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Tour-based and Supply Chain Modeling for Freight in Chicago

Prepared for:
CMAP Pre-Symposium Webinar on Advanced Modeling

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Project Goal and Acknowledgements

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Project Goal

Identify a framework that can be adopted by MPOs in the U.S. for use in evaluating transportation investments and their impacts on freight mobility.

Acknowledgements

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Project Motivation

Address current weaknesses identified in standard practice freight forecasting

- The lack of detail at the traffic analysis zone level
  - Synthesize firms and goods movements at the zone level
- The lack of information about the local pickup and delivery trips
  - Specifically model the delivery system at the end of the supply chain
- The need to estimate shifts in long-haul and short-haul demand resulting from regional investments
  - Connect movements from supplier to buyer by modeling in a single framework
- The ability to capture trip-chaining that occurs
  - Represent distribution channels in the supply chain and touring during deliveries
- The need to represent commodities produced and consumed by different industries
  - Represent commodity movements as links between buyers and suppliers

Advanced Freight Forecasting Models

3 Types Emerging

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

Hybrid Models
- Combined supply chain and tour-based models
- For Regional/Statewide planning, but with a National component

▪ Mode and path selection

eling truck movements

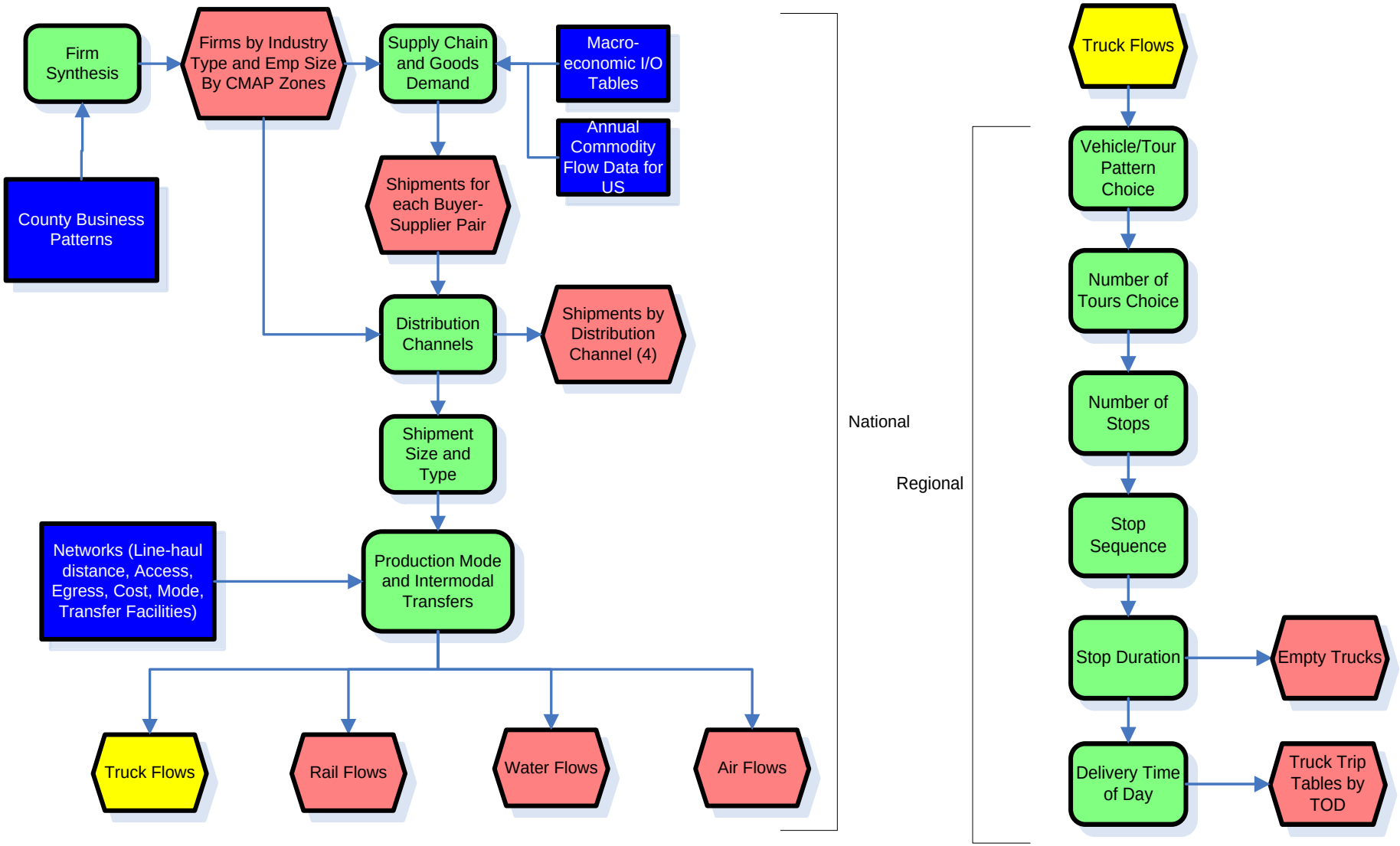
ents such as tour generation,

dels, and time of days models

incrementally

- Models shipments using the supply chain framework
- Regional pick up and delivery of shipments is handled by touring trucks

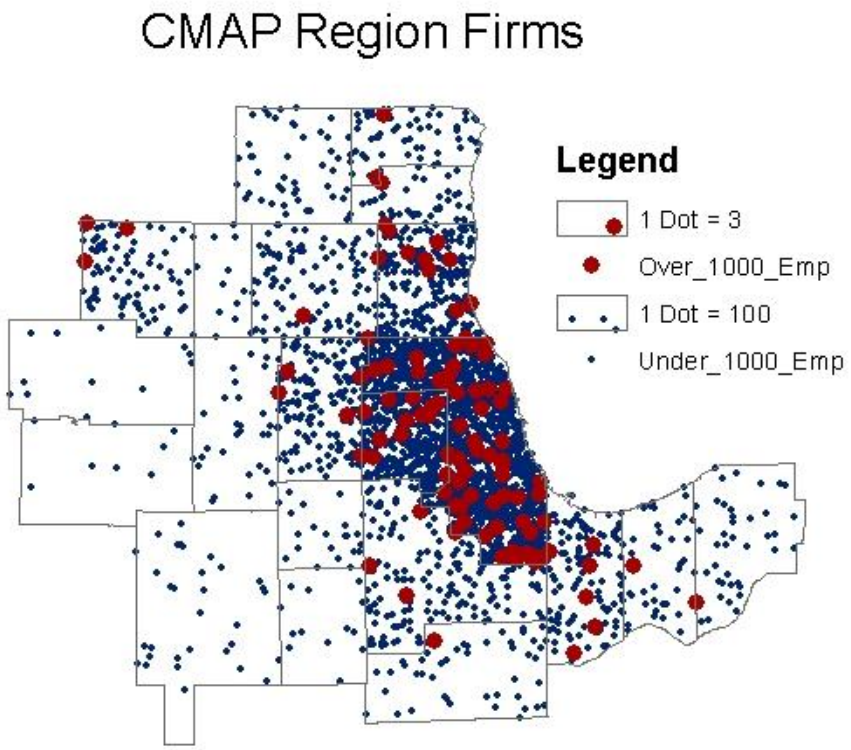
FHWA Freight Forecasting Framework in Chicago



