Reroute or Wait It Out:
Estimating the Time until Spoilage in the Presence of Unexpected Delays

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Outline

1. Introduction
   ▶ Problem
   ▶ Contribution
   ▶ Lit Review

2. Model
   ▶ Data
   ▶ Theory
   ▶ Empirical Model

3. Conclusion
   ▶ Results
   ▶ Further Work
Problem

- Trucks make up a small percentage of road users, but bear a large percent of the costs from delays.
  - increased labor costs, wasted fuel, etc...

![Travel by Vehicle Type](Image)

- Passenger Vehicle: 93%
- Truck: 7%

![Congestion Cost by Vehicle Type](Image)

- Passenger Vehicle: 78%
- Truck: 22%
The purpose of this paper is to determine whether the cost of delays disproportionately affect certain industries.

Research Question:

“Which industries (commodities) are the most time-sensitive in the presence of unexpected delays?”
Time + price represent the full cost (or demand) of a good [Hsiao - 2009]

Demand at time $t$ is different than demand at time $t + 1$ [Allon, Federgruen, and Pierson - 2011]

Customers “trade off price for waiting time” [Nowlis, Mandel, and McCabe - 2004]

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Data

- Origin-destination survey by Washington State University and the Washington DOT.
- 4600 truckers surveyed on I-90, the major thoroughfare between Eastern and Western Washington.
- origin, destination, commodity, weight, truck configuration, route frequency, origin/destination facility, etc...
Survey question of interest:

“In the event of a weather related closure on Snoqualmie Pass, how long are you willing to wait before taking an alternative route?”

- Categorical: immediately, 1 hour, 3 hours, 5 hours, 5+ hours
- Bound 5+ hours?
  - Used road closure duration data on Snoqualmie Pass from the past 5 years; chose 90th percentile
Theory

- reroute time + wait time ≤ time until spoilage
  \[X + Z \leq Y\]

Idea: Knowing that the reroute time is X minutes and the time until spoilage is Y minutes, the driver can wait up to Z minutes. However, this equation must be standardized.
Theory

How to standardize?

- $K = \text{reroute time} - \text{original route time}$

Idea: $K$ is the *minimum extra* time required to reach the driver’s destination. This allows us to compare different destinations.

The standardized equations becomes: $K + Z \leq Y$

- $Y = \text{the standardized time until spoilage}$
Theory

Eustice, Sage, & Casavant (WSU)

Reroute or Wait it Out
Model

- $Y = X\beta + S\alpha + e$
  - $Y =$ the standardized time until spoilage
  - $X =$ control variables
  - $S =$ indicator variable for each commodity
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### Selected Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>(Std. Err.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>398.45***</td>
<td>(11.02)</td>
</tr>
<tr>
<td>West</td>
<td>46.18***</td>
<td>(7.05)</td>
</tr>
<tr>
<td>Value</td>
<td>-0.04</td>
<td>(0.03)</td>
</tr>
</tbody>
</table>

#### Commodities

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Coefficient</th>
<th>(Std. Err.)</th>
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</thead>
<tbody>
<tr>
<td>Animal feed</td>
<td>34.29**</td>
<td>(16.31)</td>
</tr>
<tr>
<td>Textiles</td>
<td>21.74</td>
<td>(30.08)</td>
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<tr>
<td>Ceramic/Glass</td>
<td>-46.44**</td>
<td>(23.24)</td>
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<tr>
<td>Other food</td>
<td>-20.21*</td>
<td>(12.16)</td>
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<tr>
<td>Electronics</td>
<td>40.13</td>
<td>(29.04)</td>
</tr>
<tr>
<td>Gasoline</td>
<td>-115.04***</td>
<td>(32.77)</td>
</tr>
</tbody>
</table>

Significance levels:  

- * : 10%  
- ** : 5%  
- *** : 1%

▶ Intercept (base case): Agriculture products and trucks traveling East
Further Work

- Update the bound on 5+ hours
  - time of day
  - hours of driving
  - weighted bound