Safety Evaluation of raised speed limit on Kansas freeways using EB method

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Introduction

- Speed limit has significant impacts on safety.
- Typically operating speeds are much higher than the speed limit. Driver behavior!!
- Also, higher the speed → higher the energy release and damage.
- Many times speed limits have been raised in Kansas. Important to evaluate the safety implications.
- Understanding will help in the future decision making.

Background

- HB 2192, a bill signed by the Governor and was effective July 1, 2011.
- As a result of this bill, which highways to raise the speed limit on was determined
- Criteria to determine speed limit increase:
- 1-Rural/Urban area
- 2-Commuter traffic
- 3-Geometrics
- 4-Surrounding State Speed Limits

Background (continued)

- Raising Speed Limit **opponents** and **Supporters** ideas:
- **Supporters Statements**:
- drivers were already driving 5-10 mile above the posted speed limit and therefore it made sense to make it formal and it also help the economic development of Kansas
- **Opponents Statement**:
- drivers would not change their behavior and still driving above the posted speed limit bringing the actual speeds to even higher values

Objective:

- Safety Evaluation of raised speed limit based on **Empirical Bayes Before-after studies** as the First Methodology offered by **Highway Safety Manual** (HSM)

Literature review

Author	Country	Speed limit change	Findings
Renski, H., Khattak	North Carolina, U.S.A	55 mph to 65 mph	Injury severity increased on rural roadways
Malyshkina, N.	Indiana, U.S.A	65 mph to 70 mph	Injury and fatality rate increased on rural roads
Lund, V. K	Iowa, U.S.A	65 mph to 70 mph	Crash severity, fatal and major injury crashes increased on rural interstates
Rock, S.M.	Illinois, U.S.A	55 mph to 65 mph	Caused additional crashes and more deaths and injuries on rural interstates

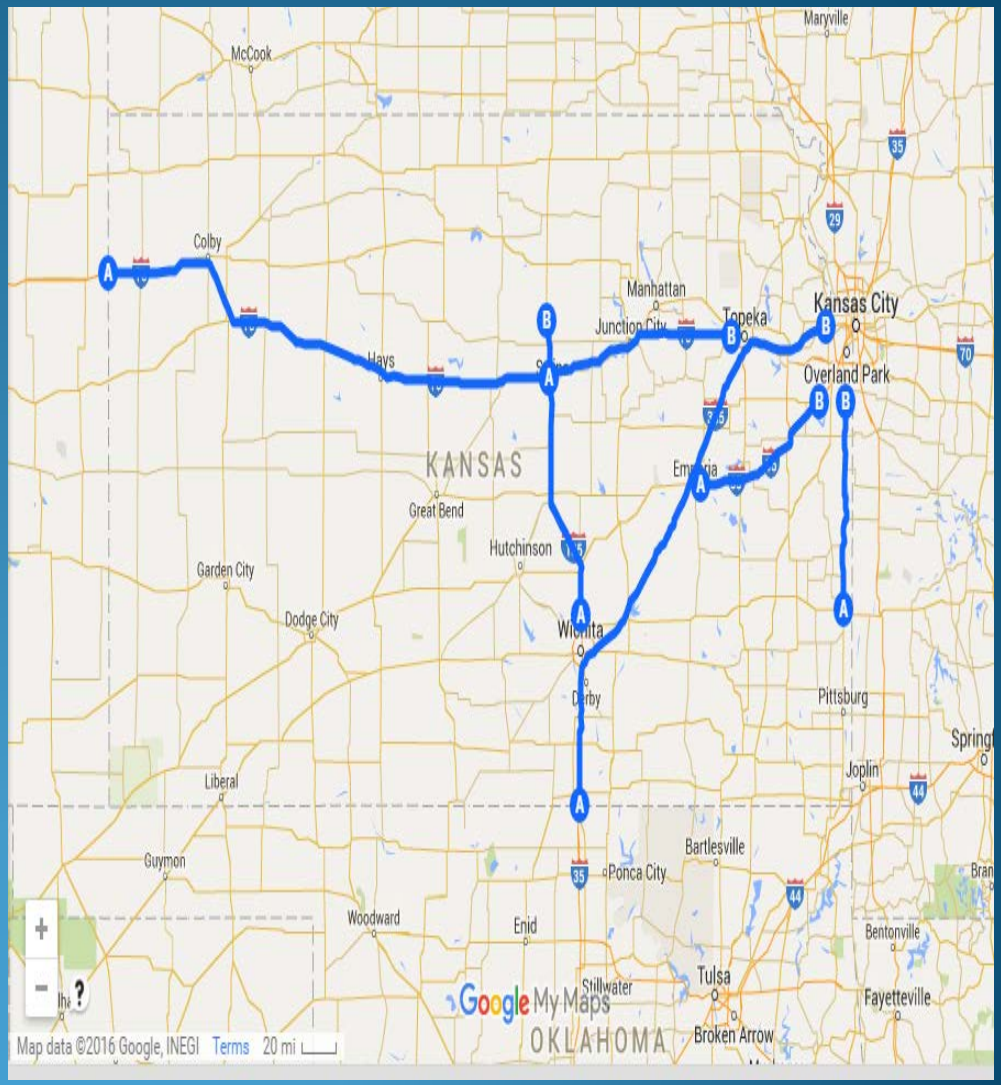
Literature review(continued)

