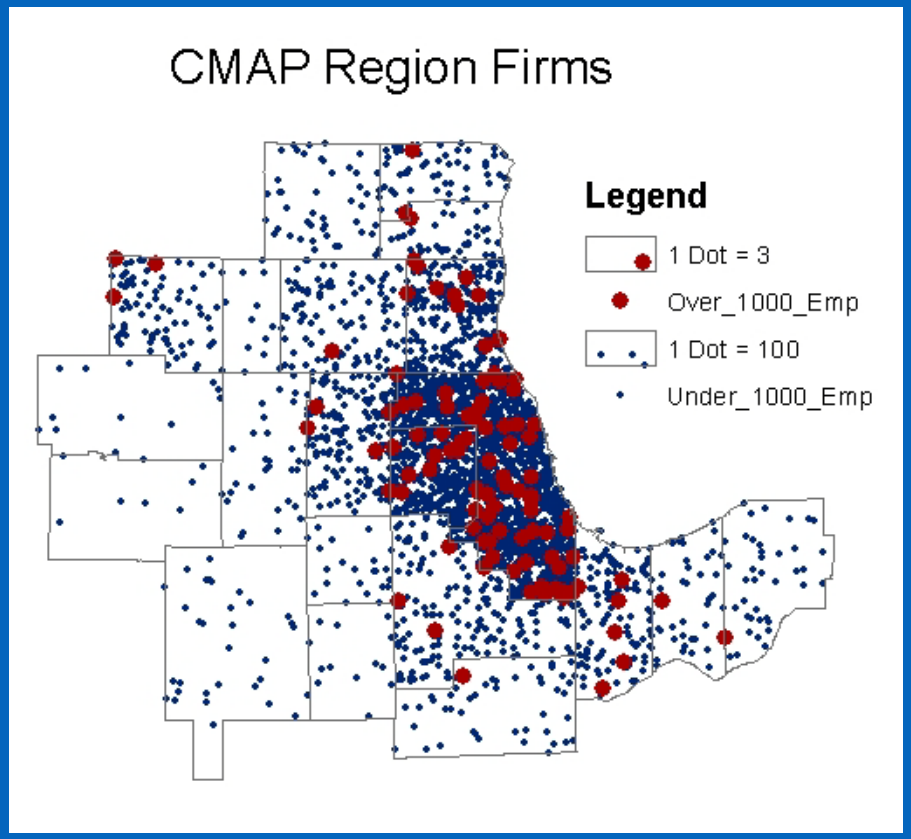
Freight Forecasting Framework National Scope

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)
- Spatial resolution is less detailed that is used regionally as counties are larger than the CMAP mesozones. Allocation from Counties to mesozones is based on mesozone employment