National Supply Chain Models

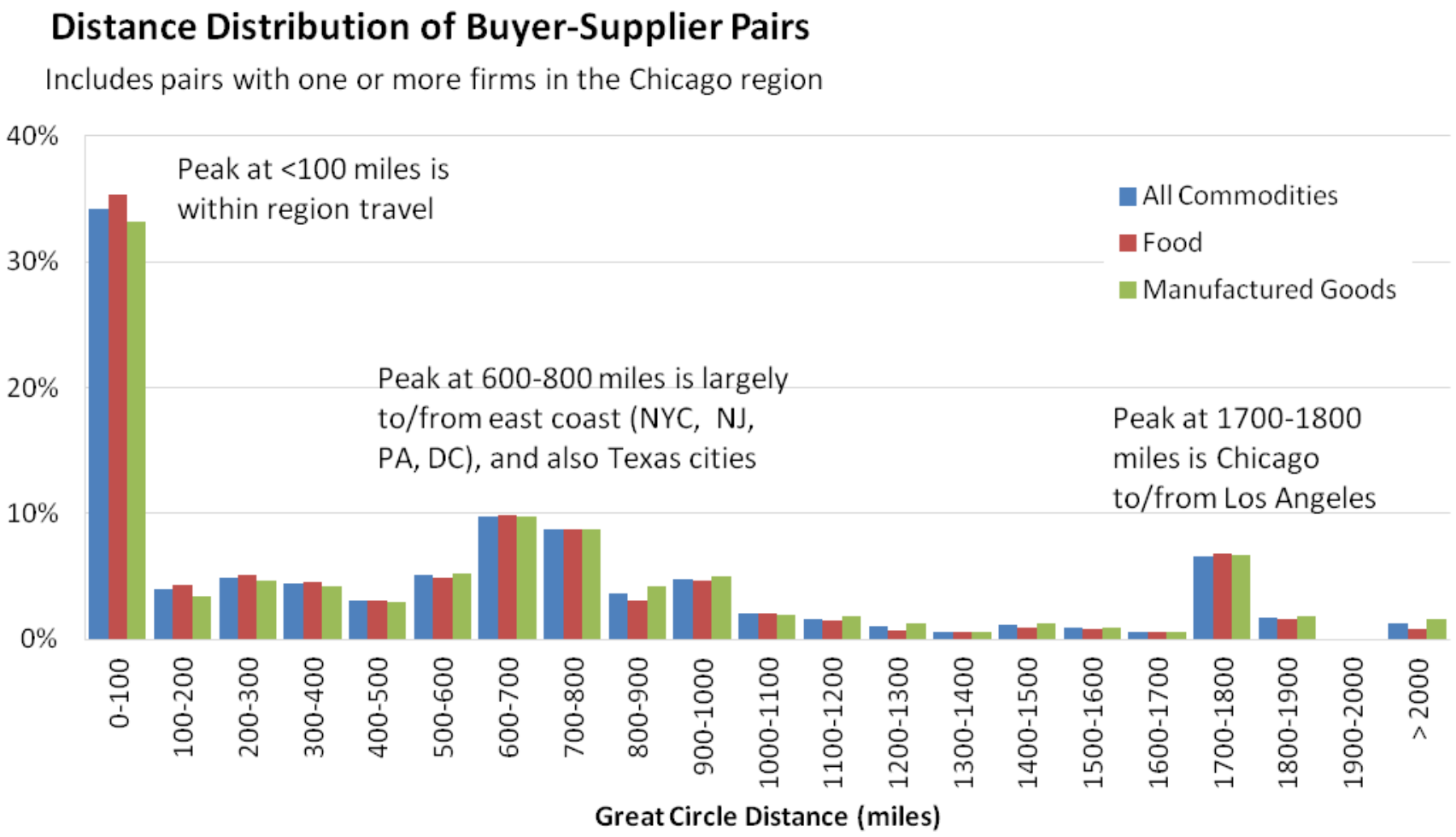
Firm Synthesis

- 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)



