Estimating the Safety Effects of Raising Speed Limits on Rural Freeways in Ohio

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Introduction

- In 2010 the Ohio Turnpike Commission requested to raise the speed limit on the Ohio Turnpike from 65 mi/h to 70 mi/h
- Then the Ohio legislature implemented the 70-mi/h speed limit on 570 miles of rural freeways in Ohio on July 1, 2013
- An additional 398 miles of rural freeways starting on September 29, 2013 were included in this speed limit raise
- The primary goal of this study was to investigate the safety impacts of this speed limit raise using available crash, roadway, and traffic characteristics data

Data Collection

- Traffic crash data from January 1, 2010 to December 31, 2015 was obtained from the Highway Safety Information System (HSIS)
- Therefore, we had 3 years of data prior to the speed limit increase and 2 years after the change were available for this study
- We would have wanted to have at least 3 years for the after period, but currently as this study was in progress, HSIS did not yet have 2016 or newer data.
- The dataset is composed of 36 months before and 24 months after speed limit changes were implemented and were used to assess the impact of the increased speed limits

Figure 1: Road segments where speed limits were raised to 70 mi/h in Ohio

Data Collection…

Table 1: Summary statistics for variables used in the models

Variables	N	Levels	Min	Max	Mean	Std Dev
Number of lanes	2,395	2				
Segment length (mi)	2,395	N/A	0.010	10.040	1.4036	1.6034
FI Crashes	2,395	N/A	0	48	2.4327	3.374
Total Crashes	2,395	N/A	0	153	12.316	15.12
AADT	2,395	N/A	4,870	75,040	35,884	10,830
Median Type	2,395	2				
Median Width (ft)	2,395	N/A	3.0	99.0	50.8	25.14

Methodology

- SPFs were developed using the data available for the before speed limit increase data to estimate the average annual frequency of crashes that occurred on each segment for the observed period
- The negative binomial (NB) model was used to develop the SPFs using JMP Pro 14 software package
- Akaike's Information Criterion (AIC) was used in this study to determine the best fit model
- The study utilized the empirical Bayes (EB) before-after study method in the evaluation of safety effectiveness of the raised speed limit

Methodology…

- Variables shown in Table 1 and their interactions were used in building the SPF models
- The interactions that occur in the algorithm process help in creating an understanding of the relationship amongst the independent variables in the model

Results

- Two models were developed for: (1) total crashes and (2) fatal and injury (FI) crashes
- All independent variables and their interactions were tested at the significance level of $\alpha = 0.05$ for inclusion in the models
- The results are discussed separately for each model

Results….

Total crashes model

- The results show that the natural log of AADT, segment length (mi), and number of lanes were significant at $\alpha = 0.05$
- Median width and median type were not significant in the total crashes model
- Although median width was not significant but due to its interaction with the number of lanes, it was left in the model
- Table 2 shows only variables that were either significant or their interaction terms were significant
- Non-significant variables were removed and thus do not show up in Table 2

Table 2: Total crashes model results

Parameter	Estimate	Standard Error	P value
Intercept	-3.3078	0.6156	<.0001
Ln (AADT)	0.46	0.0575	<.0001
Number of Lanes	-0.2671	0.0798	<.0001
Segment Length	0.51075	0.0136	<.0001
Median Width	0.0029	0.002	0.1485
Number of lanes* Median Width	-00079	0.0023	0.0006
Segment Length* Ln (AADT)	0.2001	0.0345	<.0001
-Loglikehood	4412.42		
AIC	8840		
Generalized R^2	0.655		

Results….

Fatal & injury (FI) crashes model

- The results show that the natural log of AADT, segment length (mi), and median width were significant at $\alpha = 0.05$
- Number of lanes and median type were not significant in the FI crashes model
- The segment length and natural log of AADT had a significant interaction
- Table 3 shows only variables that were either significant or their interaction terms were significant
- Non-significant variables were removed and thus do not show up in Table 3

Table 3: F&I crashes model results

Parameter	Estimate	Standard Error	P value
Intercept	-6.5910	0.8911	<.0001
Ln (AADT)	0.639	0.0836	<.0001
Segment Length	0.4458	0.4458	<.0001
Median Width	-0.0037	-0.0009	<.0001
Segment Length* Ln (AADT)	0.1638	0.0378	<.0001
-Loglikehood	2536.8		
AIC	5085.7		
Generalized R^2	0.446		

Results…

- Thus, the SPF models generated were used to predict the number of crashes that would have occurred if the speed limits were not raised in the after period
- These SPFs were utilized in the EB before-after study method to produce a conclusion on the effect of posted speed limit changes on rural freeways in Ohio that occurred in 2013

Results…

Before and After Empirical Bayes Safety Effectiveness Evaluation Results

- The intent of the EB method is to estimate the expected number of crashes that would have occurred had there been no speed limit change
- Then compares that with the number of observed crashes after posted speed limit change occurred
- The EB before-after study is a reliable method because it accounts for the potential bias due to regression-to-the-mean (RTM)
- The results of the EB before-after analysis for the two crash models developed in this study are summarized in Table 4
- The treatment safety effectiveness is presented for each crash severity level; it is the final step used to determine how the posted speed limit change has affected the safety performance

Results…

Table 4: The Before and After Empirical Bayes Estimation Results

Parameters	Total Crashes	FI Crashes
Overall Unbiased Estimate of Treatment (OR)	0.754	0. 912
Safety Effectiveness	24.6%	8.8%
Variance of Overall Unbiased Effectiveness Var (OR)	0.000	0.001
Standard Error of the Variance SE(OR)	0.015	0.031
SE (Safety Effectiveness)	1.5%	3.1%
Abs [Safety Effectiveness/SE (Safety Effectiveness)]	15.93	2.85
Statistical Significance Confidence Level	95%	95%
CMF	0.754	0.912
SE(CMF)	0.015	0.031

Results…

- The evaluation results in Table 4 show that for raising posted speed limits on the segments analyzed in this study, the safety effectiveness of total crashes was 24.6%
- Likewise, the safety effectiveness of speed change for fatal and injury crashes combined was 8.8%
- The results show that the overall impact of speed raise from 65 mi/h to 70 mi/h was a reduction in the number of total crashes and the number of fatal and injury crashes on rural freeways in Ohio.
- These results are statistically significant at the 95% confidence level
- The reduction seems to be more effective to PDO crashes

Conclusions

- The findings in this study are based on data collected from reported traffic crashes that occurred on selected rural freeways from January 2010 to December 2015
- The safety impacts of the raised posted speed limits on rural freeways in Ohio are based on the SE percentages computed by the EB before-after study method using the Highway Safety Manual (HSM) procedures
- The following are the findings from the Ohio safety effectiveness results:
  - ✓ Safety effectiveness for total crashes is 24.6%, which translates into a CMF of 0.754
  - ✓ Safety effectiveness for fatal and injury crashes combined is 8.8%, which leads into a CMF of 0.912.

Conclusions…

- The results of the study show evidence that the increase of posted speed limit from 65 mi/h to 70 mi/h in July and September of 2013 reduced the crash frequency on the rural freeways in Ohio
- The EB analysis shows that in fact total crashes went down by 24.6% and injury and fatal crashes went down by 8.8% during the two years (2014-2015) after the posted speed limits change was implemented
- However, these results should be interpreted with caution because the after period did not meet the minimum of 3 years recommended by the HSM
- In the current study, only 2 years of the after period were available
- Nevertheless, efforts are underway to obtain additional data from HSIS and ODOT that are more recent for updated analysis

Questions ?