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65 mph SPEED LIMIT: ANALYSIS OF FATAL ACCIDENT INJURY SEVERITY

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I. Overview

Several studies of the fatality experience in the 38 states that implemented a 65 mph speed limit on Rural Interstate highways in 1987 concluded that the higher speed limit has caused fatalities to increase [1]. This relationship between the speed limit and fatalities was found when the experience of all these states was considered simultaneously.

Another perspective has been used as well, mainly in more informal analyses. These analyses examined the fatality experience of one state to draw conclusions about that state, and often, by inference, other states. These efforts have produced mixed results. The small and variable numbers of Rural Interstate fatalities makes individual state analyses difficult.

This study seeks to extend the studies of the group experience of states that raised the speed limit along three lines:

(1) including all 1988 data from the Fatal Accident Reporting System (FARS) to look for effects on occupant fatalities. Most studies used data only for 1987 [2].

(2) examining not only occupant fatalities, but the injury severity distribution of all occupants in fatal accidents.

(3) using the added data to try to learn more about the way in which speed affects the number and severity of accidents.

II. Summary of Findings

This study reaches three main conclusions:

(1) Rural Interstate fatalities among occupants increased in 1988 in the 40 states that implemented the 65 mph speed limit. In 1988, occupant fatalities on those Rural Interstates were 20 percent higher than would be expected based on the statistical relationships (from 1975-1986) among Rural Interstate occupant fatalities and all other fatalities occurring in the same years and states. A 95 percent confidence interval would place the estimated effect within a range of 8 to 32 percent. If no other forces acted to change the 12-year relationship, the fatality increase in 1988 must be attributed to the higher speed limit.

(2) Not only have occupant fatalities increased, but all injuries in fatal accidents increased as well. Unfortunately, a good companion series for injuries in fatal Rural Interstate accidents was not found. This limited the conclusions from the annual comparisons to descriptions of the change. The comparisons showed that there were 1,788 more occupants involved in fatal Rural Interstate accidents in 1988 than in 1986 (in the first 38 states to raise the speed limit). Incapacitating injuries increased 49 percent. Non-incapacitating injuries increased 43 percent. People who were reported as "may have been injured" increased 44 percent. People reported to have no injury increased 36 percent.

While the before-after comparison has some limitations, it appears that non-fatal injuries in fatal accidents have increased as least as much as have fatalities.

No shift in the distribution of injury severity after the implementation of the 65 mph speed limit was detected. Possibly the broad definition of injury categories prevents such detection.

(3) Increases in occupant fatalities and injuries in fatal accidents have increased most among persons 18 years-old and younger, when the 1986 experience is compared to that of 1988. Occupant fatalities among this age group are 56 percent higher. Incapacitating injuries in fatal accidents are 83 percent higher. Non-incapacitating injuries are 72 percent

higher. Persons of this age group in fatal occupant accidents who may have been injured have increased 91 percent. Those reported to have no injuries were up 86 percent.

Caution must be exercised in judging to what degree these changes can be attributed to the 65 mph speed limit. Among the reasons for exhibiting caution are: increases are measured as simple comparisons to 1986; other are age groups have risen although not nearly as much; and injury levels from which these percentage increases are measured are small, making increases appear large in percentage terms.

Unless the increase in the 18 years-old and younger age group is merely a statistical artifact, it will be important to understand the reason for the increase regardless of whether or not it is from the 65 mph speed limit.

III. Introduction

The Surface Transportation and Relocation Assistance Act passed by Congress on April 2, 1987, allowed states to raise the speed limit on selected segments of Rural Interstates to 65 mph. In 1987, 38 states increased the speed limit from 55 mph. In 1988, two additional states -- Georgia and Virginia -- raised the speed limit.

Whether the increases in the legal speed limit would have any effect on safety was much debated at the time of Congressional enactment. The debate continues today after more than two years from the time that the vast majority of states have implemented the 65 mph speed limit.