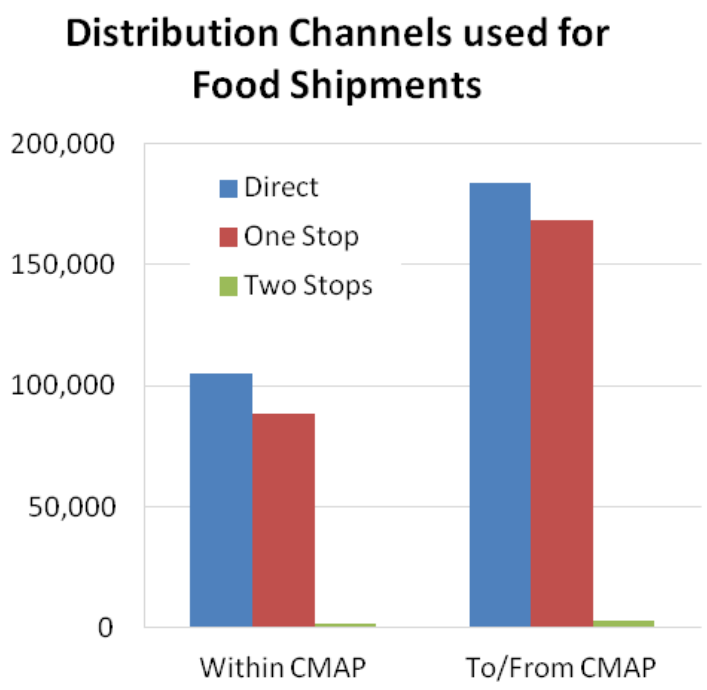
Supplier Selection Results

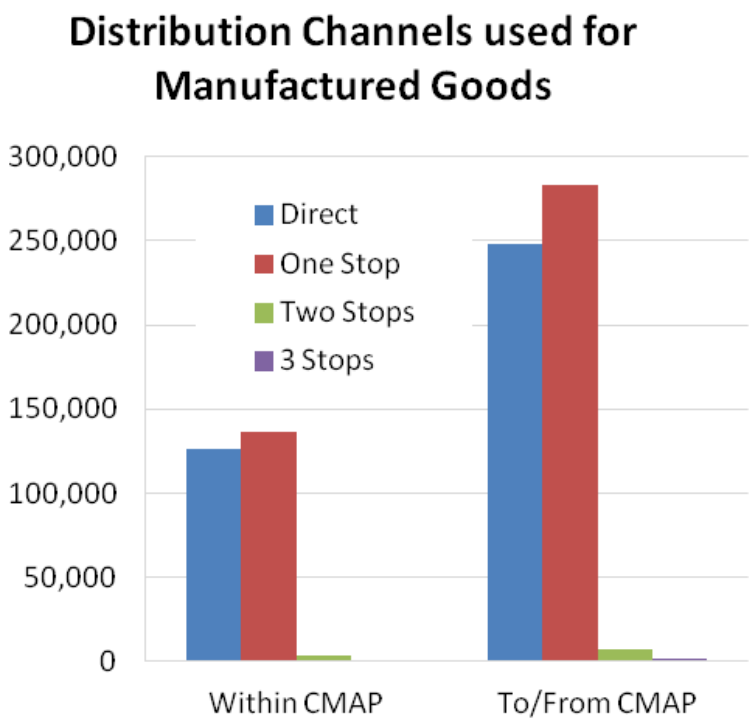
- The model builds 2.8 million buyer-supplier pairs with one of the pair in the Chicago region
- The distance distribution of buyer-supplier pairs reflects the spatial distribution of commodity flows



Distribution Channel Results

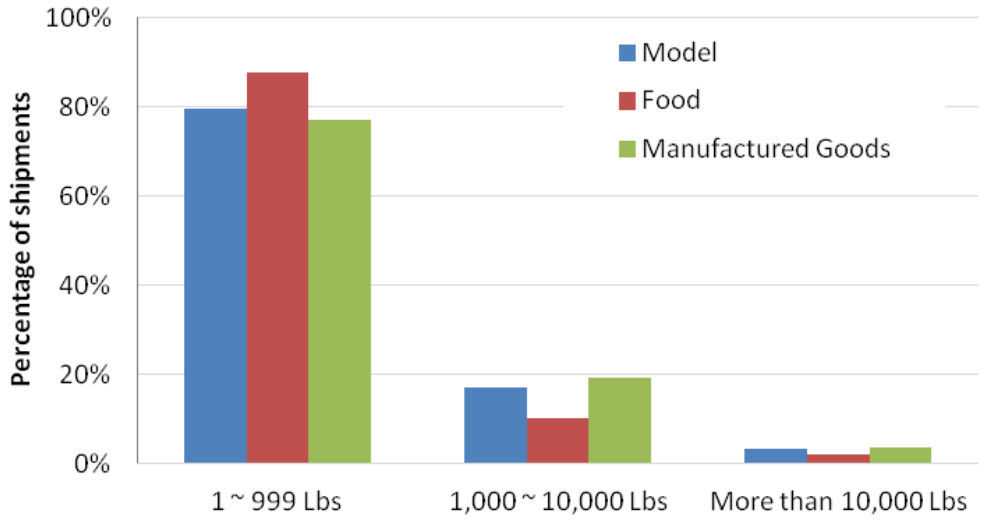
Direct distribution channels and channels involving a single type of stop are evenly split and account for almost all of the shipments