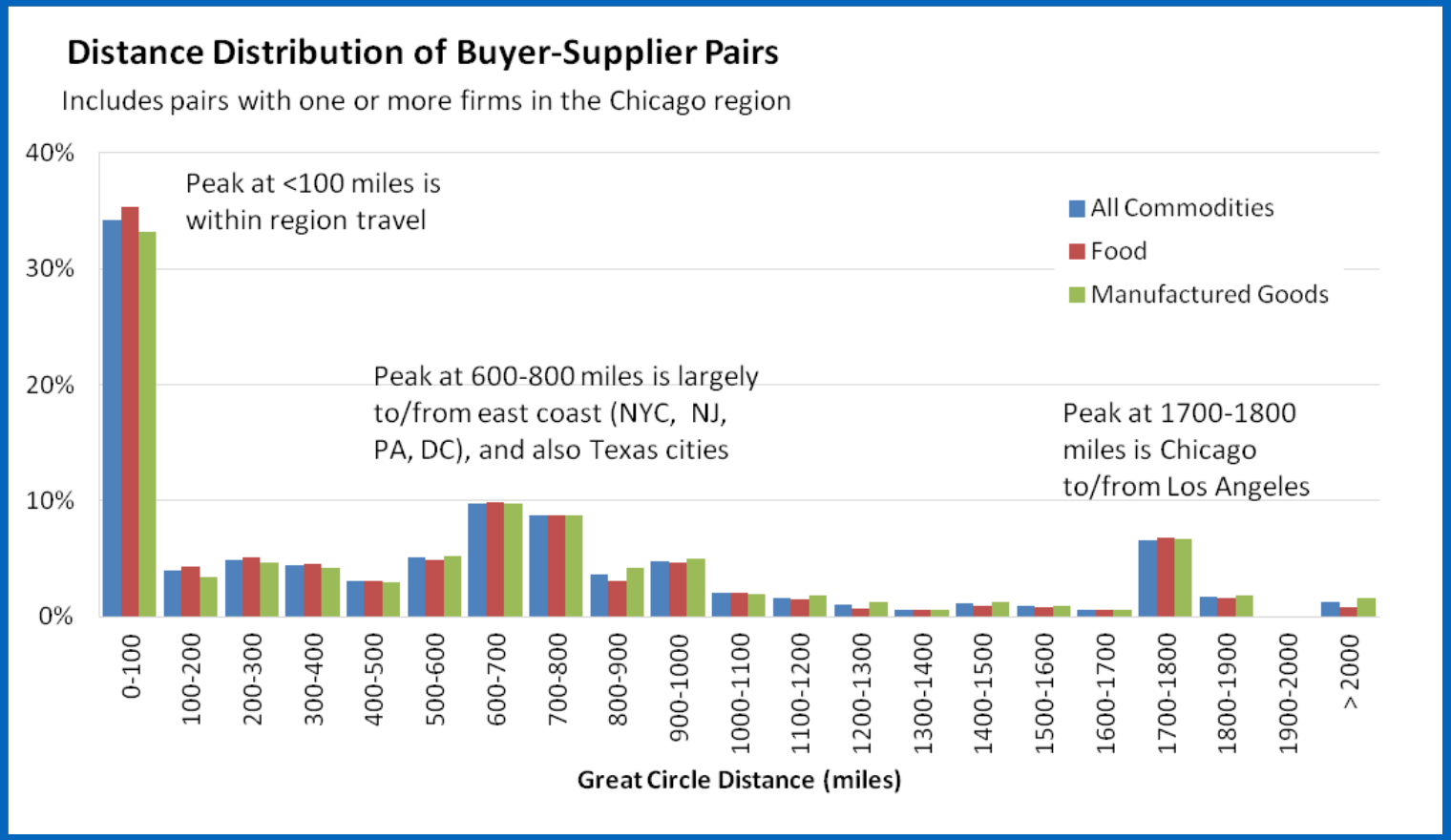


Firm Synthesis by Industry and Size

NAICS Groups	1-19	20-99	100-249	250-499	500-999	1,000-2,499	2,500-4,999	Over 5,000	Total
Agriculture	631,703	83,328	11,941	2,897	954	382	46	13	**731,264**
Mining\Construction	774,697	73,607	10,090	3,711	2,363	1,900	1,744	1,716	**869,828**
Manufacturing	228,381	74,451	18,942	6,170	2,384	828	143	49	**331,348**
Transportation\ Wholesale\Retail	1,518,135	214,956	34,082	7,305	1,536	393	71	34	**1,776,512**
Information\Finance\ Professional Services	2,094,868	186,140	32,431	10,141	4,336	1,737	295	97	**2,330,045**
Education\ Healthcare	731,344	110,504	20,120	4,523	2,168	1,748	435	157	**870,999**
Entertainment\ Recreation\Food	558,052	186,140	11,069	1,522	576	269	43	15	**757,686**
Other Services	694,640	45,377	3,409	548	163	40	12	3	**744,192**
Total	**7,231,820**	**974,503**	**142,084**	**36,817**	**14,480**	**7,297**	**2,789**	**2,084**	**8,411,874**

