The 70 mph Speed Limit: Speed Adaptation, Spillover, and Surrogate Measures of Safety

Victor Lund
Department of Civil, Construction, and Environmental Engineering
Iowa State University
394 Town Engineering
Ames, IA 50011
vklund@iastate.edu

Reginald Souleyrette
Center for Transportation Research and Education
Iowa State University
2711 S. Loop Dr., Suite 4700
Ames, IA 50010
reg@iastate.edu

Thomas Stout
Department of Civil, Construction, and Environmental Engineering
Iowa State University
352 Town Engineering
Ames, IA 50011
stouttom@iastate.edu

ABSTRACT

Although numerous publications have studied the safety effects of speed limit policy, the topic continues to be the subject of lively debate. On July 1, 2005, the speed limit on rural interstates in Iowa was increased from 65 mph to 70 mph. This research first conducted a before–and-after study on rural interstates and other facilities to study the effects on safety performance in Iowa due to this speed limit change. The study explored the impact of the speed limit change on two effects known as the "speed adaptation" and "spillover" effects. Research was also conducted on traffic citations issued on the rural interstate because citations may be a surrogate measure for highway safety. Finally, research was conducted on the recent increase in the retail price of gasoline and its effect on driver behavior.

Key words: safety—speed adaptation—speed limit—spillover effect—traffic citations

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DISCLAIMER

The data analysis included herein is not intended to be an exhaustive before-and-after study of the safety effects due to the increase of the rural interstate speed limit from 65 mph to 70 mph and should therefore be considered preliminary. No conclusions on the actual impact the increased speed limit has had on safety can or should be drawn from these data. An additional study conducted by the Center for Transportation Research and Education will be completed when more data are available.

1. PROBLEM STATEMENT

One of the essential components in providing safe roads is the speed limit. However, speed limit policy continues to be controversial. On July 1, 2005, the speed limit on rural interstates in Iowa was increased from 65 mph to 70 mph. This change had been long considered by policymakers and the Iowa Department of Transportation (Iowa DOT) and was the subject of lively debate. Of concern was the impact the speed limit change on rural interstates had on safety performance and whether this change negatively affected other facilities (spillover) in terms of crashes and speeds. Additionally, the rural interstate speed limit introduced a 15 mph speed limit differential to rural primary highways that intersected and shared mutual access with the interstate. This speed limit differential may have induced or augmented an effect known as the “speed adaptation” effect.

2. RESEARCH OBJECTIVES

This research first examined crash performance on and off the system. It also explored the impact of the speed limit change on an effect known as the “spillover” effect to determine if increasing the speed limit on the rural interstates negatively affected other systems in terms of crashes or speeds. Because traffic citations reflect driver behavior, they may be a surrogate for highway safety. Research was then conducted on traffic citations issued before and after the speed limit change. If the recent increase in the retail price of gasoline did reduce the amount of travel, it may have partially masked any negative effects of the speed limit change. Research was conducted on the retail gasoline price and its corresponding effect on driver behavior in terms of the amount of travel. Finally, this research studied the speed adaptation effect in rural Iowa to determine if this effect exists and over what distance.

3. RESEARCH METHODOLOGY

Crash data were obtained for the period January 1, 2003, to December 31, 2006. This provided up to 30 months for the before period and up to 18 months for the after period. The crash data used for this study were downloaded from the Iowa DOT database on April 2, 2007, and included a variety of information about each crash. Each crash is assigned a geographical coordinate that can be mapped using a geographical information system (GIS) software package. Crashes that were within a specified distance of any facility of interest were assigned to that road type within GIS. A total of 3,261 out of 232,061 crashes (for the years 2003 to 2006), or 1.4%, were not assigned a coordinate, and thus they could not be located on a map and were not used for this research. Once the crash data were assigned to the appropriate road types, they were summarized by the number of crashes within the various severity categories on a monthly basis. The severity categories included in this analysis were fatal, fatal and major injury, and all crashes. The analysis period for crashes included a before period of July 2003 to December 2004 and an after period of July 2005 to December 2006.

In addition to the crash data, speed and volume data for each facility type were collected from the Iowa DOT. During discussions with the Iowa DOT, it was noted that the automatic traffic recorder (ATR) database was changed during the summer of 2004. Because of this change, the analysis period for the speed data was August 2004 to December 2006. The speed data were summarized by the average speed and 85th percentile speed. Volume data were obtained from the monthly ATR reports provided on the Iowa DOT's website. The analysis period for volume was the same as for the crash data.

