Measuring the Effect of Weather Events on Long-Haul Truck Traffic Using Anonymous Truck GPS Data

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Outline

1. Background and Motivations
2. Method
3. Application
4. Discussion
5. Future Research
Problem Statement

- Severe weather conditions can have major effects on truck traffic volumes
- Truck GPS data, a valuable source of freight movement
- Large data stream, how to deduce insights

Research Question

Can we develop a model that predicts Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) changes of trucks resulting from weather events?

Applications

- Assist state and regional transportation agencies in developing freight-oriented programs and policies.
- Assist trucking industry to better plan accurate routes to estimate ETA and revenue miles.
Method of the Study

Data Inputs
- GPS Data
- Weather Data

Variables
- Trip Length (in miles)
- Trip Duration (in hours)
- Truck Volume
- Daily Parameters (i.e., precipitation, temperature, etc.)
- Extreme Events

Model
- Spatial Panel Regression Model

Dependent Variables
- Trip Length
- Trip Duration
- Truck Volume

Independent Variables
- Daily Parameters
- Extreme Events
Mobile Sensor Data: GPS Data Sample

- Sample provided by the American Transportation Research Institute (ATRI)
- Over 35 million raw pings per week in Arkansas
- 10-15% coverage of truck traffic
- 2-week sample (in 2016)
  - February: 82,770 Trucks
  - May: 81,891 Trucks
  - August/September: 83,112 Trucks
  - November: 110,319 Trucks

Legend
- State Boundary
- GPS Pings

Total Pings: 88,241,136
Truck Volume from a Large GPS Data

Collected GPS Data

Route Identification

National truck GPS sample
2 week period, 82,000 trucks

Complete, fully-connected links comprising the truck path
VMT and VHT on a Link

VMT = Daily Truck Volume × Total Daily Trip Length (in miles)

VHT = Daily Truck Volume × Total Daily Trip Duration (in hours)
MERRA Locations in Arkansas

Source: Modern-Era Retrospective analysis for Research and Applications (MERRA), Long Term Pavement Performance (LTPP) InfoPave Climate Tool
Extreme Weather Events in Arkansas
## Results: Spatial Autoregressive Models- VMT

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Ordinary Least Square Regression (OLS)</th>
<th>Spatial Autoregressive Models (SAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snowfall</td>
<td>-0.05***</td>
<td>-0.05***</td>
</tr>
<tr>
<td>Storm Events</td>
<td>-0.17***</td>
<td>-0.10***</td>
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<tr>
<td>Extreme Heat</td>
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<td>-0.03***</td>
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<td>Weekday</td>
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<td>Summer</td>
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<td>Fall</td>
<td>0.10***</td>
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<td>Spatial, rho ($\rho$)</td>
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<td>\textbf{R-squared:}</td>
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<tr>
<td>\textbf{AIC}</td>
<td>829.5</td>
<td>214.6</td>
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</table>
Applications of the Models

Fayetteville
West Memphis
Little Rock

Daily Vehicle Miles Traveled Change Ratio

Snowfall

Dates

1/15/2016 1/15/2016
2/14/2016 2/24/2016
3/25/2016
Discussion

These models can capture spatial effect of weather variables on truck volume.

Unlike static traffic data collection sites, like Weigh-In-Motion (WIM) or AADT, the use of GPS allows us to measure the changes in VMT/VHT at dispersed locations.

VMT/VHT better capture the effects of weather on rerouting or temporal delays to trips.
Future Work

Capture re-routing behaviors of trucks:

- Changes in VMT and VHT are not instantaneous, but delayed over time
- VMT and VHT are both spatially and temporally auto-correlated
- Develop Space-time lag model for trucks
- Using Delaunay triangle with origin-destination flows
Questions?

Thank You

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