Harsh Braking as a Surrogate for Crash Risk: A Segment-Level Analysis with Connected Vehicle Telematics

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Presentation Outlines

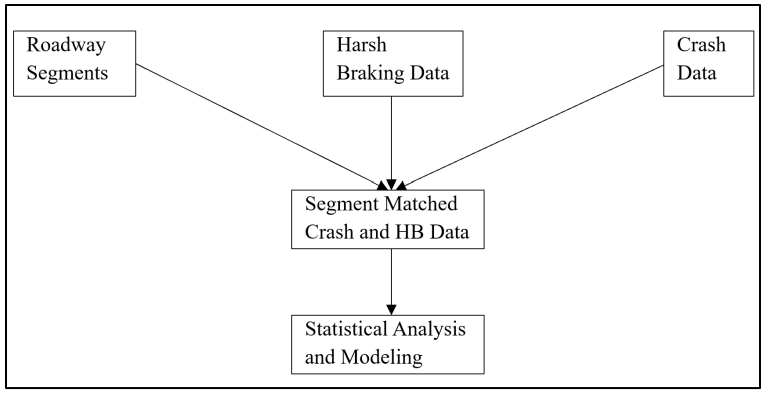
- Background and Objectives
- Methodology & Data Description
- Analysis & Findings
- Conclusions & Recommendations

Background and Objectives

Can Harsh Braking (HB) act as a surrogate measure for crash risk on New Jersey (NJ) highways?

- NJ highways have heavy traffic, toll plazas, and complex interchanges that result in higher crash risk and conditions for sudden stops.
- Traditional safety relies on historical crash records (reactive approach).
- Harsh Braking (HB) events refer to sudden and forceful stops captured by connected vehicle (CV) telematics.
- If HB patterns can reliably identify crash-prone segments, action can be taken before crashes happen (proactive approach).
- **Goal:** to determine whether HB pattern associated with crash frequency.

Methodology



❑ Data Used

- About 8.5 million Drivewyze truck telemetry records (July–Dec 2024).
  - ✓ *Define HB if deceleration >= $6\,fts^{-2}$, approximately 0.2g (FHWA), resulting 3,819 HB events*
- 45,000 NJ police crash reports, known as NJTR-1 reports, (same period)

❑ **Segmentation:** NJ interstate highways split into 1-mile segments. Identified 1,023 segments.

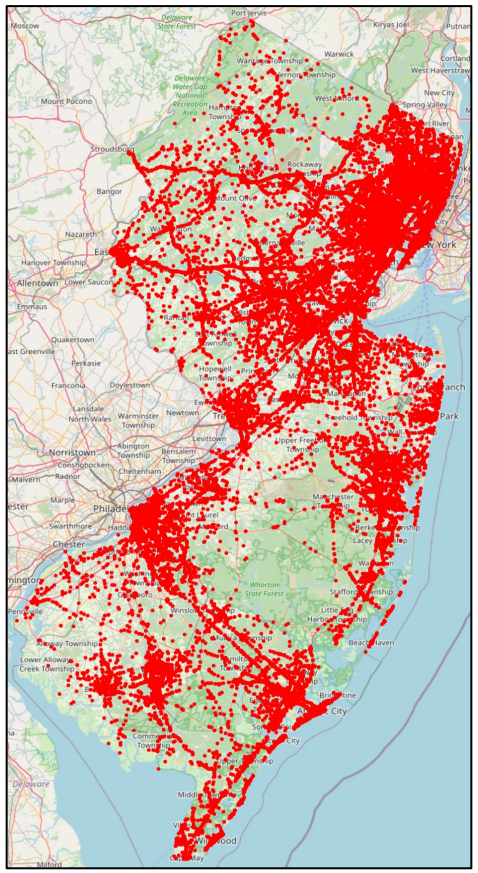
❑ **Matching:** Crashes and HB events linked to the same segments using geo-fencing (GIS buffers).

❑ **Modeling:** Statistical models, Zero-Inflated Negative Binomial (ZINB) tested if more HB results in more crashes.