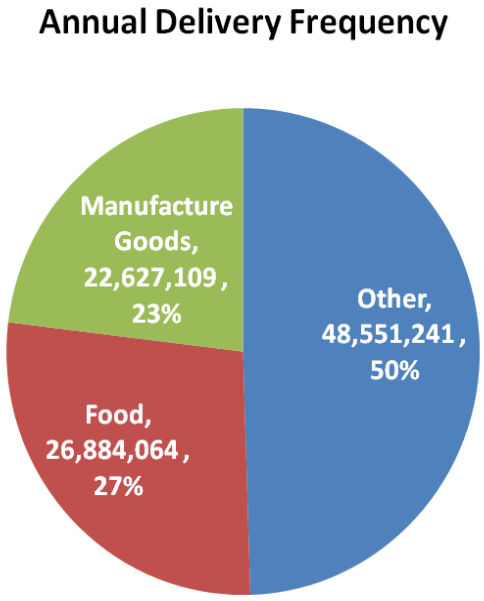




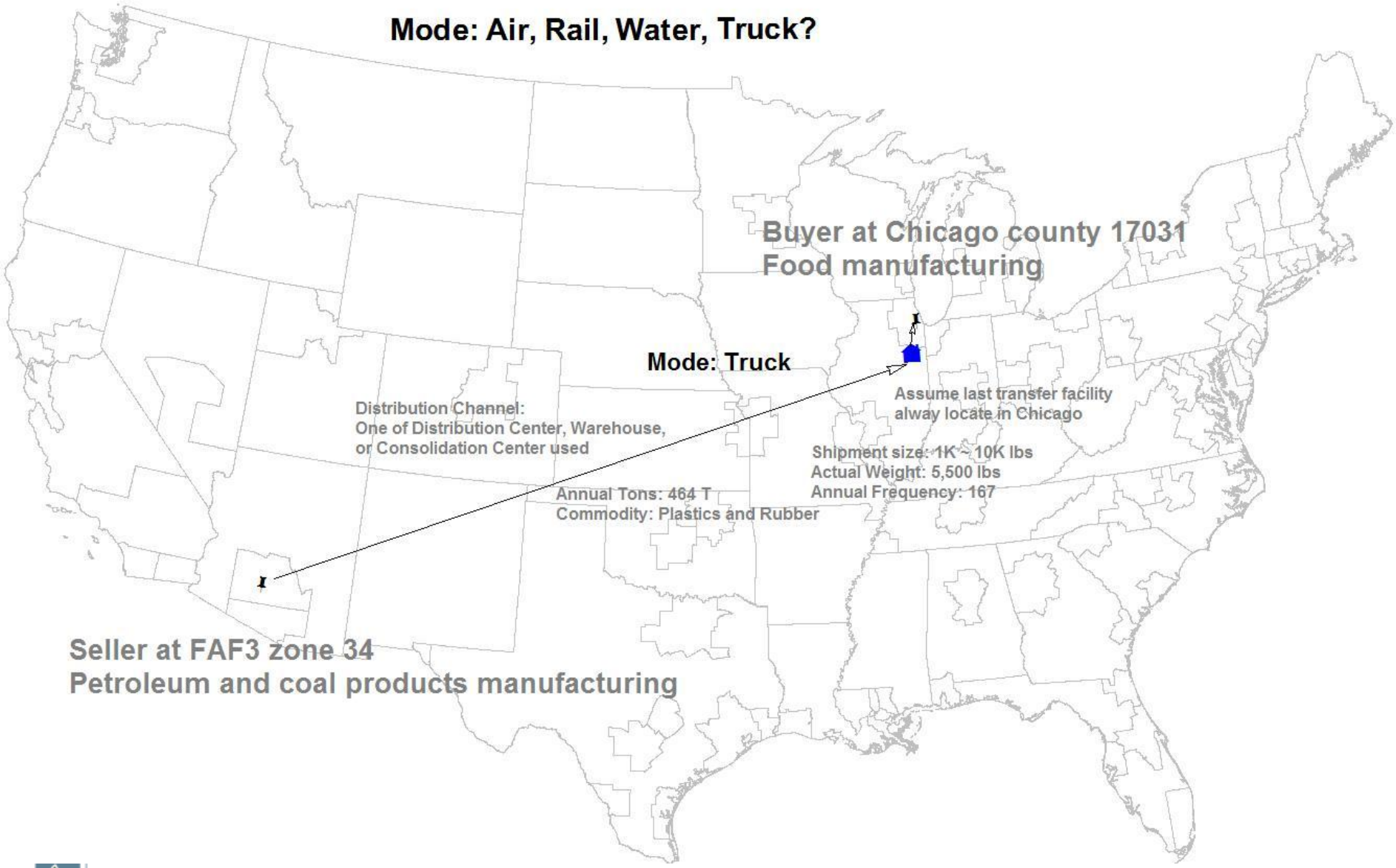
Shipment Size and Frequency Models

- 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





National Model Sequence



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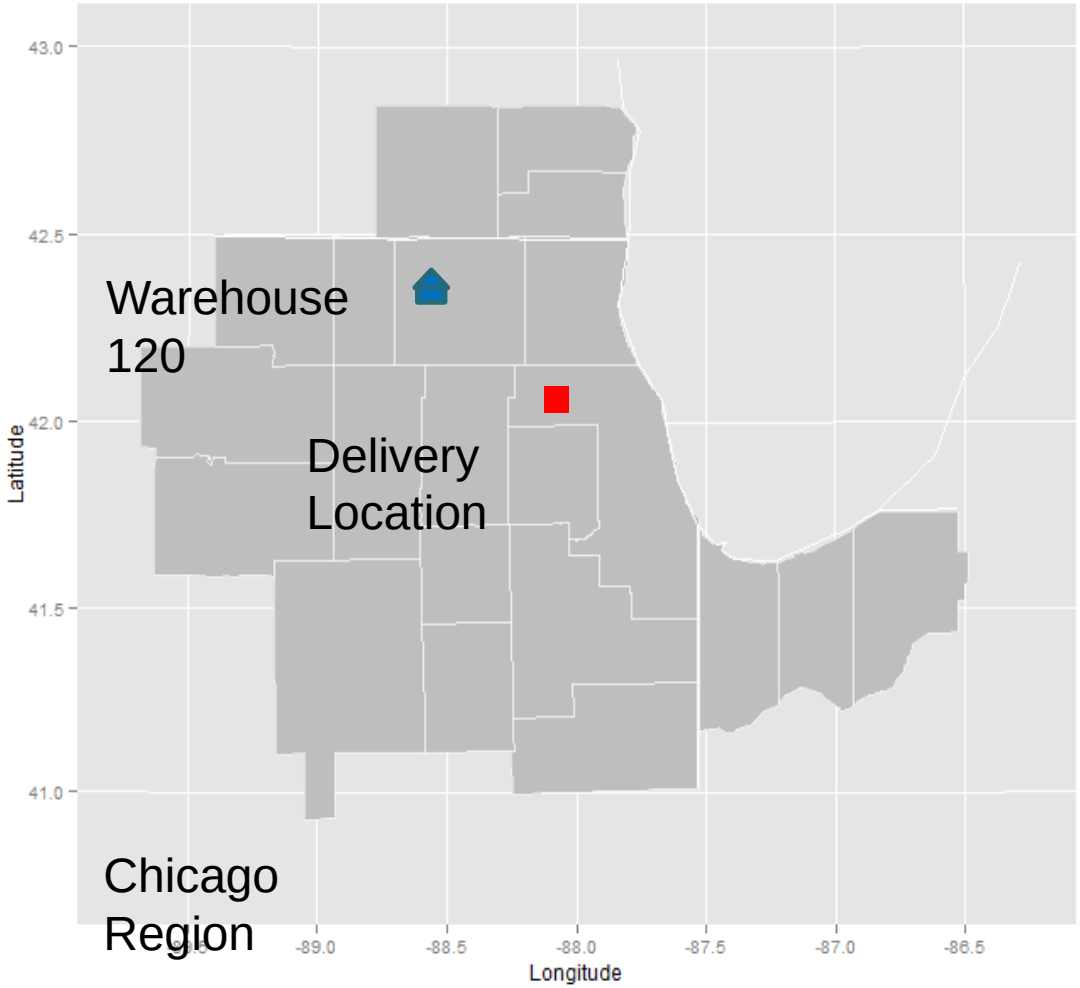
Regional Tour-based Models

