0.1 Executive Summary

Rumble strips are a road safety feature that alerts inattentive drivers of dangers either through vibration, noise or both. With successful placement, rumble strips may reduce the number of accidents. In this analysis, the dataset contained 1,988 Pennsylvanian roads that either were untreated or treated with rumble strips. Our analysis of the data concludes that although there were promising statistics like up to almost 60% reduction in accident rates with certain treated roads from 2008 to 2012, they were not statistically significant. We recommend more road data especially on treated roads and finer time points.

0.2 Hypothesis

We propose that after rumble strips were installed throughout 1,987 road segments in Pennsylvania, the amount of accidents significantly decreased. Our analysis set out to find if there was truly a significant decrease, and if so, if there were specific road characteristics like width and speed that showed the greatest significant decrease, warranting possible future installations with similar roads.

0.3 Data and EDA

The data used contained individual roads with their number of accidents in the years 2004, 2008, and 2012 along with their characteristics like annual average daily traffic (AADT), length, width, speed, shoulder, and intersections. 332 roads were treated with rumble strips and 1656 roads were not; it was not stated which specific year a road was treated, only that the roads with rumble strips were installed between 2008 and 2012.

Our first goal was to determine if PennDot had installed the rumble strips in targeted areas with specific road features, or if treatment was applied randomly. A logistic regression was created with variables adt, width, speed, shoulder, driveway, intersection, and curves which had an AIC of 1635. After removing insignificant variables, the final model was:

$$\begin{aligned} Y \text{ (treat 0 or 1)} = {} & -3.73 + 0.83(\text{adt\_1}) + 1.05(\text{width\_1}) + 1.37(\text{width\_2}) - 0.6(\text{speed\_1}) \\ & + 1.2(\text{shoulder\_1}) + 1.58(\text{shoulder\_2}) + 0.4(\text{intersection\_1}) \end{aligned}$$

This also gave a lower AIC of 1630.9. Looking at the logit curve (Fig. 1), we can conclude that rumble strips were not installed with a pattern or specific criteria in mind, since no point has predicted probability of treatment higher than 0.5; a flip of a coin would give you better chances of predicting which kind of road would have rumble strips installed. To narrow down specific types of roads to test significant difference for, we calculated for the highest percent differences in accident reduction between 2008 and 2012 (Table 1).

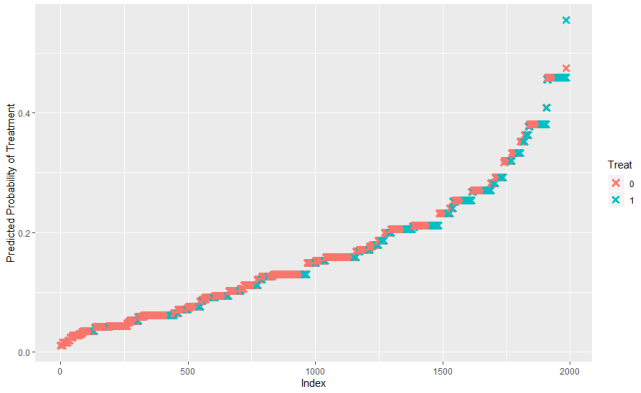

Figure 1. Logit curve of final model

0.4 Results

Since we concluded that there was no pattern in rumble strip installation, we tested for significant reduction in accidents by conducting multiple two-sample, one-tailed t-tests between non-treated and treated roads. A new variable, "adjDiff" was created to control for traffic volume; the difference in traffic accidents from 2008 to 2012 was divided by AADT. This became the mean for our t-tests. Assumptions of normality were met with variable adjDiff (App. Fig. 2 and 3).

	Treatment	'08 to '12 accident reduction rate	n
Width <= 20 feet	0	-5.03%	346
	1	-54.55%	20
AADT <2000	0	-6.67%	510
	1	-33.33%	114
Width <=20 and AADT <2000	0	0.00%	272
	1	-54.55%	19
No intersection	0	2.72%	1162
	1	-10.00%	257

Table 1: Road characteristics with the highest accident reduction rate difference between 2008 and 2012.

Looking at the various p-values for the t-tests (Table 2.), we can see that overall, there's no significant reduction in accidents from 2008 to 2012 between treated and non-treated roads. Testing for specific road characteristics yielded slightly stronger evidence of accident reduction, but still none were statistically significant; roads with width under 20 feet and under 2,000 AADT was closest to significance with p-value 0.1028.