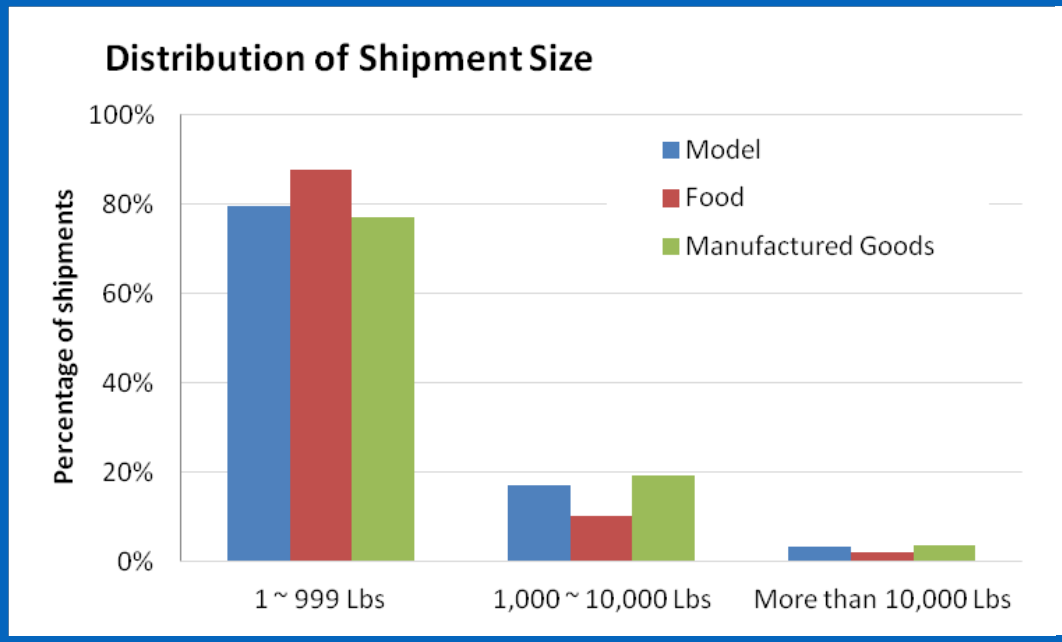
Supplier Selection Results

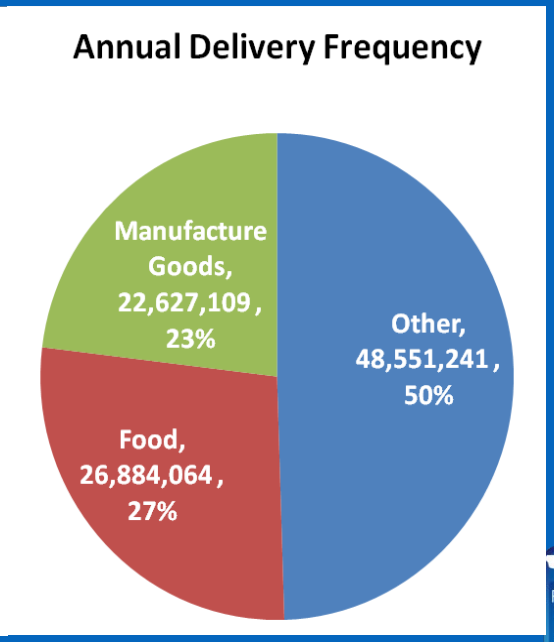
- **The model builds 2.8 million buyer-supplier pairs with one of the pair in the Chicago region**
- **The distance distribution of buyer-supplier pairs reflects the spatial distribution of commodity flows**



Shipment Size and Frequency Models

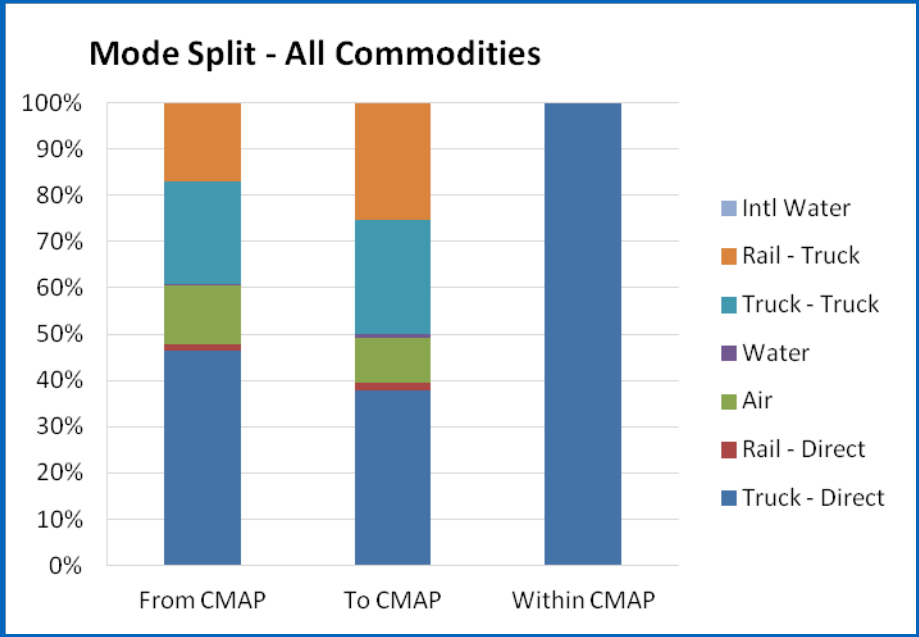
- Small shipments (<1,000 lb) make up the largest proportion of shipments
- There is relatively little variation between the commodities: a slightly higher proportion of food shipments are small
- Annual shipment frequency is calculated by dividing the annual flow for each supplier-buyer pair by the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