3.1. Before and After Study

Rural interstates were the primary focus of this research. Rural interstate crashes were further defined as occurring during the day or night based upon official sunrise and sunset times obtained from the United States Naval Observatory. The website of the United States Naval Observatory provides an online product that provides the sunrise and sunset times for a given year at any location within the United States (US Naval Observatory 2006). Because of the longitudinal width of the state of Iowa, the sunrise and sunset times are different for the east and west ends of the state. Therefore, it was assumed that the sunrise and sunset times for a central location in Iowa would approximate the sunrise and sunset times for every location within the state. The central location selected was Ames, Iowa.

3.2. Spillover Effect

To determine if the speed limit change negatively affected other systems, other road types were analyzed to test for any type of spillover effect. The four road types that were analyzed are the following:

- Urban interstates
- Rural expressways
- Rural other primary highways
- Rural non-primary roads

3.3. Rural Interstate Traffic Citations

When the speed limit increase was passed by the Iowa Legislature, the governor committed to stepping up enforcement to mitigate any potential safety concerns. A change in the number of speeding citations could be considered as a surrogate for a change in the number of speed-related crashes. However, information was only available for electronic citations (not paper). Therefore, the number of electronic speeding citations could not be compared before and after the change in the speed limit. Instead, the monthly ratio of rural interstate electronic speeding citations to all rural interstate electronic citations was calculated for the period of January 2004 to December 2006. A database consisting of all electronic traffic citations issued by the Iowa State Patrol was obtained through the Center for Transportation Research and Education (CTRE) at Iowa State University.

3.4. Retail Gasoline Price

The recent increase in the retail price of gasoline may have affected the travel behaviors of drivers in Iowa. Because of the higher prices, drivers may tend to drive less and attempt to conserve fuel. Therefore, it is possible that the higher cost of gasoline may have partially canceled out some effects of the increase of the rural interstate speed limit. To determine if the cost of gasoline did have an effect on driver behavior and therefore offset some of the possible negative impacts of the speed limit change, the price of gasoline for the recent history in Iowa was collected. It was presumed that if drivers altered their behavior due to the higher cost of gasoline, this behavior would be most pronounced on a facility that accommodates longer trips, namely rural interstates.

Data for the retail price of gasoline in Iowa were obtained from the United States Department of Energy (Energy Information Administration 2007). The gasoline formulation selected for this analysis was regular grade gasoline sold through retail outlets. Prices were recorded on a monthly basis. The analysis period was selected as January 2002 to December 2006, coincident with the availability of ATR reports.

3.5. Speed Adaptation

Speed adaptation is thought to occur in locations where drivers exit a high-speed facility and enter a lower speed facility (Casey and Lund 1987; Matthews 1978). Therefore, when studying this effect, it is desirable to find two adjacent facilities (one being a rural interstate) with mutual access and a large speed limit differential. In Iowa, the locations that best support these criteria are rural interstate interchanges. Study sites were selected at locations in which a rural two-lane undivided primary highway intersected with and provided access to a rural interstate that provided a speed limit differential of 15 mph. After reviewing potential study sites, a total of four were selected along the I 35 corridor. For each study site, a test section was located on the east side of the interstate. All four sites were located on flat terrain with no horizontal curves. The fourth site was eventually eliminated from the study because of data corruption that occurred during the data collection process. Figure 1 illustrates the study locations.

Using a series of road tubes, vehicles exiting the interstate were tracked through the study site. Since the counters (as shown in Figure 1) could not communicate with each other, a computer program was written to track experimental vehicles at each counter. The program used the date, time, and class fields to identify target vehicles at each counter, and it used a progressive process to track the vehicles through the system. This progressive process used speeds and times at the first counter as the basis for identifying target vehicles at the second counter. Once all the target vehicles had been tracked to the second counter, they were used as the basis for identifying vehicles at the third counter. This process was repeated until all target vehicles were identified. Control vehicles were those identified as traveling in the westbound lane. Speeds for control vehicles were observed at the last (east-most) counter.