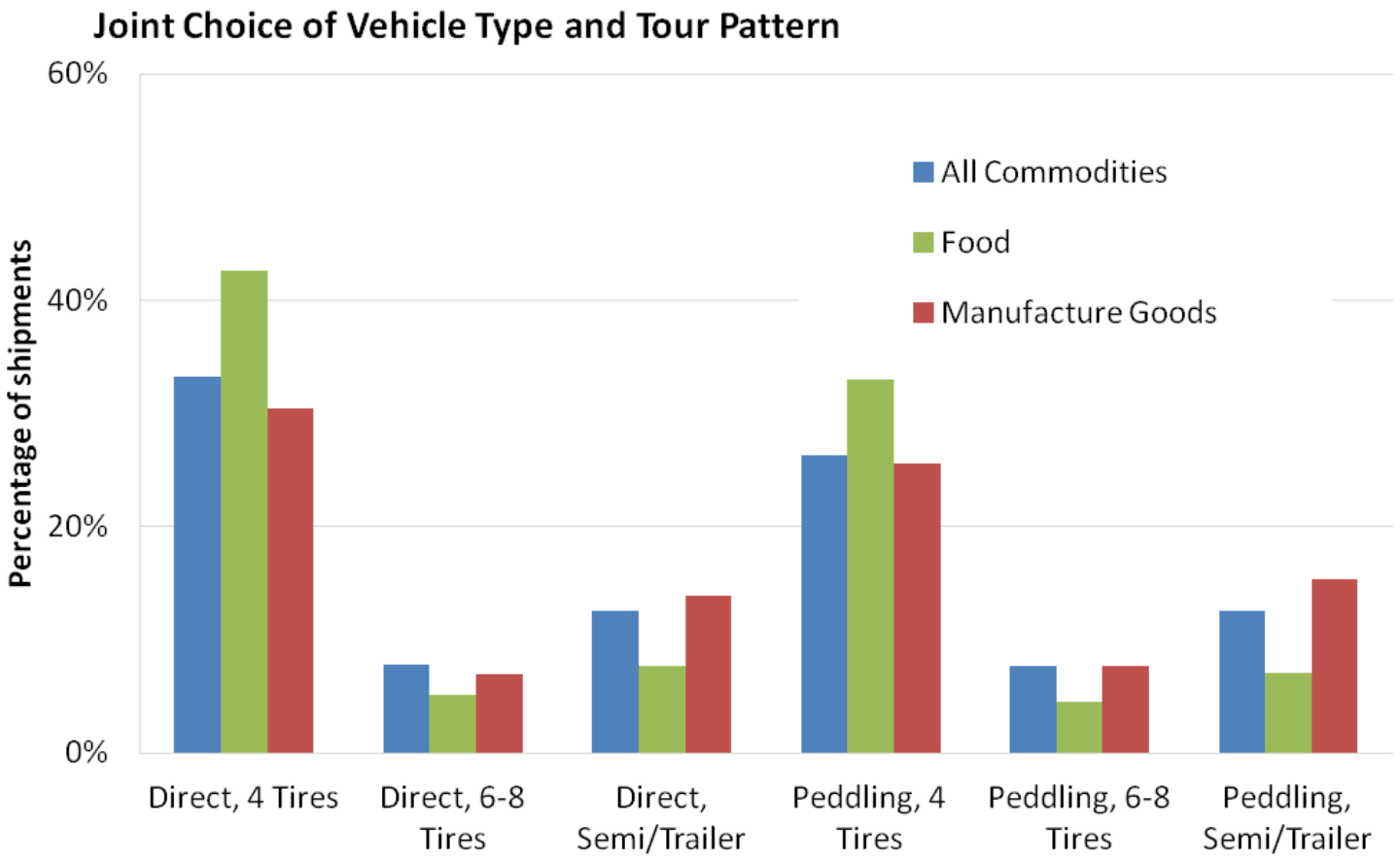
Convert to Daily Shipments and Select Warehouse



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

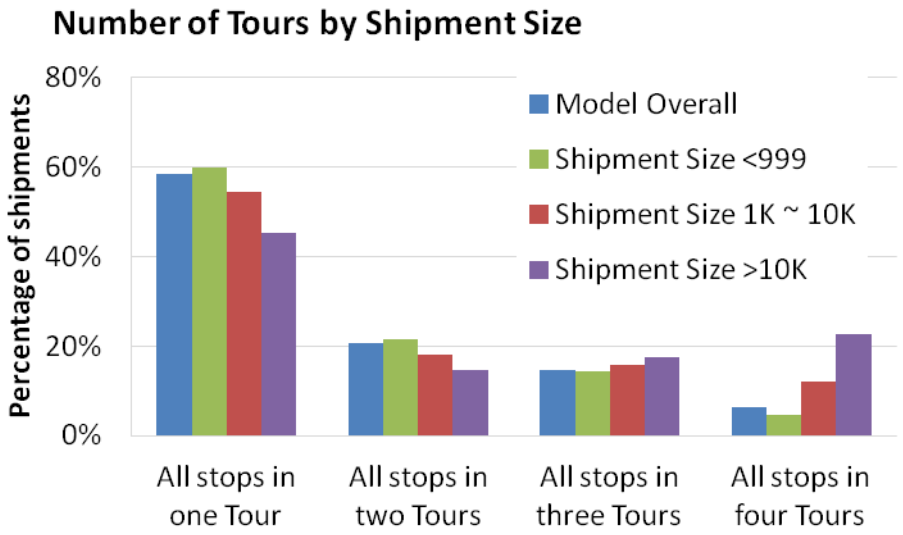
Select Vehicle Type and Tour Pattern

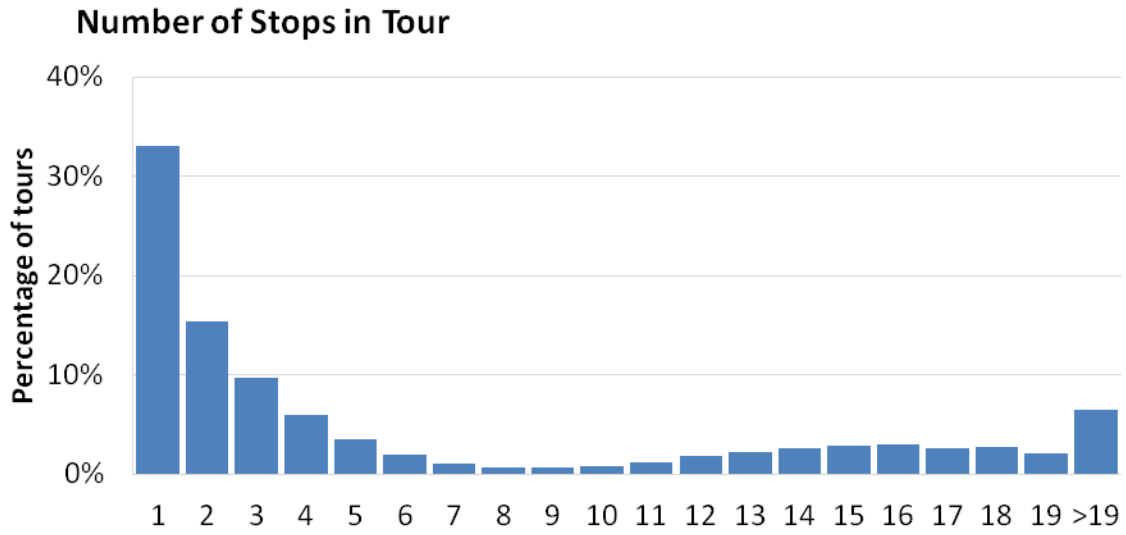
- Results produce the majority of tours using smaller 2 axle trucks
- There are slightly fewer peddling tours than direct tours



