The Effect of Segment Characteristics on the Severity of Head-on Crashes on Two-lane Rural Highways

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Project Introduction

- Sponsored by the US DOT through the New England University Transportation Center
- The results will be mathematical models for the rate and severity of head-on crashes on rural two-lane highways in Connecticut
Outline

- Background
- Study design
- Data collection
- Methodology
- Results
- Discussion
- Conclusion
Background and Objectives

Question to be answered:
- How do highway characteristics affect the severity of head-on crashes?

Analysis context:
- Two-lane highways in Connecticut
- Head-on Crashes in Connecticut
Crashes in Connecticut

Crash and Fatality Proportions by Crash Type in Connecticut (1991–2000)

Crash Type

- % of Crashes
- % of Fatalities
## Variables Considered

<table>
<thead>
<tr>
<th>Road Characteristics</th>
<th>Crash Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of center line</td>
<td>Crash severity (KABCO)</td>
</tr>
<tr>
<td>Lane and shoulder width</td>
<td>Time Period</td>
</tr>
<tr>
<td>Number of Access Points</td>
<td>Light Condition</td>
</tr>
<tr>
<td>Speed Limit</td>
<td>Surface Condition</td>
</tr>
<tr>
<td>Horizontal curvature</td>
<td>Weather Condition</td>
</tr>
<tr>
<td>(degree &amp; length of curve)</td>
<td>Contributing Factors</td>
</tr>
<tr>
<td>Vertical curvature</td>
<td>Heavy vehicle involved</td>
</tr>
<tr>
<td>(K &amp; length of curve)</td>
<td></td>
</tr>
</tbody>
</table>
Data Collection

- Roadway characteristics
  - PhotoLog Software of Connecticut rural highway system, courtesy of ConnDOT
  - PLV(HC/VC) Software, courtesy of ConnDOT

- Crash characteristics
  - Traffic Accident Viewing System (TAVS), courtesy of ConnDOT
## Data Patterns

### 228 Head-on Crashes

<table>
<thead>
<tr>
<th>KABCO Scale</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>31</td>
</tr>
<tr>
<td>A</td>
<td>48</td>
</tr>
<tr>
<td>B</td>
<td>66</td>
</tr>
<tr>
<td>C</td>
<td>38</td>
</tr>
<tr>
<td>O</td>
<td>45</td>
</tr>
</tbody>
</table>

### Head-on Crash Severity

- **K**: 31
- **A**: 48
- **B**: 66
- **C**: 38
- **O**: 45

### Frequency KABCO Scale

- **0**: 50
- **50**: 100
- **100**: 150
- **150**: 200
- **200**: 250

### Variable Table

<table>
<thead>
<tr>
<th>Variable</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAVY VEH.</td>
<td>7</td>
<td>221</td>
</tr>
<tr>
<td>WET</td>
<td>125</td>
<td>103</td>
</tr>
<tr>
<td>DARK</td>
<td>82</td>
<td>146</td>
</tr>
<tr>
<td>NIGHT</td>
<td>29</td>
<td>199</td>
</tr>
</tbody>
</table>
Methodology

- Ordered Probit Modeling

\[
\begin{align*}
y = 0 & \quad \text{if} \quad y^* \leq 0 \\
y = 1 & \quad \text{if} \quad 0 < y^* \leq \mu_1 \\
y = 2 & \quad \text{if} \quad \mu_1 < y^* \leq \mu_2 \\
& \quad \vdots \\
y = j & \quad \text{if} \quad \mu_{j-1} < y^* \leq \mu_j \\
\end{align*}
\]

\[
\begin{align*}
P(y = 0) &= \Phi(-\beta'x) \\
P(y = 1) &= \Phi(\mu_1 - \beta'x) - \Phi(-\beta'x) \\
P(y = 2) &= \Phi(\mu_2 - \beta'x) - \Phi(\mu_1 - \beta'x) \\
& \quad \vdots \\
P(y = j) &= 1 - \Phi(\mu_{j-1} - \beta'x)
\end{align*}
\]
## Model Estimation Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; $\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.0000</td>
<td>0.0000</td>
<td>.</td>
</tr>
<tr>
<td>Intercept1</td>
<td>0.5524</td>
<td>0.0819</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intercept2</td>
<td>1.3870</td>
<td>0.1129</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intercept3</td>
<td>2.1623</td>
<td>0.1394</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WET</td>
<td>0.7944</td>
<td>0.1445</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NIGHT</td>
<td>0.4977</td>
<td>0.2131</td>
<td>0.0195</td>
</tr>
<tr>
<td>WIDTH</td>
<td>-0.1152</td>
<td>0.0133</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ACCESS</td>
<td>0.0223</td>
<td>0.0111</td>
<td>0.0446</td>
</tr>
</tbody>
</table>
Discussion

- Crash-related factors that increase severity
  - Wet Surface
  - 22pm~6am Occurrence
- Roadway factors that increase severity
  - Access Points (Driveways+Minor Intersections)
  - Narrow Pavement
Conclusions

- **Expected Findings**
  - Wet surface reduce braking capability
  - Driving speeds higher at night

- **Unexpected Findings**
  - Access points **should** decrease speed
  - Narrow pavement **should** lead driver to be more cautious
Thank You!