DEVELOPMENT OF EXTERNAL TRUCK TRIPS FOR MPOS

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Overview

• Benefits of external truck trips for MPOs
• External Truck Model Design
  • Freight data summary
  • National Truck Model
  • Sub-Area analysis
  • Disaggregation to MPO TAZs
  • Model calibration
  • Model results
• Current uses
• Questions?
BENEFITS OF EXTERNAL TRUCK TRIPS

Modeling External Trucks
Benefits

- Ability to model long distance truck trips.
- Built to forecast any year from 2007-2040
- Outputs a trip table that can be incorporated into your MPO model with minimal effort.
- Can be split by time of day.
- Adds appropriate truck congestion to roadways.
MODEL DESIGN
Modeling External Trucks
Purpose

- Generate external truck trips, including
  - Internal-to-external trips
  - External-to-internal trips
  - External-to-external (or through) trips
Model Design

A: National Truck Model

B: Subarea Analysis

C: Disaggregation to MPOs TAZ

NCSTM

Java

TransCAD

Trip tables with external trucks

Java
A: FREIGHT DATA
SUMMARY
Modeling External Trucks
FAF³ Data

Published by FHWA, contains freight flows by
• 123 domestic and 8 international FAF zones
• 7 modes
• 43 SCTG commodities
• Port of entry/exit

Most current version: FAF³.4
North Carolina FAF Zones
FAF Zones and MPOs
FAF Model Years

2007  2015  2020  2025  2030  2035  2040

FAF$^3$ years
B: NATIONAL TRUCK MODEL
Modeling External Trucks
Model Design

FAF3.4 data

- Disaggregate flows from 123 FAF zones to 3,138 counties
  - BLS County Employment by eleven industries
  - BEA Input/Output coefficients
  - Payload factors

- Convert flows in tons into flows in trucks

- Add empty truck trips

- Assign flows to national network
# FHWA Vehicle Classes

<table>
<thead>
<tr>
<th>FHWA Vehicle Classifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 axles, 2 or 3 tires</td>
</tr>
</tbody>
</table>

| **5. Single Unit 2-Axle Trucks** | **6. Single Unit 3-Axle Trucks** | **7. Single Unit 4 or More-Axle Trucks** | **8. Single Trailer 3- or 4-Axle Trucks** |
| 2 axles, 6 tires (dual rear tires), single unit | | 4 or more axles, single unit | 3 or 4 axles, single trailer |

| **9. Single Trailer 5-Axle Trucks** | **10. Single Trailer 6 or More-Axle Trucks** |
| 5 axles, single trailer | 6 or more axles, single trailer |

| **11. Multi-Trailer 5 or Less-Axle Trucks** | **12. Multi-Trailer 6-Axle Trucks** |
| 5 or less axles, multiple trailers | 6 axles, multiple trailers |

| **13. Multi-Trailer 7 or More-Axle Trucks** |
| 7 or more axles, multiple trailers |
### Disaggregation of FAF$^3$ Flows

#### FAF zone A

#### FAF zone B

**8,000 tons**

<table>
<thead>
<tr>
<th>Flow</th>
<th>Calculation</th>
<th>Weight</th>
<th>Share</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>i → k</td>
<td>1,000 * 5,000</td>
<td>5,000,000</td>
<td>30%</td>
<td>2,424</td>
</tr>
<tr>
<td>j → k</td>
<td>2,000 * 5,000</td>
<td>10,000,000</td>
<td>61%</td>
<td>4,848</td>
</tr>
<tr>
<td>i → l</td>
<td>1,000 * 500</td>
<td>500,000</td>
<td>3%</td>
<td>242</td>
</tr>
<tr>
<td>j → l</td>
<td>2,000 * 500</td>
<td>1,000,000</td>
<td>6%</td>
<td>485</td>
</tr>
<tr>
<td>Total</td>
<td>16,500,000</td>
<td>100%</td>
<td></td>
<td>8,000</td>
</tr>
</tbody>
</table>
## Convert Tons to Trucks

