CENTER FOR TRANSPORTATION RESEARCH

Empirical Bayes Before-After Study on Safety Effect of Narrow Pavement Widening Projects in Texas

Presenters: Hui Wu, Zhe Han, Michael R. Murphy , Zhanmin Zhang

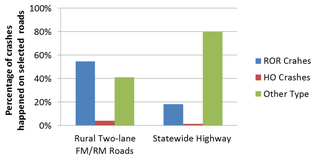
THE UNIVERSITY OF TEXAS AT AUSTIN

Abstract

Texas has approximately 40,000 lane miles (64,000 km) of two-lane farm-to-market (FM) and ranch-to-market (RM) roads with total paved widths of 18 to 22 ft (5.5 to 6.7 m), most of which are in rural areas. The goal of this study is to investigate the safety effects of narrow pavement widening projects for rural two-lane FM/RM roads in Texas.

Background and Motivation

- Crash rate -- 108.4 per 100 million VMT in 2012
- Crashes happed on these roads -- relative high risk of fatal, run-off-the-road (ROR), head-on (HO) crashes



Methodology

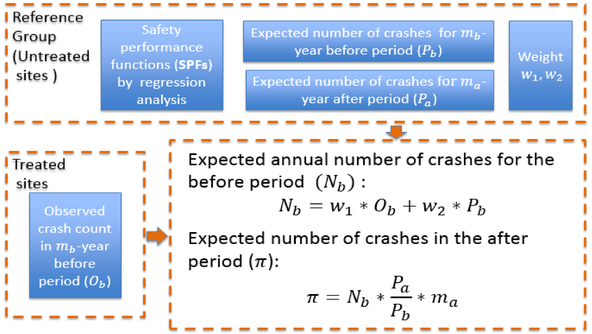
Empirical Bayes before-after method, safety effect of a treatment at a site is estimated by:

$$\delta_{site} = \pi - \lambda$$

where π = the expected number of crashes that would have occurred without the treatment ;

λ = the total number of reported crashes observed in the after period.

Estimation of π :



Data Description

- 22 Narrow Widening (NW) projects in Texas from 2004 to 2011
- Crash data from 2003 to 2012
- For each project, a minimum of 12 months of crash data was available for the before/after periods
- Reference group: 1,585 roadway segments with similar characteristics as the 22 NW projects

		Mean		Min		Max	
		Before	After	Before	After	Before	After
Project Length(mi)		3.54		0.34		14.75	
Construction Period (month)		16		4		35	
Analysis Period(month)		50	54	13	13	93	89
Mean AADT		2573	2709	487	433	7417	7407
Lane + Shoulder Width (ft)		20.7	29.7	20	28	22	40
Crash Counts	Run-off	12	7	0	0	79	43
	Head-on	1	0	0	0	7	6
	Rear-end	1	1	0	0	5	3
	Other	8	5	0	0	55	21
	F+I	12	7	0	0	83	29
	Injury	10	5	0	0	59	26
	PDO	10	6	0	0	61	27
	All	**23**	**13**	**1**	**0**	**145**	**61**
Crash Rates (per million VMT)	**All**	**225**	**107**	**34**	**0**	**1076**	**279**

Variable	Mean	Std. Dev.	Min	Max
Segment Length (mi)	4.05	3.12	0.20	15.09
AADT	575	678.71	7	6263
Curve percentage	0.13	0.18	0	0.75
LW_10	0.60	0.49	0	1
LW_11	0.34	0.47	0	1
All Crash (/year)	0.85	1.66	0	22
ROR Crash (/year)	0.47	1.04	0	13
HO Crash (/year)	0.03	0.20	0	3
F+I Crash (/year)	0.38	0.90	0	14
Injury Crash (/year)	0.35	0.86	0	13
PDO crash (/year)	0.45	0.99	0	14

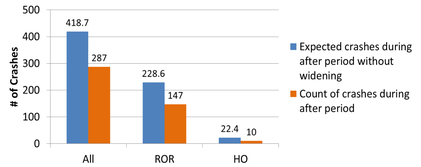
$$P = \exp(\alpha + lnL + \beta_1 lnAADT + \beta_2 LW_{10} + \beta_3 LW_{11} + \beta_4 Curve_{PCT})\gamma_i$$

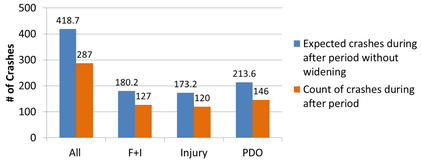
Results

Parameters	Regression models					
	ALL Crash	ROR Crash	HO Crash	F+I	Injury Crash	PDO Crash
α	-7.77	-7.98	-12.83	-8.28	-8.41	-8.56
β_1	1.02	0.96	1.26	0.98	0.99	1.03
β_2	-0.13	-0.16	-0.28	-0.11	-0.13	-0.15
β_3	-	-	-	-	-	-
β_4	-0.13	-	-	-	-	-0.18
γ_{2003}	1.00	1.00	1.00	1.00	1.00	1.00
γ_{2004}	0.94	0.89	0.99	0.91	0.91	0.96
γ_{2005}	0.97	0.95	1.16	0.92	0.93	1.00
γ_{2006}	1.02	0.96	0.95	0.92	0.95	1.09
γ_{2007}	0.94	0.96	1.19	0.87	0.87	1.02
γ_{2008}	1.00	0.87	1.44	0.84	0.85	1.14
γ_{2009}	0.93	0.80	0.84	0.84	0.86	1.00
γ_{2010}	1.00	0.98	1.36	0.87	0.87	1.14
γ_{2011}	0.91	0.93	1.04	0.80	0.81	0.96
γ_{2012}	1.08	1.12	1.48	1.00	1.00	1.15
Dispersion parameter	0.33	0.42	0.68	0.43	0.44	0.30

	All	ROR	HO
# of crashes in after period	287	147	10
Expected crashes in after period without widening (STDV)	418.7 (22.1)	228.6 (15.6)	22.4 (4.4)
% reduction in crashes (STDV)	31.5 (5.4)	35.7 (6.8)	55.4 (15.4)
Index of effectiveness (STDV)	0.68 (0.05)	0.64 (0.07)	0.43 (0.15)

	All	F+I	Injury	PDO
# of crashes in after period	287	127	120	146
Expected crashes in after period without widening (STDV)	418.7 (22.1)	180.2 (15.8)	173.2 (12.7)	213.6 (15.1)
% reduction in crashes (STDV)	31.5 (5.4)	29.5 (8.7)	30.7 (8.0)	31.7 (7.4)
Index of effectiveness (STDV)	0.68 (0.05)	0.70 (0.09)	0.69 (0.08)	0.68 (0.07)





Conclusions

- In general, narrow widening was found to be an effective safety treatment for narrow two-lane FM/RM roads in rural areas.
- Overall crashes decreased by 31.5 percent.
- Significant reductions were found in run-off-the-road and head-on crashes.
- Impacts of narrow widening did not differ significantly among crash severity levels.