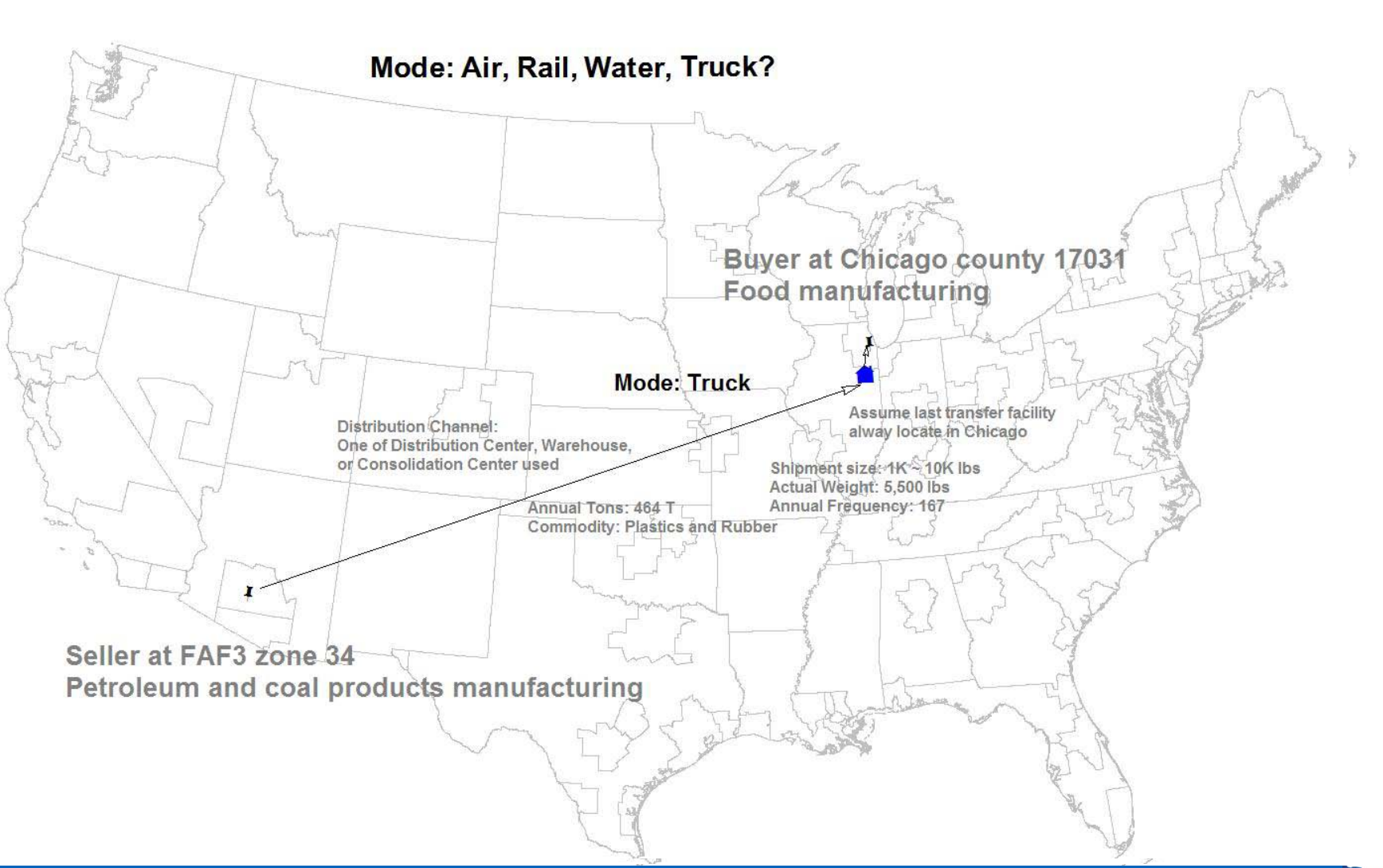


Mode and Transfer Movements

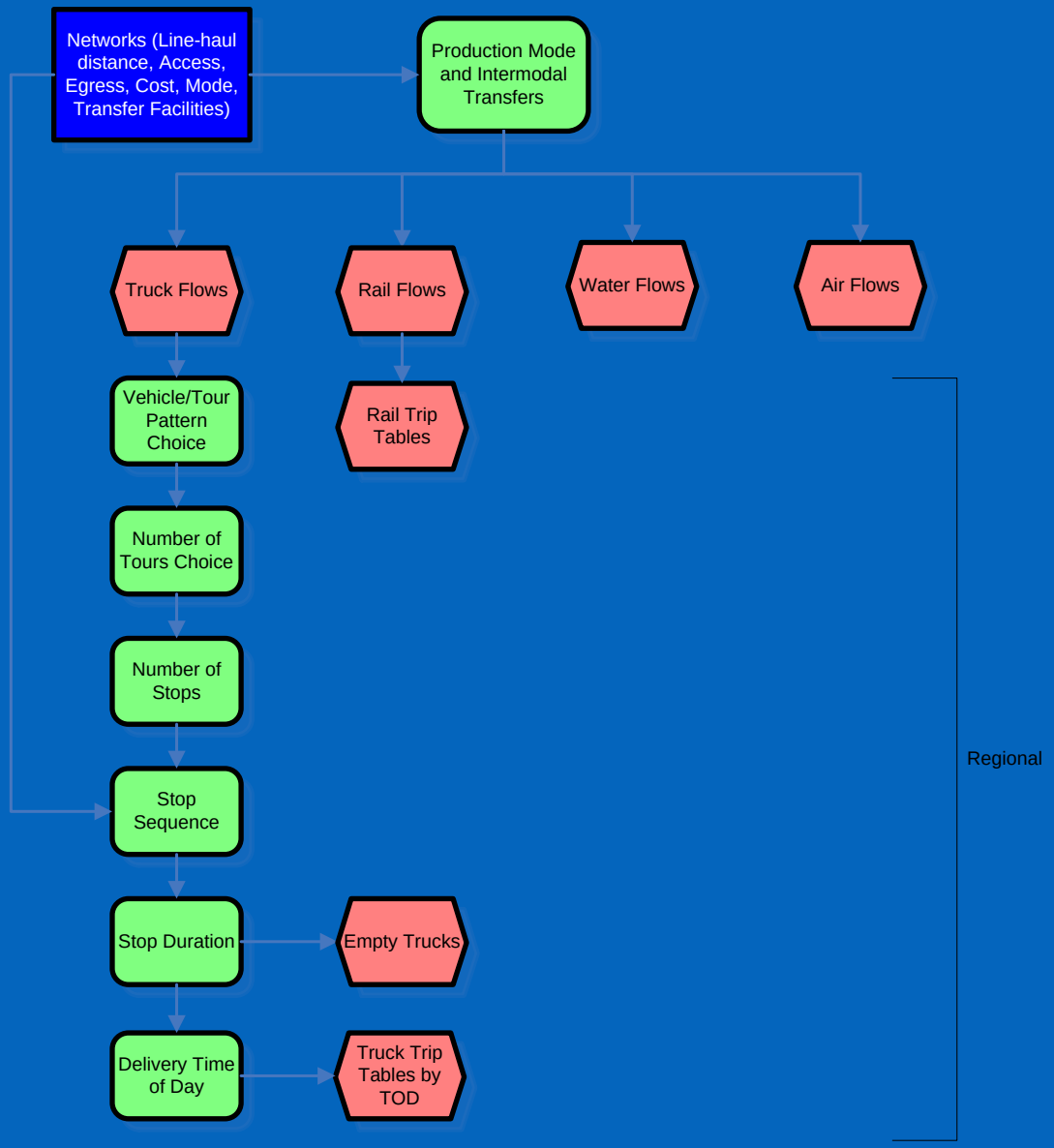
- Within Chicago movement is all via truck
- Longer movements include significant intermodal elements, including conversion between (for example) FTL and LTL