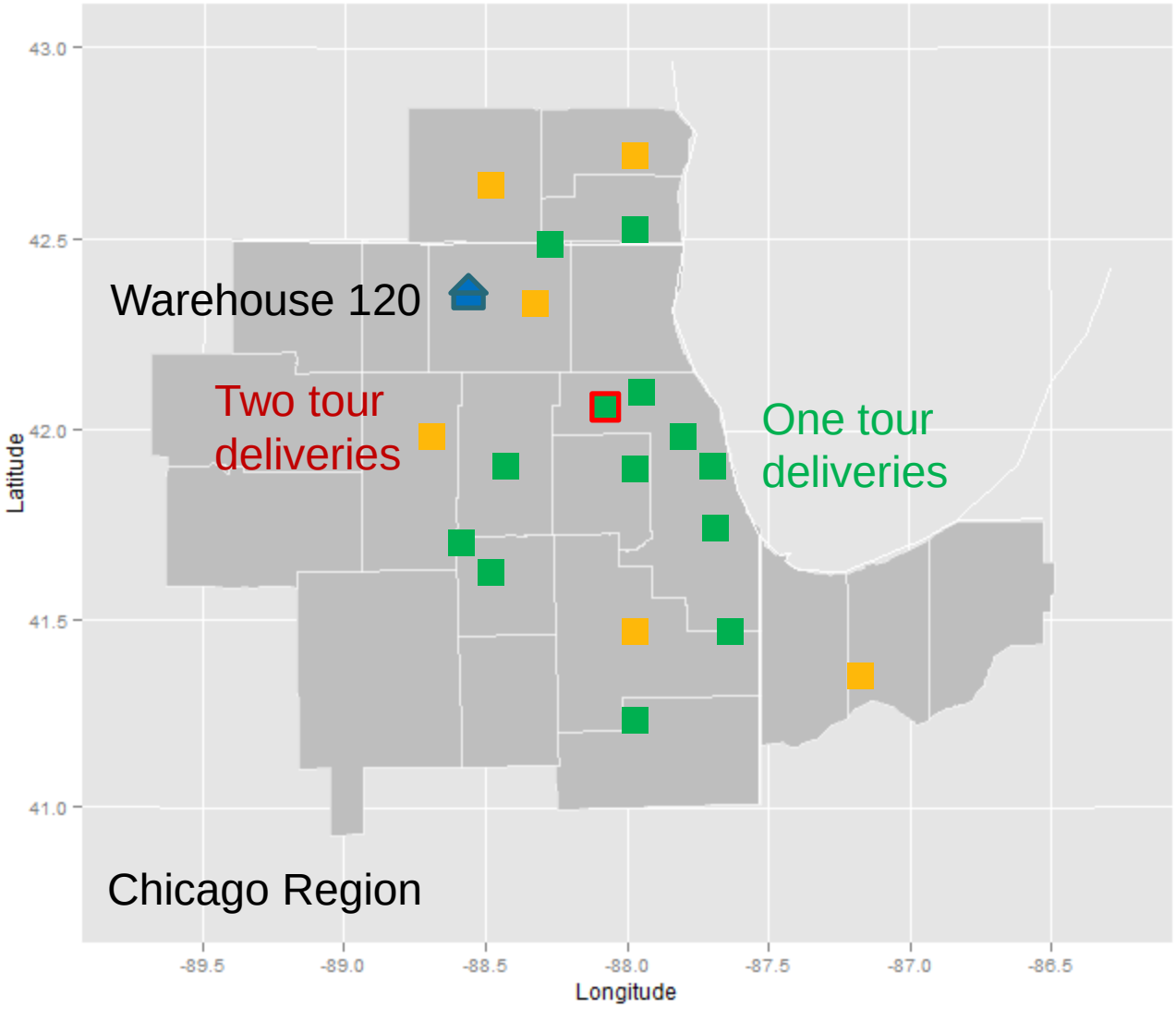
Allocate Shipments to Tours and Stops

- 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



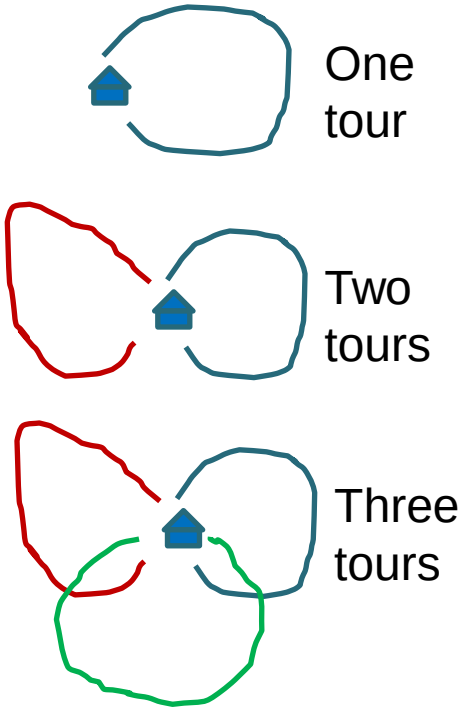


Regional Model Sequence



Number of tours

An MNL choice model is used to assign deliveries to tours patterns with one tours, two tours, three tours or four tours