Analysis & Findings

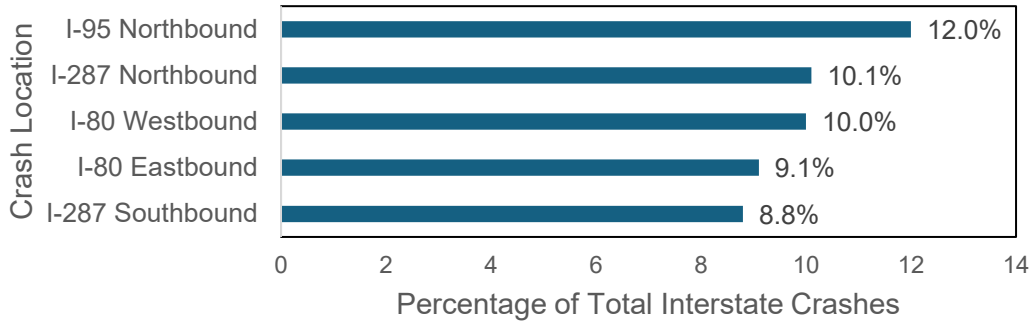
Overview of HB and Crash Locations in New Jersey

HB Locations (July–Dec 2024)



Crash Locations (July–Dec 2024)

- **HB**
  - HB incidents are concentrated along major interstate corridors
    - I-95, I-295, I-195, I-78, I-80, I-280, and I-287
- **Crash**
  - Most crashes were concentrated along the I-95, I-80, I-78, I-287, and I-280 corridors.