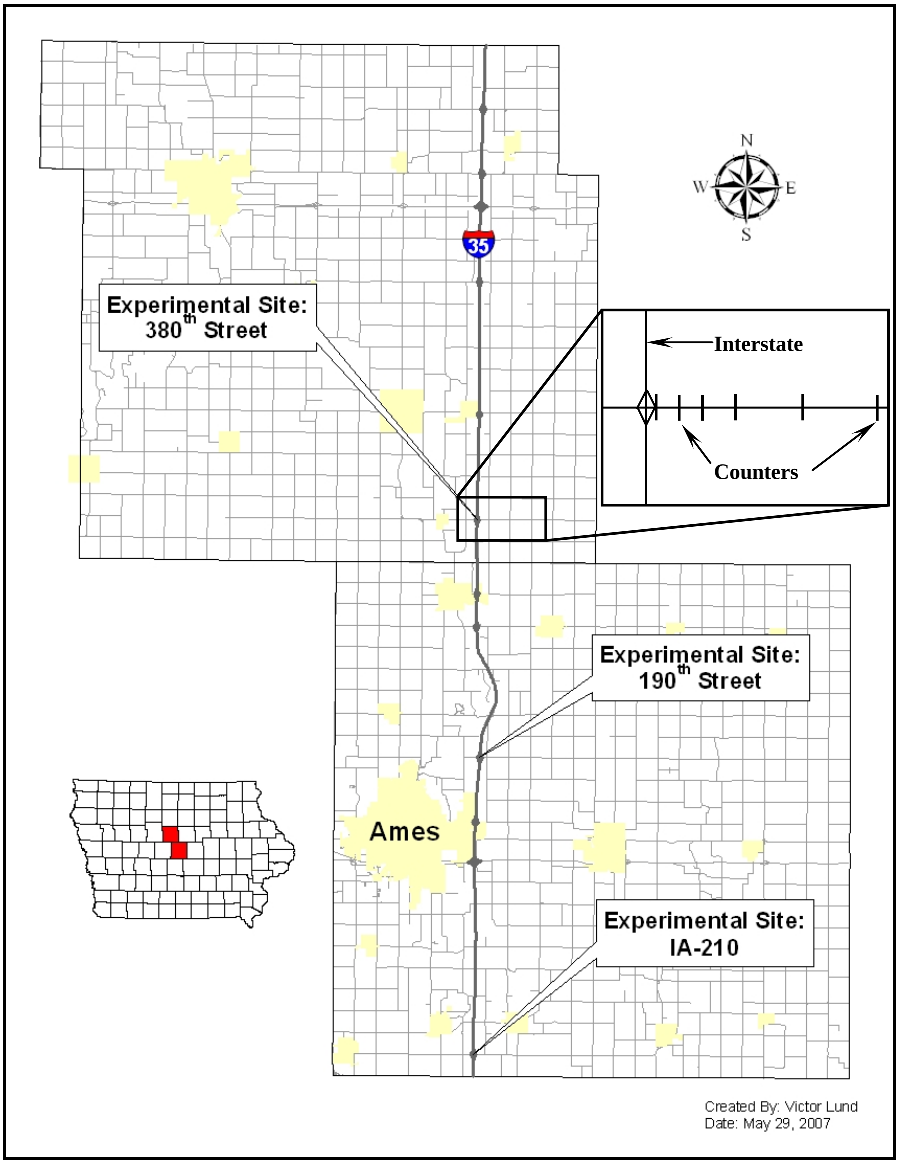

Figure 1. Speed adaptation sites

4. KEY FINDINGS

Table 1 displays a comparison of the before and after period monthly crash frequency means with a before period of July 2003 to December 2004 and an after period of July 2005 to December 2006. For each road type, a two-sample t-test assuming unequal variances was conducted to determine if the change in the crash frequency mean was statistically significant at the 95% confidence level. The results of a similar t-test are also displayed in Table 1 for average and 85th percentile speeds for each road type. A plus (+) sign indicates a statistically significant increase, while a negative (-) sign indicates a statistically significant decrease. The recorded monthly crashes are frequency means, and are not rate-adjusted for traffic volume. However, only small changes were observed in the traffic volume between the before and after periods.