National Model Sequence

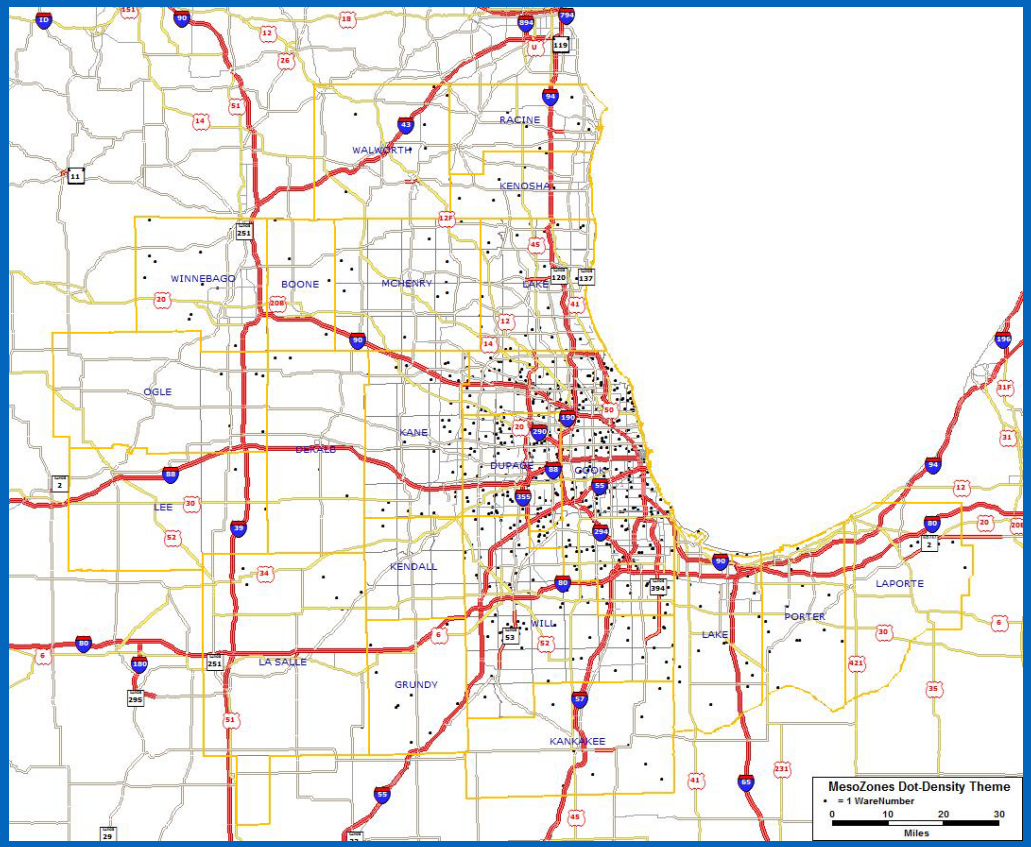


Freight Forecasting Framework Regional Scope



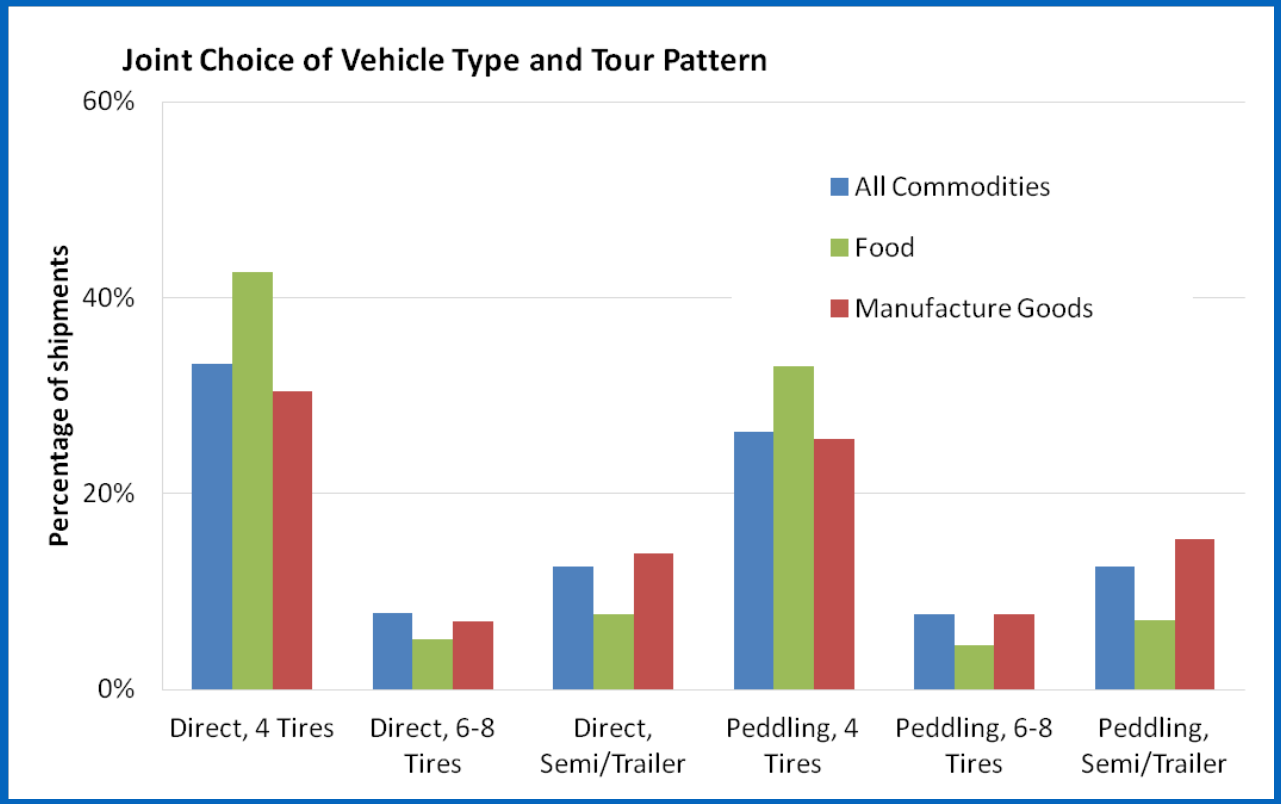
Daily Shipments and Warehouse Selection

- Convert annual to daily shipments
- Assign shipments to a warehouse/ distribution center
- Identify warehouse/ distribution center locations from the synthesized business establishments