The increase in the legal speed limit, which occurred in most states between April and June 1987, provides a significant opportunity to assess the effects of speed on the frequency and severity of accidents. Not since 1974, with the implementation of the national 55 mph speed limit, has there been such an opportunity for isolating speed as a factor in the complex mechanism which causes accidents and determines severity.

Previous attempts to measure the effects of the 65 mph limit have utilized two perspectives. Some studies have looked at the experience of individual states to determine if increases in fatalities and injuries have occurred which can be attributed to increased speed. Finding statistically significant changes from the experience of one state over a one or two year period is extremely difficult because of the small size and yearly variation of fatality and injury counts. To overcome the limitations of using data from one state, and to secure a national estimate of the effects of the 65 mph speed limit, data from all the states was aggregated. Studies that evaluated the national effect of the 65 mph speed found an increase in fatalities on Rural Interstates ranging from 14 to 20 percent. However, it seems likely that there are differences among states. Some states may have had no increase in fatalities. Only recently has data beyond 1987 become available [2].

One main purpose of the current study is to extend the estimation period through 1988, the latest available FARS data. No attempt is made to re-estimate the effect in 1987. Doing so would require that the fatal accident data be structured on a less than yearly

basis. In 1987, no state implemented the higher speed limit for the full year. The average period of the 65 mph speed limit for a state was probably about 6 months.

A second purpose of this study is to broaden the outcome measure for the possible impact of the 65 mph speed limit. Most analyses of the increased speed limit has focused on changes in fatalities. (Some of the individual state studies have examined the impact of 65 mph on injuries and property damage accidents.) This concentration on fatalities is understandable because to detecting such changes requires historical data. Injury data to form these time-series controls is not available on a consistently measured basis for all the states which implemented the 65 mph speed limit impact.

However, there is data available on the injury distribution of persons involved in fatal accidents, from FARS. While the 65 mph may affect nonfatal accidents looking at injury severity in fatal accidents will provide a broader measure of the effect of the 65 mph speed limit. FARS categorizes injury severity into five classes: (1) fatal; (2) incapacitating; (3) non-incapacitating; (4) may be injured; (5) uninjured.

'Incapacitating' is sometimes defined in FARS as injury serious enough to prevent the carrying on of normal activities for at least 24 hours. 'Non-incapacitating' injury is injury other than fatal or incapacitating. 'May be injured' results when there is no visible sign of injury but there is a complaint of pain or momentary loss of consciousness. The degree to which these categories remain consistently defined over time is not known. However, the conclusions based on this data regarding 65 mph probably do not depend on exact definitional consistency.

A final purpose of this study is to try to identify the mechanism through which the increased speed limit has acted. Knowing how increased speeds have affected accidents, or knowing which types of accidents have been affected, would be beneficial in developing remedies.

IV. Methods

The first purpose of this study is to determine the effect of the 65 mph speed limit on occupant fatalities on Rural Interstates in 1988. Most previous studies drew conclusions based on data through 1987.

Evaluating the effect of an intervention like the 65 mph speed limit requires a very careful consideration of the question, "What would have occurred had there been no intervention?" There must be some basis on which to make a forecast. Fatalities and injuries go up and down even over consecutive years for many reasons, including changes in speed. Identifying the probable reasons for fatality and injury changes is very difficult.

Vehicle miles of travel (VMT) and speed compliance data (which gives average speed and the 85th percentile speed by various road types) do not fully account for fatality and injury changes. VMT measures changes in travel and not changes in the risk distribution of that travel. Speed data is highly aggregated and does not account for individual behaviors that cause change. (The existence of differential effects among fatality and injury classes, as was found in this study when classes were stratified by age, demonstrates that these general exposure measures do not fully explain the reasons for changes.) Even if all the factors that cause changes in fatalities and injuries could be identified, only some of the factors would be quantifiable and only a few are actually collected on a consistent basis over time.