<table>
<thead>
<tr>
<th>SCTG</th>
<th>Commodity</th>
<th>Payload factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCTG01</td>
<td>Live animals/fish</td>
<td>24,492</td>
</tr>
<tr>
<td>SCTG02</td>
<td>Cereal grains</td>
<td>27,945</td>
</tr>
<tr>
<td>SCTG03</td>
<td>Other ag prods.</td>
<td>22,140</td>
</tr>
<tr>
<td>SCTG04</td>
<td>Animal feed</td>
<td>22,967</td>
</tr>
<tr>
<td>SCTG05</td>
<td>Meat/seafood</td>
<td>30,691</td>
</tr>
<tr>
<td>SCTG06</td>
<td>Milled grain prods.</td>
<td>11,831</td>
</tr>
<tr>
<td>SCTG07</td>
<td>Other foodstuffs</td>
<td>25,926</td>
</tr>
<tr>
<td>SCTG08</td>
<td>Alcoholic beverages</td>
<td>20,573</td>
</tr>
<tr>
<td>SCTG09</td>
<td>Tobacco prods.</td>
<td>25,168</td>
</tr>
<tr>
<td>SCTG10</td>
<td>Building stone</td>
<td>25,429</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCTG43</td>
<td>Mixed freight</td>
<td>11,826</td>
</tr>
</tbody>
</table>
Convert Annual Into Weekday Flows

\[
trucks_{daily} = \frac{trucks_{yearly}}{365.25} \cdot \frac{AAWDT}{AADT}
\]

\[
\frac{AAWDT}{AADT} = 1.02159
\]
Empty Truck Trips

Zone A
-10 trucks
+5 trucks
-8 trucks
+5 trucks
-8 trucks

Zone B
-2 trucks
+0 trucks
-5 trucks
+10 trucks
+3 trucks

Zone C
-5 trucks
+8 trucks
-0 trucks
+2 trucks
+5 trucks

3 empty trucks
10 trucks
5 trucks
0 trucks
2 trucks
8 trucks
5 trucks
5 empty trucks

Assignment

• At national level for all counties
• Multi-class assignment
• PCE for single-unit trucks (1.5) and multi-unit trucks (2.0)
• Background volume assumed based on facility type
National Assignment
C: SUBAREA ANALYSIS
Modeling External Trucks
Sub-Area Analysis
Sub-Area Analysis (cont.)

39 External stations
7 Internal Nodes
D: DISAGGREGATE TO MPO TAZS
Modeling External Trucks
Input Files

- National FAF Network
- Centroids
- Local Network
- Local TAZ Layer
- Local Socioeconomic Data
- Trip Rates
- TAZ to County mapping
- External Station Mapping
- Counts for Calibration
Disaggregation to MPO TAZ

Triad
1,718 TAZ
## Disaggregation of Truck Trips to TAZ

<table>
<thead>
<tr>
<th>Direction</th>
<th>Origin</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal-to-External</td>
<td>Based on employment</td>
<td>Given by external station</td>
</tr>
<tr>
<td>External-to-Internal</td>
<td>Given by external station</td>
<td>Based on employment</td>
</tr>
<tr>
<td>External-to-External</td>
<td>Given by external station</td>
<td>Given by external station</td>
</tr>
</tbody>
</table>
E: CALIBRATION

Modeling External Trucks
Scaling Factors

- Master truck ton adjustment
- Percent SUT adjustment
- Truck trip adjustment
  - FAF_FAF,
  - STATE_STATE,
  - STATE_FAF,
  - FAF_STATE
- County scalar
Model Refinements

- Splitting counties by employment
- Increase/decrease speeds to adjust travel time
- Run select link analysis
Split counties into 3 phantom counties based on employment density in the area.
Model Refinements (cont.)