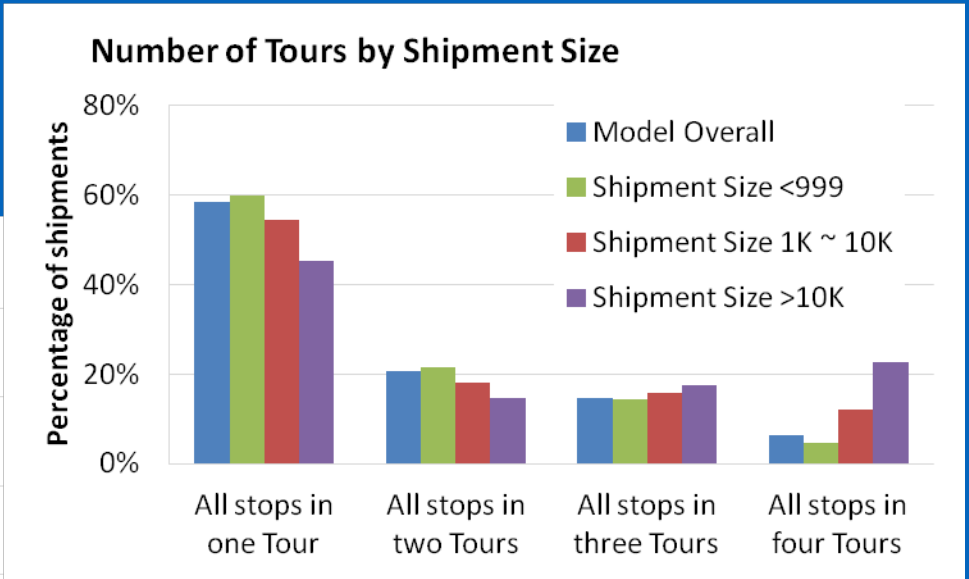
Vehicle Choice/Tour Pattern Results

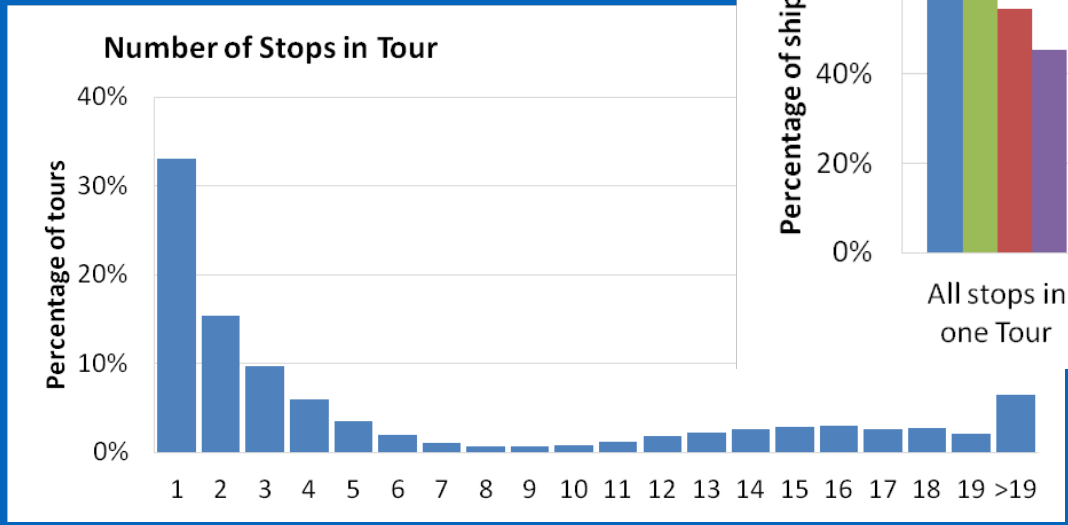
- Results produce the majority of tours using smaller 2 axle trucks
- There are slightly fewer peddling tours than direct tours



Number of Tours and Stops

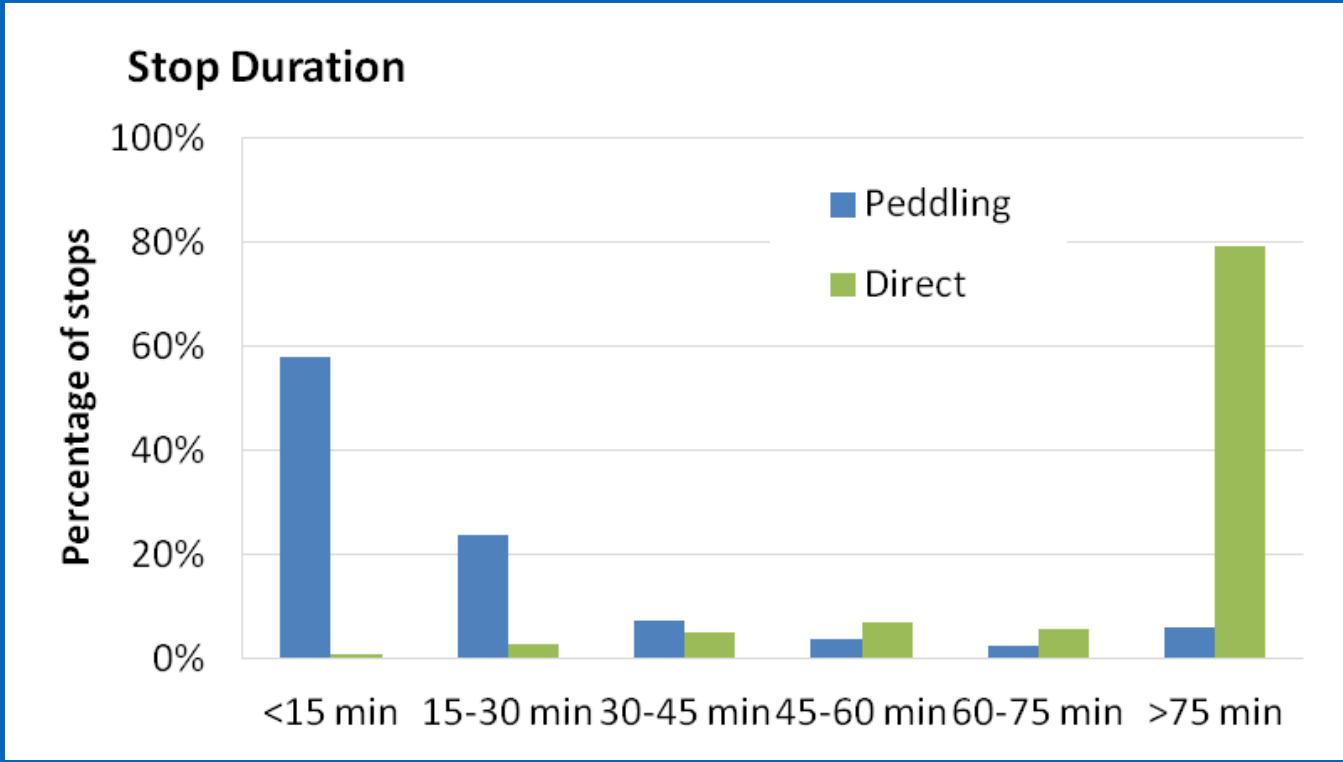
- The model allocates most shipments to single tour patterns
- Larger shipments are most likely to be in multiple tour patterns
- There is a long tail of tours with many stops (this is discussed in more detail later in the presentation)



