An Overview of CSA 2010 and Some Statistical Methods Used in Crash Data Analysis

Truck Talk Series

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The goal of the FMCSA is to reduce CMV-related crashes, injuries, and fatalities.

Activities of FMCSA include:

- Enforcement of safety regulations (FMCSRs)
- Enforcement of hazardous materials regulations (HMRs)
- Collection of safety information to target high-risk carriers

One of the agency’s enforcement activities is to conduct Compliance Reviews (CRs) on motor carriers operating on the nation’s highways.
Compliance Review (CR)

- A compliance review is an on-site examination of a motor carrier’s operations by a U.S. federal safety investigator to determine a motor carrier’s safety fitness.

- A CR reviews operations such as
  - Driver’s hours of service (HOS)
  - Vehicle maintenance and inspection
  - Driver qualification
  - Controlled substance and alcohol testing
  - Commercial driver license requirements
Motor Carrier Safety Status Measurement System (SafeStat)

- SafeStat was developed for FMCSA in the mid-1990s by Volpe to measure the relative safety fitness of CMV operators.
- SafeStat combines data on crashes, roadside inspections, traffic violations, and CRs from the previous 30 months to produce a SafeStat score.
- The scores are ranked to identify high risk carriers for subsequent CRs and roadside inspections.
- If the SafeStat score is greater than 225, a carrier is identified as “at risk” (A, B carriers).
Limitations of the Current Model

- Trucking industry is comprised ~700,000 carriers
- FMCSA conducts ~17,000 CRs annually
- FMCSA resources are limited despite increases in the trucking population
- CRs are costly to the agency
- SafeStat groups safety problems together to identify carriers for a one-size-fits-all CR
- FMCSA often cites the Large Truck Crash Causation Study (LTCCS) as evidence to focus on driver behavior *
Comprehensive Safety Analysis (CSA 2010) – The New Operational Model

- CSA 2010 is the new FMCSA operational model test being used to monitor the safety of motor carriers (began in February, 2008)

- Within CSA 2010 is the new Safety Measurement System (SMS) designed to replace SafeStat

- Originally tested in four states (CO, GA, MO, NJ) plus several new states have been added

- CSA 2010 will eventually be rolled out nationally

- UMTRI is conducting the evaluation of the SMS.
CSA 2010 Safety Measurement System (SMS)

- SMS is the new measurement system that will replace SafeStat.
- SMS is designed to focus on specific behaviors and safety problems.
- SMS uses data from roadside inspections, State-reported crashes, and reported violations of FMCSRs to quantify performance (MCMIS data).
- Carriers are ranked relative to their peers in six Behavior Analysis Safety Improvement Categories (BASICs) and a Crash Indicator (CI).
- Carriers that exceed thresholds are subject to intervention.
The SMS BASICs

- Unsafe Driving – speeding, reckless driving
- Fatigued Driving – HOS violations, log book
- Driver Fitness – CDL or medical violations
- Controlled Substance and Alcohol
- Vehicle Maintenance – brakes, lights, etc.
- Improper Loading/Cargo Securement – spilled cargo, unsafe handling of hazmat
- Crash Indicator – high crash involvement
Interventions

Carriers that exceed BASIC thresholds are subject to interventions

- Warning letter
- Off-site investigation
- On-site focused investigation
- On-site comprehensive investigation
- Cooperative Safety Plan (CSP)
- Notice of Violation (NOV)
- Notice of Claim (NOC)
Evaluation of SMS

- In the original four test states (CO, GA, MO, NJ) carriers were randomly assigned to test and control groups
- 50% test carriers, 50% control carriers (~70,000 carriers total)
- Test carriers are subject to the new CSA Operational Model Test (SMS and Interventions)
- Control carriers are subject to the old model (SafeStat and CRs)
Evaluation and Research Questions

- Are BASICs good surrogates of safety?
- How does SMS compare to SafeStat?
- Are interventions effective?
- What are the costs to FMCSA of implementing CSA 2010 compared to the old model?
Association Between Crash Rates and BASIC 1 – Unsafe Driving

Nonparticipating Carriers, April 2009 BASIC Percentiles

Graph showing the association between crash rates and BASIC 1 percentiles for unsafe driving.
Association Between Crash Rates and BASIC 2 – Fatigued Driving

Nonparticipating Carriers, April 2009 BASIC Percentiles
Association Between Crash Rates and BASIC 3 – Driver Fitness

Nonparticipating Carriers, April 2009 BASIC Percentiles

![Graph showing the association between BASIC 3 percentiles and log crash rates per 100 PUs. The graph indicates a negative correlation, with BASIC 3 percentiles increasing as log crash rates decrease.]
Association Between Crash Rates and BASIC 4 – Controlled Substance & Alcohol