Author	Country	Speed limit change	Findings
Gates, T.	Michigan, U.S.A	55 mph to 65 mph	It caused an increase in fatal and incapacitating injuries for non freeway sections
Ossiander, E.M.	Washington, U.S.A	55 mph to 65 mph	Fatal crashes increased per year but total crashes did not change any on rural freeways.
Najjar, Y.M.	Kansas, U.S.A	55 mph to 70 mph	Fatal crashes increased on two lane rural highways

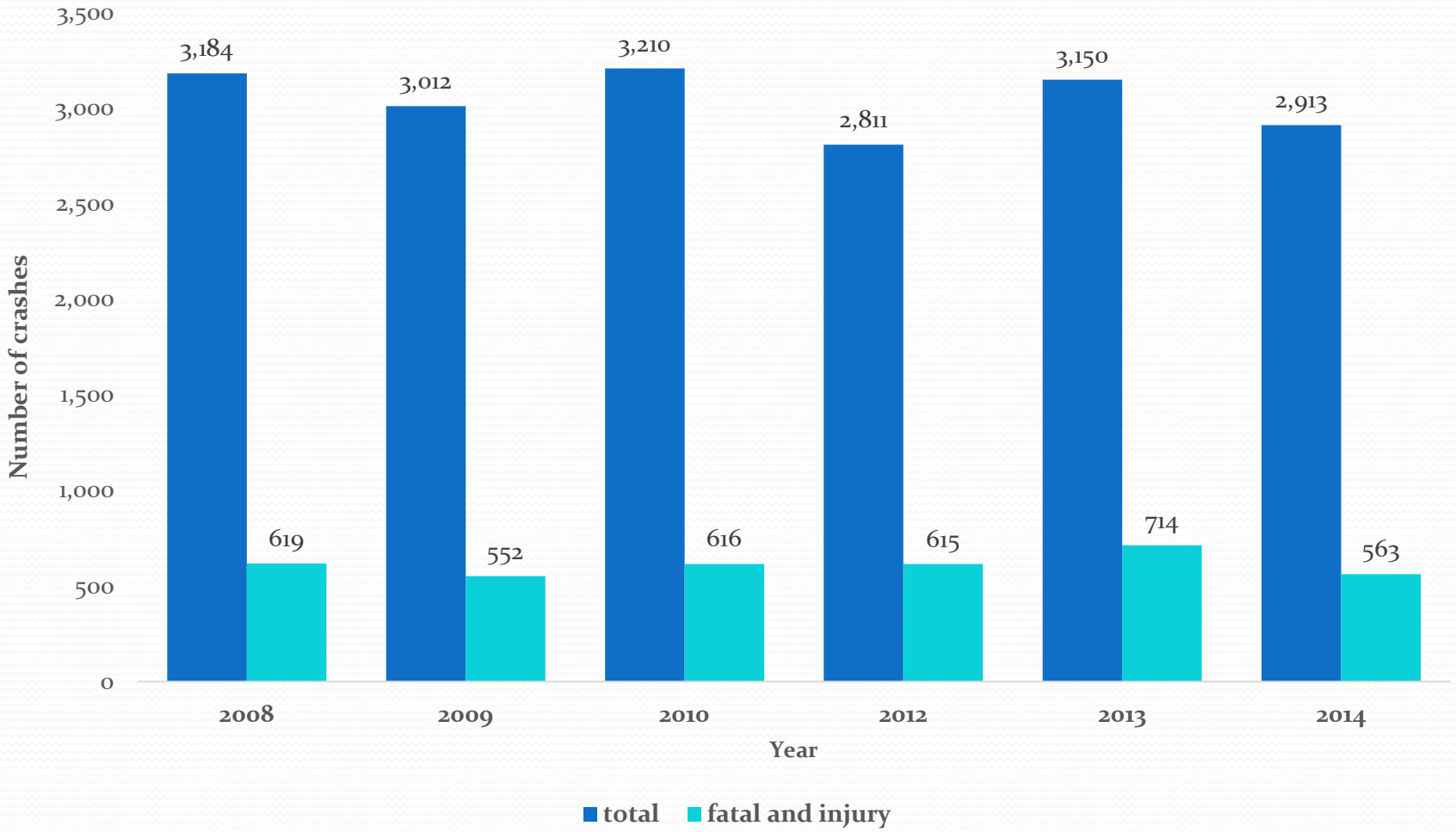
Roadways Affected by SL Change

The freeways that speed limit changed from 70 mph to 75 mph in July 2011 :

Route	Start point	End point	Total mileage(miles)
I-35	0	198.406	198.406
I-70	0	401.152	401.152
I-135	22.270	95.738	73.468
I-335	0	50.130	50.130
I-470	6.842	13.722	6.88
U.S-69	67.683	129.235	61.552
U.S-81	151.786	169.018	17.232
Total Mileage			**808.82**



Total crashes and fatal plus injury crashes of the subject roadways



Safety Evaluations using Crash Modification Factors (CMF)

CMF Definition:

A multiplicative factor used to compute the expected number of crashes after a treatment implementation.

The most common CMF development methods used to evaluate the safety effectiveness are:

- **Empirical Bayes before-after study**