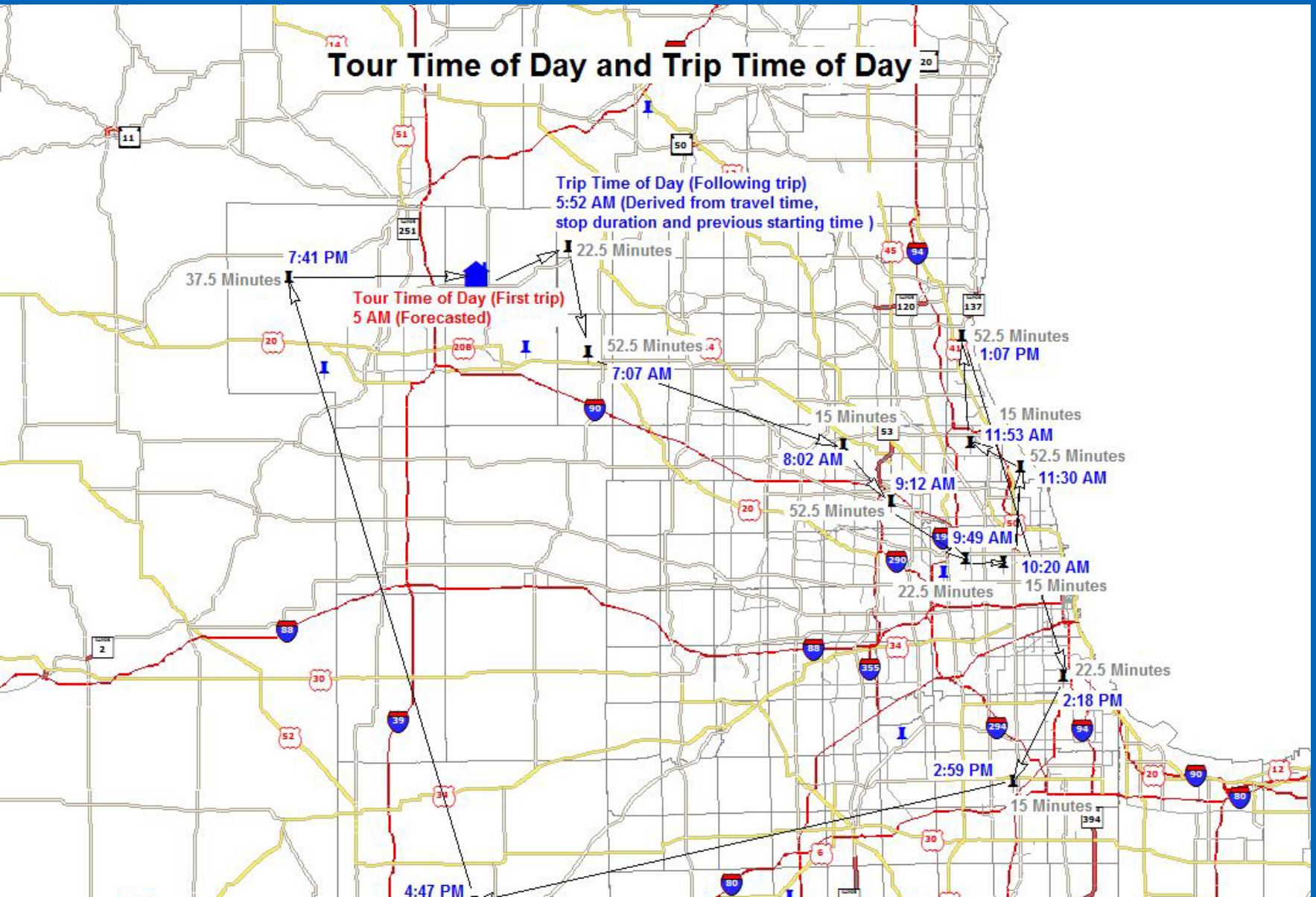


Stop Duration

- The model predicts that stops will generally be short on peddling tours and long on direct tours



Regional Model Sequence



Recommendations for FDOT Statewide Models

- Enhance with the supply chain features of the FHWA framework
  - Synthesizing firms and selecting suppliers
  - Segmenting by distribution channels
  - Mode choice can be enhanced by path choice and shipment size and frequency and transfer facility details
- Models could be estimated from existing data sources and calibrated to statewide conditions
- FDOT could support national data collection efforts

Recommendations for FDOT Regional Models

- Build tour-based vehicle models for each region
  - Vehicle type and tour patterns
  - Number of tours and stops
  - Stop duration and time of day
- Models could be estimated from existing data (Texas) and calibrated to local conditions
- Data could be collected for all metropolitan areas in Florida to support model estimation

Data Requirements for Application

- Freight Analysis Framework data (FAF3)
- County Business Patterns
  - Firms by industry and size
  - Additional data on agriculture and construction employment helpful
- Macroeconomic Input/Output tables
  - Producer and consumer connections
- Modal Networks (Highway, Rail, Air, Water)
  - Distance, access and egress times, cost
  - Intermodal and transfer facilities

Regional Surveys of Vehicle Tours

- Survey distribution centers and business establishments in the region
- Collect information on the movements of establishment's fleet over a 24 hour time period
- Collect detailed truck tour information
  - Vehicle type
  - Day and tour pattern
  - Tour timing
  - Location and duration of stops
  - Commodities
- Use supplemental SP survey to estimate values of time

Contact Information

Maren Outwater
Resource Systems Group, Inc
maren.outwater@rsginc.com
414-446-5402
www.rsginc.com/transportation/

Colin Smith
Resource Systems Group, Inc
colin.smith@rsginc.com
802-295-4999
www.rsginc.com/transportation/