Table 1. Summary of before and after period average monthly crash frequencies

Road Type	Crash Severity	Before Period Crash Frequency	Before Period Monthly Mean	After Period Crash Frequency	After Period Monthly Mean	Percent Change	Crash P-Value (one-tail)	Crash Significance (α = 0.05)	Average Speed Significance (α = 0.05)	85th Percentile Speed Significance (α = 0.05)
Rural Interstate	Fatal	29	1.61	40	2.22	37.9%	0.069	close		
	Fatal and Major Injury	117	6.50	138	7.67	18.0%	0.070	close	+	+
	All	2811	156.17	2940	163.33	4.6%	0.363			
Rural Interstate Daytime	Fatal	19	1.06	21	1.17	10.4%	0.376			
	Fatal and Major Injury	70	3.89	75	4.17	7.2%	0.374		+	+
	All	1299	72.17	1325	73.61	2.0%	0.431			
Rural Interstate Nighttime	Fatal	10	0.56	19	1.06	89.3%	0.087			
	Fatal and Major Injury	47	2.61	63	3.50	34.1%	0.143		+	+
	All	1512	84.00	1615	89.72	6.8%	0.373			
Urban Interstate	Fatal	15	0.83	16	0.89	6.8%	0.428			
	Fatal and Major Injury	93	5.17	89	4.94	-4.4%	0.383			
	All	2685	149.17	2346	130.33	-12.6%	0.106	close		-
Rural Expressway	Fatal	51	2.83	42	2.33	-17.7%	0.156			
	Fatal and Major Injury	183	10.17	178	9.89	-2.8%	0.411		-	-
	All	4365	242.50	4032	224.00	-7.6%	0.277			
Rural Other Primary	Fatal	105	5.83	140	7.78	33.4%	0.037	+		
	Fatal and Major Injury	479	26.61	490	27.22	2.3%	0.412		-	-
	All	8814	489.67	8620	478.89	-2.2%	0.421			
Rural Non-Primary	Fatal	227	12.61	218	12.11	-4.0%	0.365			
	Fatal and Major Injury	1046	58.11	981	54.50	-6.2%	0.162			
	All	15189	843.83	14801	822.28	-2.6%	0.359			
All Rural	Fatal	412	22.89	440	24.44	6.8%	0.233			
	Fatal and Major Injury	1825	101.39	1787	99.28	-2.1%	0.358			
	All	31179	1732.17	30393	1688.50	-2.5%	0.391			

4.1. Before and After Study Results

Overall, rural interstates experienced an increase in the higher severity crashes, such as fatal and fatal and major injury crashes. Table 1 shows that rural interstates experienced an increase in each crash severity, with fatal crashes increasing the most at 38%. Rural interstate nighttime fatal crashes increased by 89%. Although the change in the rural interstate monthly crash frequency mean was not statistically significant, the reported p-values were relatively low.

The diurnal effect of speed limit change was also investigated. Figure 2 displays the average daytime and nighttime speeds on the rural interstate for the period of August 2004 to December 2006. Both the daytime and nighttime speeds are observed to be slowly increasing after the speed limit change.

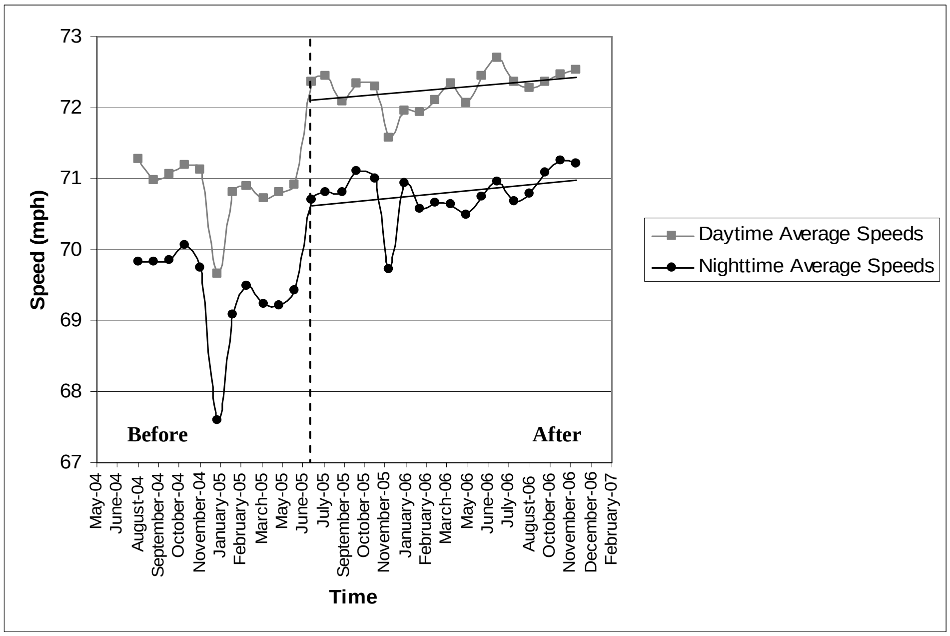

Figure 2. Rural interstate daytime and nighttime average speeds

A crash trend analysis was also completed for the rural interstates. Crash frequencies, adjusted for volume, were plotted for one-year periods. Each data point represents the one-year running average. Trend lines were fit to the before period data and extrapolated through the after period data. The difference between the expected mean crash frequency and the observed mean crash frequency in the after period was calculated and is summarized in Table 2.