While all the effects on fatalities cannot be measured, an indirect method can be used. In examining a particular accident series like occupant fatalities on Rural Interstates, if a series can be found which moves historically with the Rural Interstate series then an evaluation can be made. A valid evaluation requires that the companion series: (1) has the same determinants as the intervention series; (2) is not contaminated by the intervention; and (3) has a high degree of correlation with the Rural Interstate series. In the case of Rural Interstate occupant fatalities in the 40 states that raised the speed limit, and undoubtedly in any other highway fatality series, there is no companion series which possesses all of the desired characteristics perfectly. However, from previous empirical work it was found that an 'all other fatality series' did possess enough of those

characteristics to be useful in evaluating the 65 mph intervention. That is, fatalities which occurred in the same time period, and in the same states, can act as a control -- but not a perfect control.

The methodology used to evaluate the effect of using 1988 data on occupant fatalities on Rural Interstates is a regression model. The dependent variable is the aggregate of yearly fatalities for the 40 implementing states. The independent variable used to capture all the various forces that act upon the dependent variable is all other fatalities (AOF). A dummy variable is used to measure the effect of the speed limit intervention for 1988, the first full year of implementation for 38 of the 40 states. The regression determines how 1988 differs from the historical relationship between Rural Interstate occupant fatalities and the companion series from 1975-1986. All 1987 data is omitted from the equation. Thus the standard to which the 1988 Rural Interstate occupant fatalities are compared is the 1975-1986 period.

The second purpose of this study is to expand the analysis of the 65 mph speed limit to include a broader outcome measure. Injury data for Rural Interstates does not exist for all 40 states implementing the 65 mph speed limit. However, FARS contains the injury severity distribution of all people involved in fatal accidents. Ideally, the same regression methodology specified to evaluate fatalities would be used to see if changes in nonfatal injures have occurred relative to some companion or control series. Unfortunately, no companion series could be found. The AOF series, when segmented to include the four classifications of injuries was not correlated with its counterpart on Rural Interstates. Thus, all that can be offered now is a comparison of the 1986 injury distribution with that of 1988, the first full year of 65 mph implementation. This comparison, while lacking for reasons discussed above, does give some indication of the possible change. It should be noted that occupant fatalities increased 20 percent when compared to the historical period of 1975-1986. When compared to just 1986, occupant fatalities were up 37 percent -- nearly twice as much. Because the former method of comparison has more statistical validity, it is likely that the increases for the four other injury categories also overstate the increase attributable to the 65 mph speed limit.

The final purpose of this study is an to understand how speed affects fatal accidents -- what is the path through which speed operates. This investigation was done by trying to segment the injury distribution into homogenous groups which had differential rates of change. While this method is *ad hoc* and lacks a statistical basis for comparison, it did produce a result worthy of further investigation when the injury distribution was segmented into roughly four, twenty-year old age groupings. Clearly, more work needs to be done in investigating this finding and other possible paths through which speed may operate. (The authors have segmented the fatality and injury data by on other characteristics besides age. One such characteristic was vehicle weight. It seemed possible that weight might be a factor in the way vehicles performed relative to safety at the higher speed limit. However, this and other segmentations were not successful in detecting the possibility of any meaningful change.)

V. Results

Increases in Fatalities

Table 1 gives the number of occupant fatalities occurring on Rural Interstates for each year in the 40 states which implemented the 65 mph speed limit in 1988.

Table 1: Occupant Fatalities

YEAR	RIOF	YEAR	RIOF
1975	1847	1982	1666
1976	1902	1983	1729
1977	2183	1984	1847
1978	2393	1985	1778
1979	2192	1986	1736
1980	2132	1987	2041
1981	2183	1988	2391

This variable is labelled as RIOF for Rural Interstate Occupant Fatalities. As mentioned above, from previous empirical work, it was found that the best control, or companion series, for RIOF was all other fatalities (AOF). AOF is simply the fatality complement of RIOF. Table 2 gives the values over time for AOF.

Table 2: All Other Fatalities

YEAR	AOF	YEAR	AOF
1975	34710	1982	34893
1976	35853	1983	33818
1977	37770	1984	35378
1978	39670	1985	34861
1979	40474	1986	36781
1980	40331	1987	36521
1981	38881	1988	36884

Table 3 shows the ratio of RIOF to RIOF + AOF.