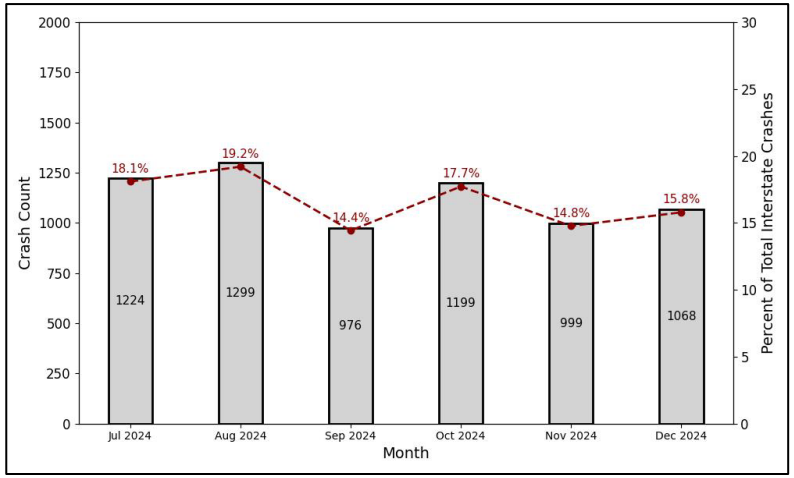


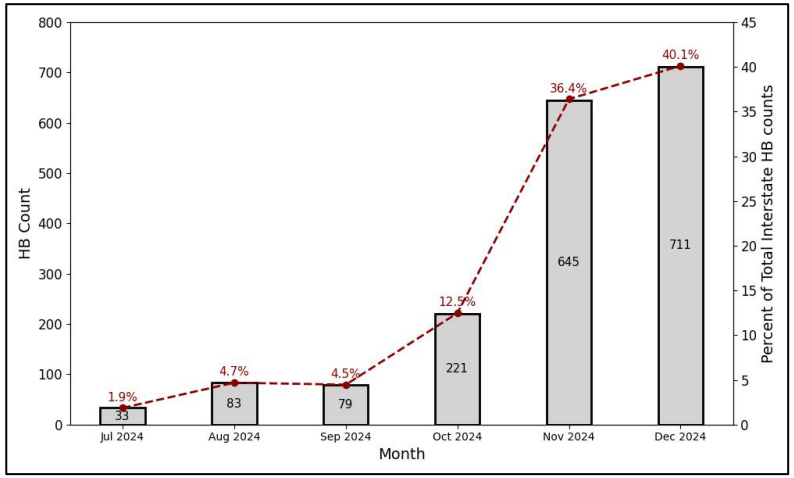
Top 10 Interstate Crash Locations

Analysis & Findings

Descriptive Analysis on Segment-Level HB & Crash Data

Top 10 Crash Locations | Top 10 HB Locations





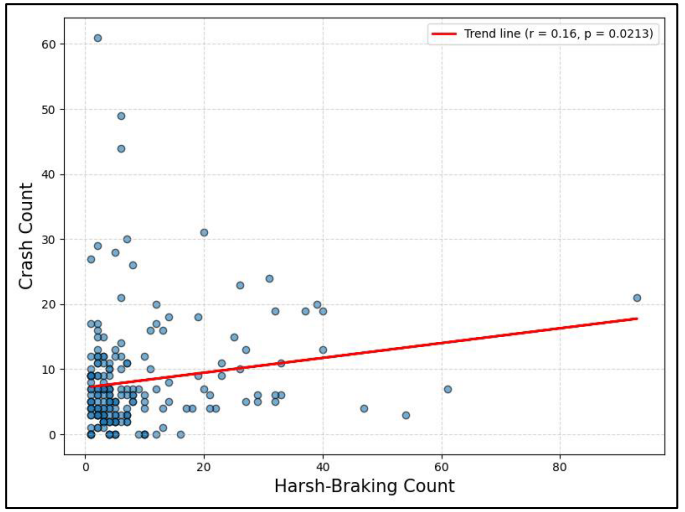
- **Crashes**
  - Identified 6,765 crashes
  - Most crashes on I-95 segments;
  - Peaks in July–October

- **HB**
  - 1,772 HB events detected
  - Most HB on I-95 segments;
  - Sharp rise in Nov–Dec (possibly due to holiday traffic and weather).

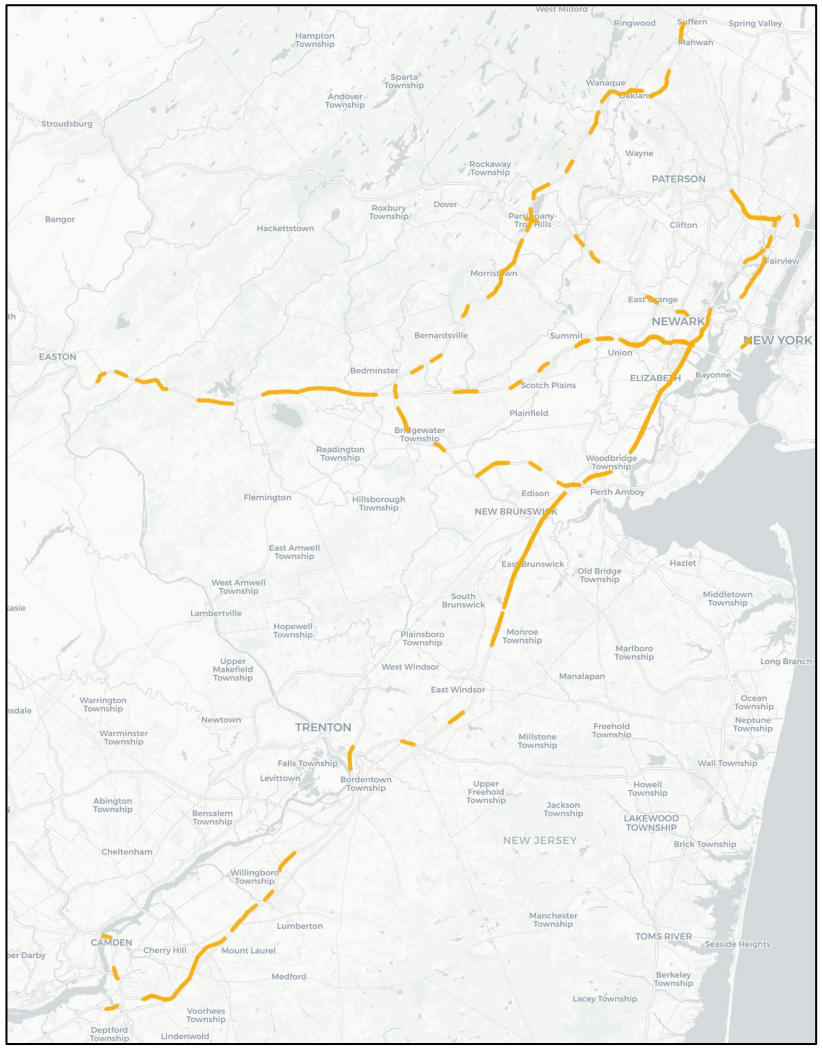
Analysis & Findings

HB and Crash Frequency Correlation

- Identified 195 Segments having both HB and crash counts
- Cluster on I-95, I-80, I-78, I-287, especially near Newark, Jersey City, and toll plazas.
- **Correlation:** Pearson correlation was 0.16 with p= 0.02, meaning a modest but significant correlation.
- **Takeaway:** More HB results in slightly more crashes.