Table 2. Rural interstate crash trend analysis

Crash Severity	Period	Observed Average Frequency	Expected Average Frequency	Difference
Fatal	before	24	24	0
	after	30	25	5
Fatal and Major Injury	before	93	93	0
	after	112	107	5
All	before	2217	2210	7
	after	2232	2175	57

4.2. Spillover Effect Results

Rural other primary highways have experienced an increase in fatal crash frequency mean relative to all other road types (33%), which was statistically significant. Both rural other primary highways and urban interstates experienced a similar change in higher severity crashes. However, rural expressways and rural non-primary roads experienced a decrease for all crash severities.

Interestingly, the increase in the monthly crash frequency means for rural other primary highway fatal crashes were statistically significant, while at the same time, a decrease in average and 85th percentile speed means were also reported as statistically significant.

4.3. Traffic Citation Results

Figure 3 displays the calculated ratio of electronic speeding citations to all electronic citations. Immediately following the change in the rural interstate speed limit, the months of July, October, and November of 2005 recorded a relatively higher ratio, which could indicate a short-term increase in the number of speed-related crashes or an increase in enforcement. Overall, there is no discernable change in the ratio of electronic speeding citations to all electronic citations on the rural interstate between the before and after periods. It is interesting to note that, very recently, the Iowa State Patrol has indicated that they will again step up enforcement due to increased numbers of crashes on the Iowa interstates.

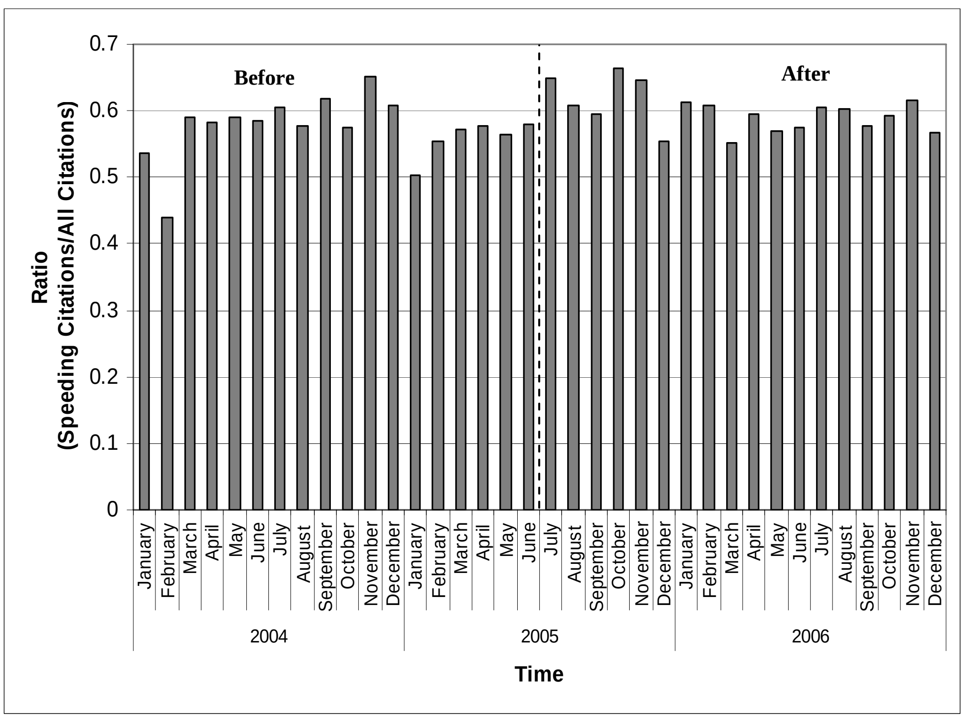

Figure 3. Ratio of rural interstate electronic speeding citations to all rural interstate electronic citations

4.4. Effect of Retail Gasoline Price Change

Because fuel prices both affect and are affected by travel demand, this relationship was examined as part of this study. Figure 4 displays the ratios of observed average daily traffic (ADT) and price in each month in 2006 to their corresponding data for 2005. As shown, the ADT ratio hovered around 1.0 while the gasoline price ratio remained mostly above 1.0. It may be concluded that, at least for Iowa in this two-year period, higher gasoline prices did not have a significant effect on rural interstate ADT.