	Overall Treat0 vs Treat1	<2000adt Treat0 vs Treat1	<20 width Treat0 vs Treat1	<2000 and <20 Treat0 vs Treat1	No intersection Treat0 vs Treat1
t	1.2347	1.5112	1.662	1.7026	1.0929
df	509.85	157.14	22.362	21.913	391.6
p-value	0.2175	0.1328	0.1105	0.1028	0.2751

Table 2. Two-sample, one-tailed t-tests and their calculated values

0.5 Conclusion

Given the results from the t-tests, we cannot conclude that installing rumble strips lowered accident rates from 2008 to 2012. Narrowing to specific types of roads like under 2,000 AADT and under 20 feet width produced lower p-values but were still not significant at a 5% level.

Some limitations encountered in the analysis include not knowing the specific year rumble strips were installed and having only three accident data points for each road. Having a bigger sample would also be beneficial because there were five times more untreated roads that treated and narrowing specific treated roads sometimes gave very small sample sizes (19 in the case of <2000 AADT and <20 feet width); compounded with many roads' accidents were zero for both 2008 and 2012 diminished the measurable effects even further.

Appendix

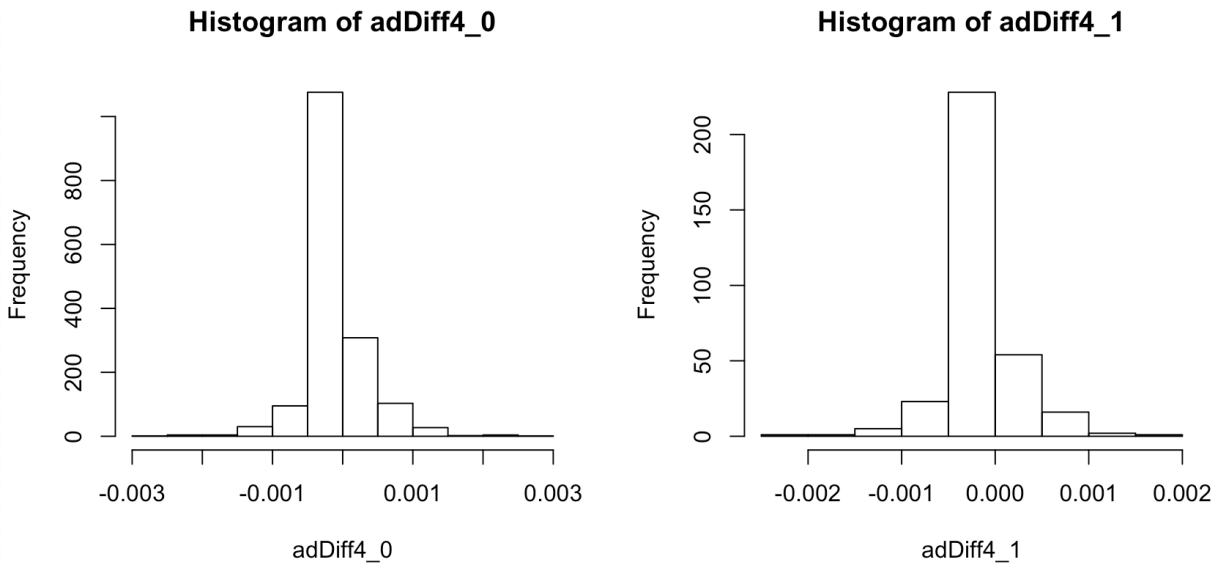

Figure 2: Histogram of 2008 to 2012 change in accidents, adjusted for adt traffic for both no treatment and treatment

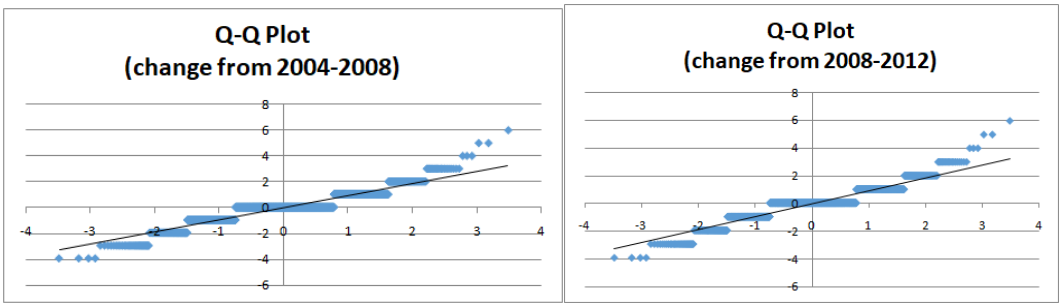

Figure 3: QQ plot of accident difference from 2004 to 2008 and 2008 to 2012