- **Before-after with comparison group**
- **Cross-sectional model**

Highway Safety Manual(HSM)

- Chapters used in this study:
- **Chapter 9**: Safety Effectiveness Evaluation methods and all relevant information to safety methods.

- **Chapter 18**: Predictive method for **freeways**

Safety evaluation using CMF

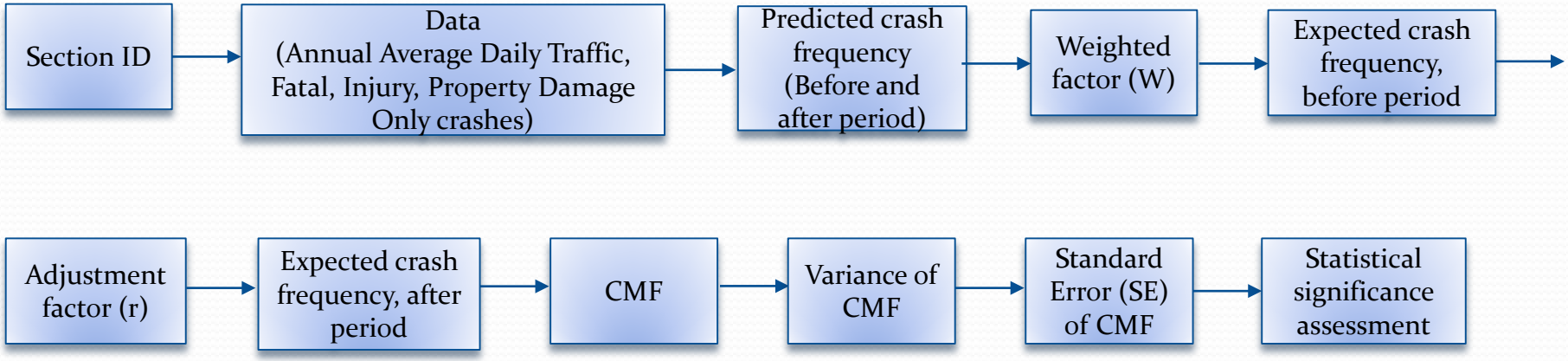
- The first CMF method "Empirical Bayes Before-After Study"
- Carried out first in this study.
- Important features:

PROs	CONs
Predicted crash frequency is considered by using SPF.	Only treated sites are considered.
CMF is estimated for treatment impact	No SPF for non-treatment sites
Safety effectiveness is estimated at a specific confidence level	No comparison between treated sections versus non-treated sections
Considers regression to the mean (RTM)	Treatment impact only works for treated sites

Data needs-EB method

- **Sections** that speed limit changed from 70 mph to 75 mph are identified with details of site characteristics and crash details.
- **3 years before(2008 to 2010) and 3 years after (2012 to 2014)** the speed limit change considered.
- The year 2011 is not considered since speed limit change happened in that year.