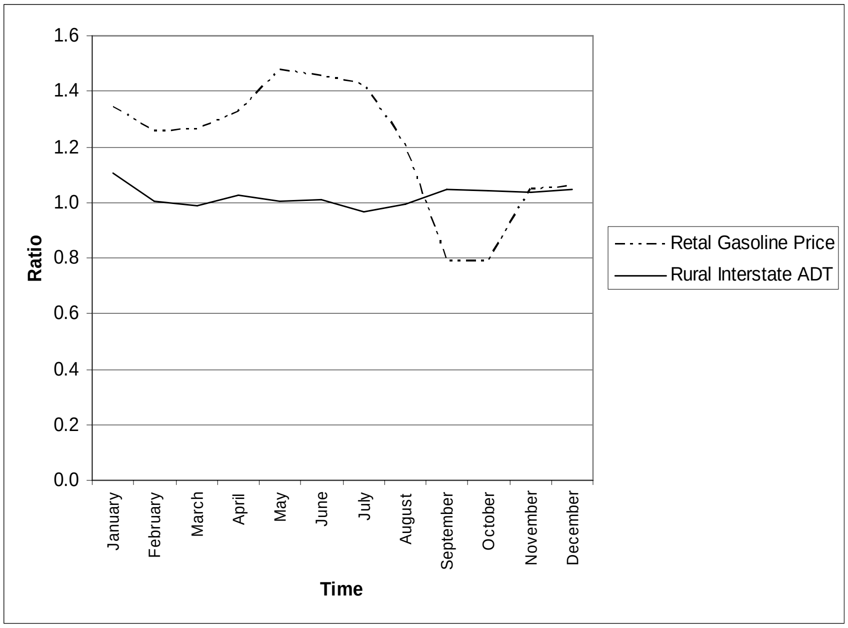

Figure 4. Ratio of rural interstate ADT to retail gasoline price in Iowa

4.5. Speed Adaptation Results

The results for all three speed adaptation study sites indicated that there was no significant difference between experimental vehicles and control vehicles' speeds for all vehicles, passenger vehicles, and those observed during the p.m. period. In fact, most of the observed experimental vehicles' mean speeds were less than the control vehicles' mean speeds. These results indicate there is little or no speed adaptation effect on those drivers who had exited the interstate onto a 55-mph rural primary highway. One of the concerns related to increasing the rural interstate speed limit was whether drivers would continue to drive at higher speeds than they normally would have upon entering non-interstate roads. Because the speed adaptation effect is not observed to exist in drivers who exit the rural interstate onto non-interstate rural primary highways, as the results suggest, a 15-mph speed limit differential is not observed to induce this effect.

5. CONCLUSIONS

Although more data (over time) would be required for statistical significance, safety performance of the rural interstate system in Iowa appears to have declined in the period following the 2005 speed limit increase. As shown in Table 1, the percentage changes in fatal crashes and in fatal and major injury crashes on the rural interstate were greater than for all crashes. The increase in more severe crashes also suggests that crashes may have become more severe as a result of a higher speed limit, especially at night.

Following the rural interstate speed limit change, daytime and nighttime average speeds are observed to be increasing over time. Comparing before and after periods, both average and 85th percentile speeds significantly increased at the 0.05 level.

No speed spillover effect was observed from rural interstates to other roads. Additionally, it was observed that there was no shift in traffic from other primary roads to the rural interstate.

The ratio of rural interstate electronic speeding citations to all rural interstate electronic citations did not seem to increase in the long run in the after period. Also, higher gasoline prices did not appear to have an effect on the amount of travel.

The speed adaptation study found no evidence of any significant differences in speeds of those vehicles exiting the interstate and those on the intersecting highway. Because there was little difference in the experimental and control vehicles' speeds, it is concluded that the speed adaptation effect is not significant on rural primary highways in close proximity to the interstates in Iowa. Although not observed in the present study, the speed adaptation effect may occur in more urbanized environments or in different types of rural facilities or locations.

ACKNOWLEDGMENTS

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