Split county by employment to adjust for improper truck allocation.

<table>
<thead>
<tr>
<th>Roadway</th>
<th>Count</th>
<th>Model</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>US64 Before Split</td>
<td>264</td>
<td>577</td>
<td>119%</td>
</tr>
<tr>
<td>US64 After Split</td>
<td>264</td>
<td>264</td>
<td>0%</td>
</tr>
</tbody>
</table>
Model Refinements (cont.)
F: RESULTS

Modeling External Trucks
External Truck Trip Table

<table>
<thead>
<tr>
<th>OrigZone</th>
<th>DestZone</th>
<th>singleUnitTrucks</th>
<th>multiUnitTrucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2905</td>
<td>2925</td>
<td>1072.9000</td>
<td>2552.1899</td>
</tr>
<tr>
<td>2925</td>
<td>2905</td>
<td>1096.5000</td>
<td>2501.6599</td>
</tr>
<tr>
<td>2876</td>
<td>2951</td>
<td>854.1900</td>
<td>1798.5500</td>
</tr>
<tr>
<td>2951</td>
<td>2876</td>
<td>780.4500</td>
<td>1731.3900</td>
</tr>
<tr>
<td>2951</td>
<td>2896</td>
<td>154.1000</td>
<td>597.8400</td>
</tr>
<tr>
<td>2951</td>
<td>2901</td>
<td>162.9700</td>
<td>574.6300</td>
</tr>
<tr>
<td>2896</td>
<td>2951</td>
<td>136.2900</td>
<td>568.8400</td>
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<tr>
<td>2901</td>
<td>2951</td>
<td>145.1600</td>
<td>551.4000</td>
</tr>
<tr>
<td>2915</td>
<td>2951</td>
<td>135.9200</td>
<td>534.6200</td>
</tr>
<tr>
<td>2923</td>
<td>2951</td>
<td>150.7600</td>
<td>520.5600</td>
</tr>
<tr>
<td>2951</td>
<td>2915</td>
<td>131.1100</td>
<td>518.2300</td>
</tr>
<tr>
<td>2951</td>
<td>2923</td>
<td>134.3600</td>
<td>448.8300</td>
</tr>
<tr>
<td>2932</td>
<td>2930</td>
<td>162.8000</td>
<td>381.8100</td>
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<tr>
<td>2930</td>
<td>2932</td>
<td>107.3300</td>
<td>326.8400</td>
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<tr>
<td>2907</td>
<td>2925</td>
<td>103.5000</td>
<td>317.2400</td>
</tr>
<tr>
<td>2925</td>
<td>2907</td>
<td>95.8600</td>
<td>305.9600</td>
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<tr>
<td>2905</td>
<td>2919</td>
<td>88.8000</td>
<td>158.7700</td>
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<tr>
<td>2876</td>
<td>2936</td>
<td>71.9500</td>
<td>139.9300</td>
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<tr>
<td>2936</td>
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<td>31.5100</td>
<td>95.6800</td>
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<td>2919</td>
<td>2905</td>
<td>30.4600</td>
<td>88.5800</td>
</tr>
<tr>
<td>2925</td>
<td>2917</td>
<td>30.8600</td>
<td>75.9100</td>
</tr>
<tr>
<td>2917</td>
<td>2925</td>
<td>30.0100</td>
<td>61.8700</td>
</tr>
</tbody>
</table>
Metrolina Network Assignment

All or Nothing Assignment
F: CURRENT USES

Modeling External Trucks
MPO Models

- The following MPO’s are using this model or a similar approach to produce external truck trips:
  - Triangle (Raleigh, NC)
  - Metrolina (Charlotte, NC)
  - NORPC (New Orleans, LA)
  - RTC (Reno, NV)
Other Models

• The national FAF model methodology is also being used in the following models:
  • NCSTM (North Carolina)
  • NYMTC (New York)
  • Illiana (Indiana and Illinois)
Questions?

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