Steps of EB method



CMF results for treated sections

ID	County	Beginning location	Length (mile)	CMF (Total crashes)	CMF (fatal and injury crashes)
1	Sumner	2.7M N state LN	33.35	1.059	0.860
2	Sedgwick	Suab Wichita	21.08	1.260	1.234
3	Butler	SCL Andover	41.86	1.308	1.002
4	Chase	1.3 M N Scol	19.87	0.883	0.833
5	Lyon	Thorndale rd	21.44	1.264	1.006
6	Coffey	I35/K131	13.36	1.118	0.697
7	Osage	1.45 M N CO L	11.47	0.907	0.857
8	Franklin	I35/K273	31.06	1.008	0.805
9	Miami	2.6 MI N W CO L	2.83	0.865	1.044
10	Sherman	I70/K267	35.28	1.130	0.742
11	Thomas	0.9 MI E WCOL	39.55	1.071	0.720
12	Logan	LG/GO CO LN	0.80	1.163	0.814
13	GOVE	I70/U40	37.50	0.980	0.790
14	Trego	1.1 MI E Wcol	30.59	1.233	0.561
15	Ellis	K247 RS 230	31.21	1.056	0.813
16	Russell	RS 48	30.05	1.097	0.481

CMF results for treated sections (Continued)

ID	County	Beginning location	Length (mile)	CMF (Total crashes)	CMF (fatal and injury crashes)
17	Ellsworth	I70/K232	23.24	1.107	0.984
18	Linclon	RS 1751	7.24	1.309	0.789
19	Saline	RS 447	30.53	1.181	0.715
20	Dickinson	I70/K221	23.45	1.120	0.586
21	Geary	RS 270	26.53	1.634	1.681
22	Riley	RS 1315	5.97	1.433	1.815
23	Wabaunsee	Wabaunsee rd	24.00	1.308	1.257
24	Shawnee	1470 Undrpas/I70	11.50	1.023	0.996
25	Douglas	1.1 MI E W CO L	17.29	0.892	1.136
26	Leavenworth	0.7 MI E W CO LN	16.56	1.063	1.189
27	Wyandotte	1.4 MI E WCOL	1.77	1.413	3.328
28	Sedgwick	RS 612	4.55	0.580	0.701
29	Harvey	I135/K196	20.82	1.174	0.805
30	Mcpherson	SJCT I135/K260	33.84	1.215	0.694
31	Saline	SJCT I135/U81/K4	18.79	1.138	0.952
32	Lyon	0.04 MN	27.35	1.060	0.473
33	Wabaunsee	WB/OS CO LN	0.58	0.708	0.000
34	Osage	OS/SN CO LN	10.60	1.126	0.717
35	Shawnee	1.5 M NE S CO L	11.58	1.498	1.015
36	Shawnee	I470/KTA	6.26	1.192	1.393
37	Miami	U69/K68	24.40	2.164	0.523

Final results from EB method

- **The overall CMF** value is estimated through the following equation :

$$OR=\frac{\frac{\sum All\ sites\ N_{Observed,After}}{\sum All\ sites\ N_{expected,After}}}{1+\frac{Var(\sum all\ sites\ N_{expected\ After}}{\sum(All\ sites\ Nexpected\ After)^2}}$$

$$\text{OR (}\mathbf{CMF}\text{)}=\frac{1.161}{1+\frac{4{,}536.764}{7{,}638.06^2}}=1.160 \text{ (Total crashes)}$$

$$\text{OR (}\mathbf{CMF}\text{)}=\frac{1.008}{1+\frac{372.141}{1{,}876.93^2}}=1.007 \text{ (Fatal and Injury crashes)}$$

- This CMF is representing **16.0% increase** in total crash frequency for treated sites.

Statistical significance results

- $\left|\frac{safety\ effectiveness}{SE(safety\ effectivenss)}\right|=\frac{16}{1.160}$=10.0≥2, the treatment effect is significant at 95% confidence level (Total crashes).

- $\left|\frac{safety\ effectiveness}{SE(safety\ effectivenss)}\right|=\frac{0.7}{2.53}$=0.27<1.7, the treatment effect is not significant at 90% confidence level (Fatal and Injury crashes).

Conclusion

- **Total crashes increased by 16% and this increase was statistically significant at 95% confidence level.**

- **On the contrary, fatal and injury crashes had no statistically significant increase at all.**

Future works:

Additional methods are needed:

- **1-Before-after with comparison group method**
- **2- Cross sectional method**
- **3-Speed study**
- **4- Contributory Crash Causes consideration and all other vehicles involved in crashes and some statistical methods utilization**
- **5-Etc.**

Questions

Thank you!!