Correlation Between HB and Crashes



Segments with both HB and Crashes

Analysis & Findings

Zero-Inflated Negative Binomial (ZINB) model fits best

- Each extra HB event contributes to a 1% increase in expected crashes per segment.
- **Example:** An increase of 10 HB events corresponds to an expected crash frequency of about 10 % higher.
- The result confirms that HB can events can serve as an early warning indicator of potential crashes.

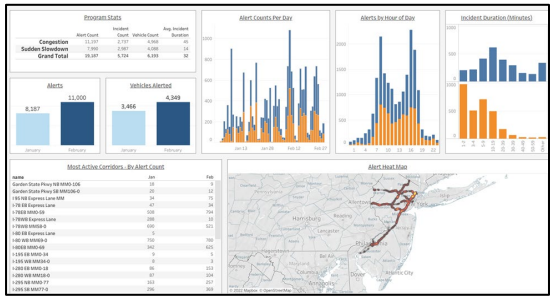
Variables	Coefficient	Std. Error	Z	P>|Z|	AIC	Alpha
Inflated constant	12.77	1097.32	0.01	0.99	1228.63	0.65
Inflated HB counts	-15.03	1097.32	-0.01	0.99		
Constant	2.01	0.08	24.88	0.00		
HB Counts	0.01	0.01	2.12	0.03		

Conclusions

- Statistical Modeling confirmed a positive, statistically significant association between HB events and crash frequency.
- Each additional HB event was linked to roughly a one percent increase in expected crashes, and segments with repeated HB activity exhibited noticeably higher crash risk.
- Although the per-event effect is modest, the cumulative influence of multiple HB events is substantial, signaling that roadway segments with persistent braking activity warrant targeted attention.
- Harsh Braking (HB) activity, derived from connected-vehicle telematics, provides a meaningful surrogate for identifying crash risk on large-scale interstate highway systems.
- From a practical perspective, these findings underscore the value of crowdsourced telematics as a proactive safety management tool.

Recommendations

- Agencies should incorporate HB monitoring into its existing safety dashboards to detect emerging danger zones in near real time.
- Segments with consistently high HB activity should be prioritized for countermeasures such as enhanced signage, targeted enforcement, improved lane guidance, and ramp metering.
- Seasonal monitoring should intensify ahead of late-fall and holiday travel periods when harsh braking surges.
- By combining HB data with crash records, weather information, and traffic conditions, agencies can respond faster and more effectively to prevent crashes before they occur.



Questions & Discussion

Thank you for your attention!

Please feel free to ask anything or share your thoughts.

References

- I. Phase, “The 100 Car Naturalistic Driving Study,” 2006, Accessed: Sept. 15, 2025. [Online]. Available: https://www-nrd.nhtsa.dot.gov/departments/Human%20Factors/driver-distraction/PDF/100CarMain-old.pdf
- Fitch, G. M., Lee, S. E., Klauer, S., Hankey, J., Sudweeks, J., & Dingus, T., “Analysis of lane-change crashes and near-crashes.” Accessed: Sept. 15, 2025. [Online]. Available: https://scholar.google.com/scholar_lookup?title=Analysis%20of%20Lane-Change%20Crashes%20and%20Near-Crashes&author=G.%20Fitch&publication_year=2009
- S. G. Klauer, T. A. Dingus, V. L. Neale, J. D. Sudweeks, and D. J. Ramsey, “The impact of driver inattention on near-crash/crash risk: An analysis using the 100-car naturalistic driving study data,” United States. Department of Transportation. National Highway Traffic Safety …, 2006. Accessed: Sept. 15, 2025. [Online]. Available: https://rosap.ntl.bts.gov/view/dot/62931
- S. G. Klauer, T. A. Dingus, V. L. Neale, J. D. Sudweeks, and D. J. Ramsey, “Comparing real-world behaviors of drivers with high versus low rates of crashes and near crashes,” 2009. Accessed: Sept. 15, 2025. [Online]. Available: https://trid.trb.org/View/894387
- S. E. Lee, E. Llaneras, S. Klauer, and J. Sudweeks, “Analyses of rear-end crashes and near-crashes in the 100-car naturalistic driving study to support rear-signaling countermeasure development,” *DOT HS*, vol. 810, no. 846, pp. 1–125, 2007.
- V. W. Inman, G. W. Davis, I. El-Shawarby, and H. Rakha, “Test track and driving simulator evaluations of warnings to prevent right-angle crashes at signalized intersections,” Turner-Fairbank Highway Research Center, 2008. Accessed: Sept. 15, 2025. [Online]. Available: https://rosap.ntl.bts.gov/view/dot/819