Nonparticipating Carriers, April 2009 BASIC Percentiles

![Graph showing the association between BASIC 4 percentiles and crash rates per 100 PUs. The graph indicates a positive correlation, with points scattered along a line that slopes upward.]
Association Between Crash Rates and BASIC 5 – Vehicle Maintenance

Nonparticipating Carriers, April 2009 BASIC Percentiles
Association Between Crash Rates and BASIC 6 – Improper Loading/Cargo Securement

Nonparticipating Carriers, April 2009 BASIC Percentiles
Association Between Crash Rates and BASIC 7 – Crash Indicator

Nonparticipating Carriers, April 2009 BASIC Percentiles
### CSA 2010 BASICs and SAFESTAT

**BASIC and SAFESTAT History During Operational Model Test (Feb 2008 – Nov 2009)**

**Number of Carriers**
(Test and Control with 22 Months Data)
**(CO,GA,MO,NJ)**

<table>
<thead>
<tr>
<th>Exceeded BASIC</th>
<th>SafeStat A/B</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>At least Once</td>
<td>Never</td>
</tr>
<tr>
<td>At least Once</td>
<td>566</td>
<td>6,132</td>
</tr>
<tr>
<td>Never</td>
<td>37</td>
<td>57,022</td>
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<tr>
<td>Total</td>
<td>603</td>
<td>63,154</td>
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</table>

**Note:** The table above summarizes the history of BASIC and SAFESTAT for a specified period, focusing on the number of carriers that exceeded BASIC at least once, never exceeded, and the total counts.
Percentage of Carriers Exceeding the Unsafe Driving BASIC Threshold

Carriers That Exceeded the Unsafe Driving Threshold
With 12 Months of Follow-Up

Test Carriers Are Closed-Completed With 1 Intervention
Control Carriers With Any Type of Compliance Review After Jan 08

![Graph showing percentage of carriers exceeding the unsafe driving BASIC threshold over 12 months with follow-up.](image)
Percentage of Carriers Exceeding the Fatigued Driving BASIC Threshold

Carriers That Exceeded the Fatigued Driving Threshold With 12 Months of Follow-Up

Test Carriers Are Closed-Completed With 1 Intervention
Control Carriers With Any Type of Compliance Review After Jan 08
Percentage of Carriers Exceeding the Vehicle Maintenance BASIC Threshold

Carriers That Exceeded the Vehicle Maintenance Threshold With 12 Months of Follow-Up

Test Carriers Are Closed-Completed With 1 Intervention
Control Carriers With Any Type of Compliance Review After Jan 08

Month

Test N=444  Control N=228
Cost of Performing Interventions

- Test Group: Intervention beyond warning letter
  $761 per carrier investigated

- Control Group:
  $1,344 per carrier investigated
Crash Data Usually Hierarchical

- Crashes
  - Vehicles
    - Occupants
Some Modeling Techniques Used to Analyze Crash Data

- Poisson and Negative Binomial Regression
- Random Effects Models
- Bayesian Models
- Extreme Value Theory
Is there a difference in crash rates between singles and doubles?
**Crash data cross-classified by four predictors.**

<table>
<thead>
<tr>
<th>Truck type</th>
<th>Road type</th>
<th>Time</th>
<th>Area</th>
<th>Casualty accidents</th>
<th>Travel</th>
<th>Rate/10^6 miles</th>
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The Model

Likelihood:
\[ y_i \mid \theta_i \sim \text{Poisson}(t_i \theta_i) \quad y_i \text{ independent} \quad i = 1, \ldots, 24 \]

Prior 1:
\[ \log \theta_i \mid \mu_i, \sigma^2 \sim N(\mu_i, \sigma^2), \]
\[ \mu_i = \beta_0 + \beta_1 x_{i1} + \cdots + \beta_p x_{ip} \]

Prior 2: (Noninformative)
\[ \beta_j \sim N(0, 10^6) \quad j = 0, \ldots, 9 \quad \frac{1}{\sigma^2} \sim \text{Gamma}(0.001, 0.001) \]
Results

No significant difference in crash rates between singles and doubles

Estimate of log RR: 0.084 (-0.12, 0.27)

Markov chain simulation
Results

- $\mu[1]$ sample: 15000
- $\mu[2]$ sample: 15000
- $\mu[3]$ sample: 15000
- $\mu[20]$ sample: 15000
- $\mu[24]$ sample: 15000
- $\sigma$ sample: 15000
Thank you