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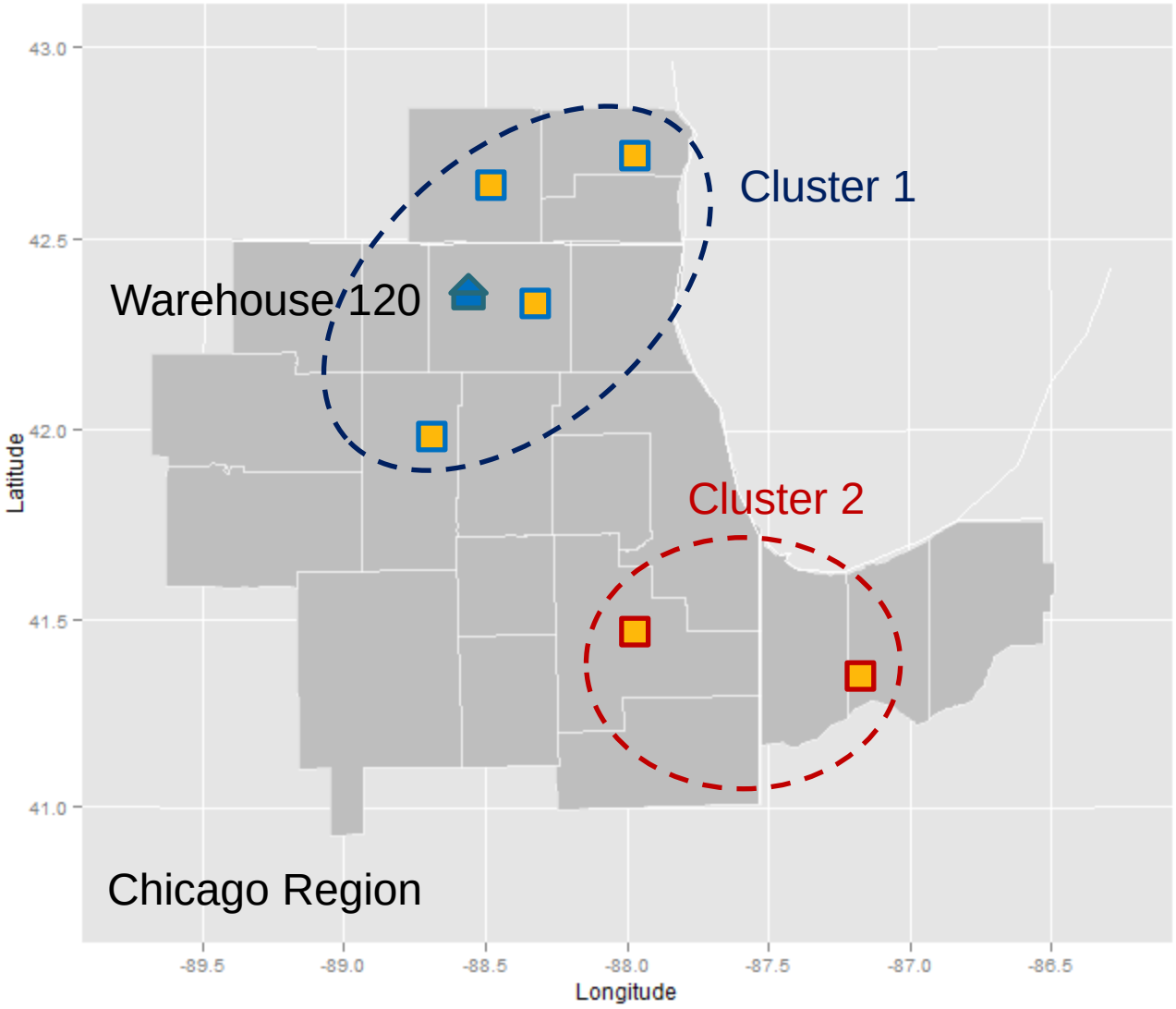


Stop Clustering

For deliveries in two or more tour patterns, the stops are assigned to a specific tour using hierarchical clustering

This technique groups together spatially close deliveries

Regional Model Sequence

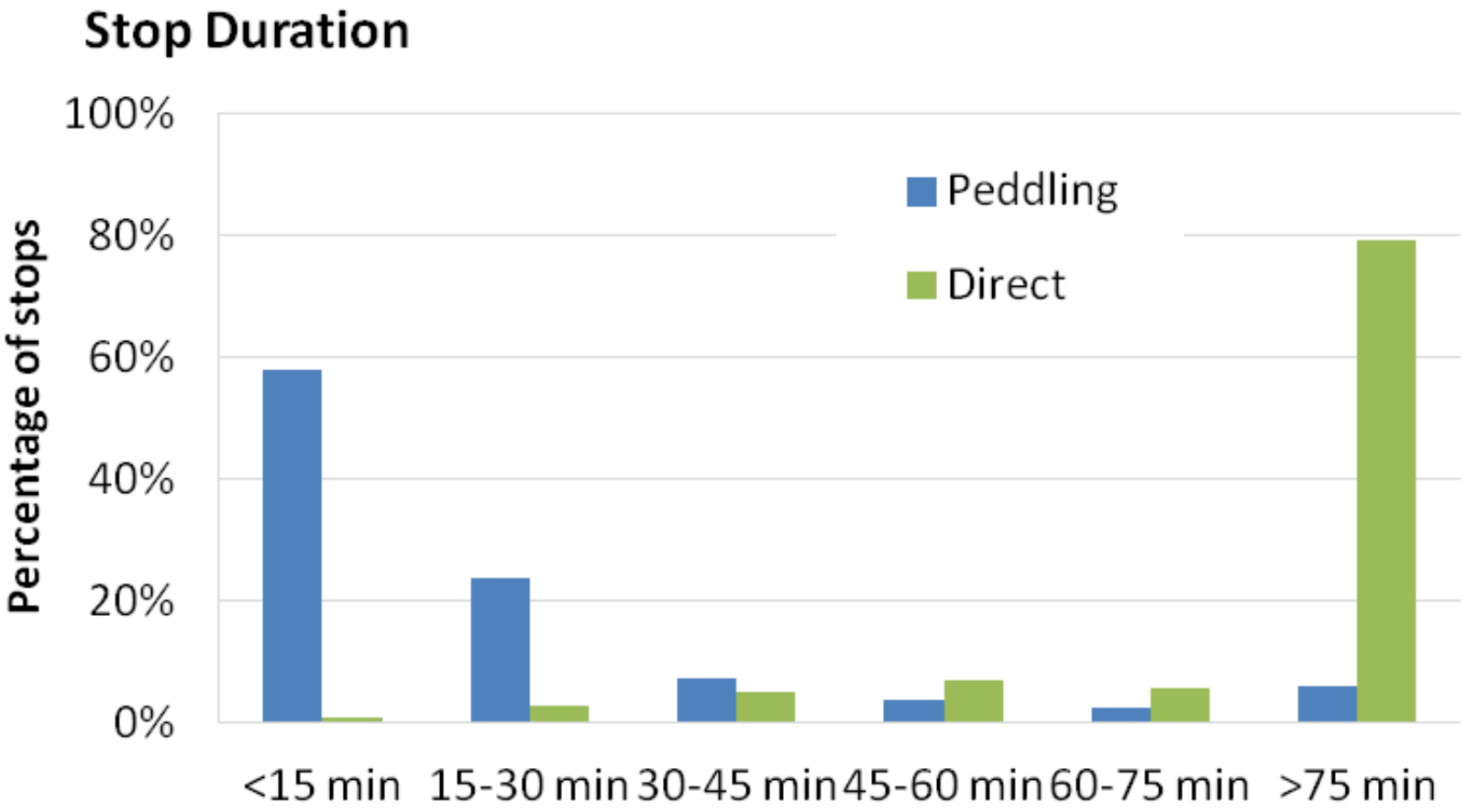
Stop Sequencing

A greedy algorithm is used to sequence the stops, which is much simpler and more realistic (according to Texas data) than a traveling salesman algorithm

1. First delivery is the closest to the warehouse
2. Second delivery is the closest to the first delivery point
3. Etc., until all deliveries are made

Stop Duration

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



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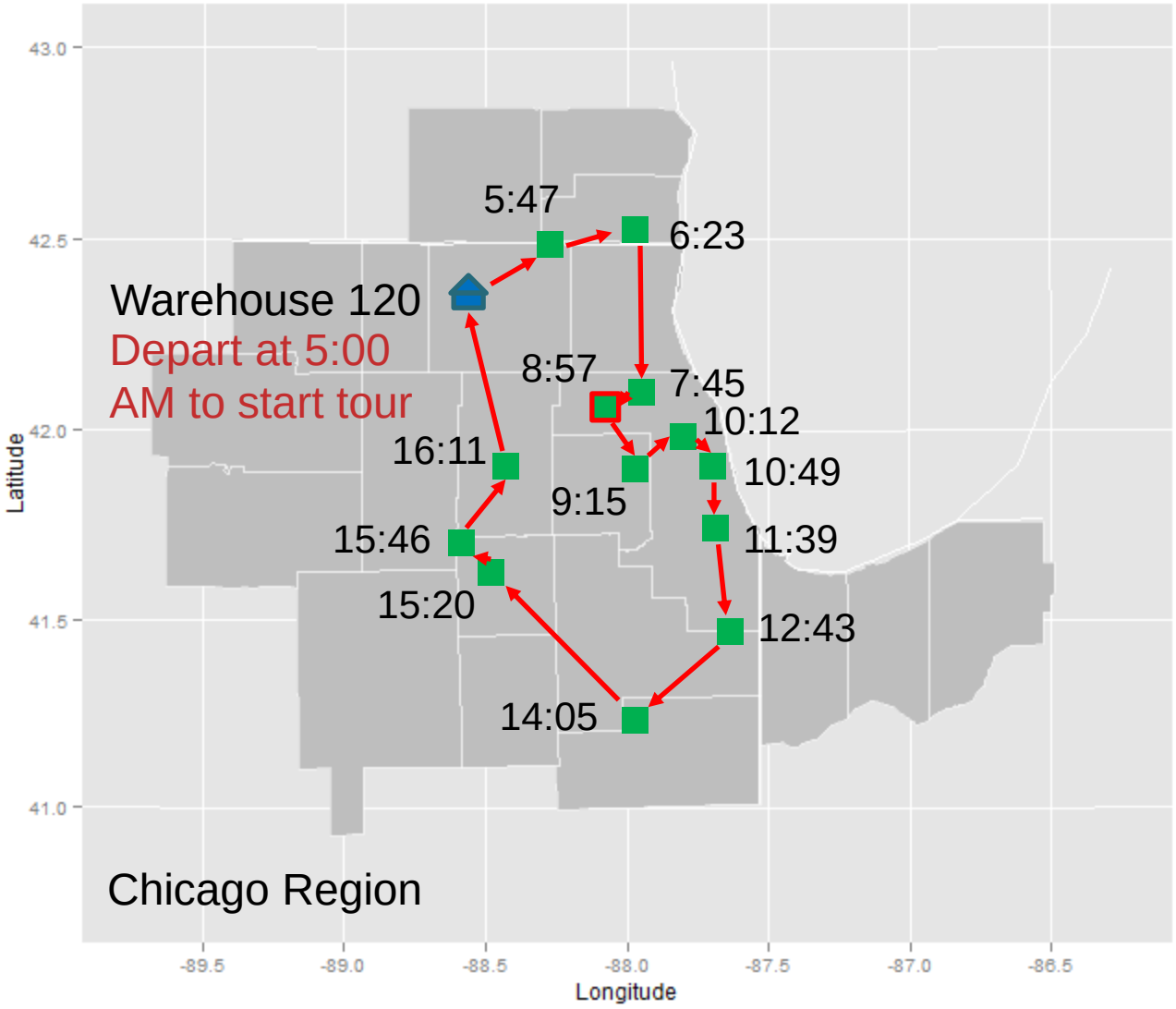


Stop Duration and Tour start time

Stop durations are short for stops in tours with a lot of stops, and are longer for larger loads

With the stop durations and travel times from skim data, the departure time of each trip can be calculated, to give a complete trip list

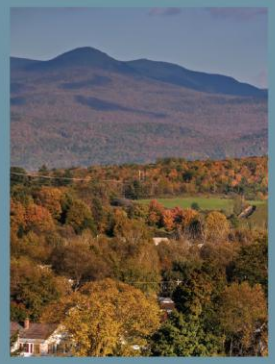
Demonstration of the Application

Demonstration in Chicago

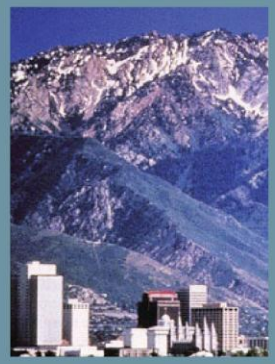
Model framework was estimated and then applied in Chicago

- Estimation work used sources such as FAME survey data (UIC) and Texas Commercial Vehicle Survey
- Models were estimated for two commodities – food and manufacture goods
- Application combined the elements of the model developed by Cambridge Systematics as part of their work on the CMAP Mesoscale Freight Model with all of the new components
- Programmed in R, open source statistical programming language
- Software was completed and turned over to CMAP for testing
- Final report available upon request

Contact


Vermont


Chicago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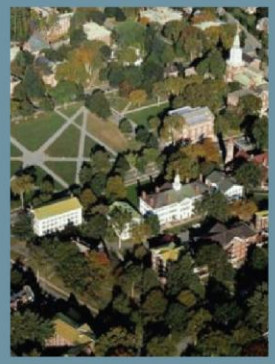
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