Table 3: RIOF as Percent of Total Fatalities

YEAR	%	YEAR	%
1975	5.05	1982	4.56
1976	5.04	1983	4.86
1977	5.46	1984	4.96
1978	5.69	1985	4.85
1979	5.14	1986	4.51
1980	5.02	1987	5.29
1981	5.32	1988	6.09

That ratio indicates that RIOF is a much larger percentage -- 6.09 percent -- of total fatalities after the 65 mph speed limit than before. Previous highs were 5.69 percent in 1978, 5.32 in 1981, and 5.29 in 1987.

That AOF is not a perfect control can be seen in Table 4.

Table 4: Yearly Percentage Change

Year	% RIOF	% AOF
1975	------	------
1976	2.98	3.29
1977	14.77	5.35
1978	9.62	5.03
1979	-8.40	2.03
1980	-2.74	-0.35
1981	2.39	-3.60
1982	-23.68	-10.26
1983	3.78	-3.08
1984	6.82	4.61
1985	-3.74	-1.46
1986	-2.36	5.51
1987	17.57	-0.71
1988	17.15	0.99

The relationship between RIOF and AOF is not perfect when both variables are transformed to a yearly percentage change. Of the thirteen yearly changes, eight of the changes, or 62 percent, occur with both RIOF and AOF moving in the same direction. It is likely that the five times that the two variables move in opposite directions is not so much that AOF is lacking as a companion series, but rather that RIOF is small and can be influenced by random shocks.

Running the regressions described in the Methods section, indicates that occupant fatalities on Rural Interstates were 20 percent higher than would have been expected in 1988 based on the statistical relationships between the RIOF and AOF variables during the 1975-1986 period. The fatality effect placed in a 95 per confidence band lies between 8 and 32 percent. No 1987 data was used in this regression. The 1988 fatality effect is

statistically significant with a t-statistic of 3.11. The AOF variable has a t-statistic of 5.59. The regression has a corrected R-square of 0.75.

Injury Severity Distribution

Table 5 compares the injury severity distribution of people involved in fatal accidents in 1986 and 1988.

Table 5: Injury Severity

Year	Fatal	Inc.	Non-Inc.	Maybe	No
1986	1743	902	610	308	871
1988	2391	1339	871	442	1179

Where (as defined by FARS):

Fatal = fatal injury
Inc. = Incapacitating injury
Non-Inc. = Non Incapacitating injury
Maybe = May have been injured
No = No injury

Table 6 gives the percent change for each injury category between 1986 and 1988.

Table 6: Percentage Change in Injuries

Year	Fatal	Inc.	Non-Inc.	Maybe	No
'86 /'88	37%	49%	43%	44%	36%

As the data in the above two tables indicates, not only are fatalities up but so are injuries. If it is to be believed that fatalities have increased because of the higher speed limit, it is likely that injuries in fatal accidents have as well. In fact it appears that incapacitating, non-incapacitating, and possible injuries were up more than fatalities.

The primary reason that injuries in fatal accidents are up is probably because the 65 mph speed limit caused more accidents and hence more people involved. To a lesser extent the increase may be there are (on average) more occupants per vehicle or because the severity of fatal accidents has changed. Table 7 gives the people in fatal accidents in each category for 1986 and 1988.

Table 7: Percentage of Injury Category

Year	Fatal	Inc.	Non-Inc.	Maybe	No
1986	39%	20%	14%	7%	20%
1988	38%	22%	14%	7%	19%

The number of people involved in fatal accidents in 1988 was 6,222, up 40 percent from the 4,434 in 1986. (The number of people involved in fatal accidents in 1987 was 5,462, a 23 percent increase from 1986.) However, the distribution of injury severity among the five categories between 1986 and 1988 is virtually the same. A shift in the injury distribution because of the 65 mph speed limit may be difficult to detect because the injury categories are broadly defined and not based on traumatic differences in pathology.

The number of fatal accidents increased 33 percent from 1986 to 1988 (1,668 vs. 2,218). The average number of occupants per fatal accident increased from 2.66 in 1986 to 2.81 in 1988.

Clearly, comparing 1986 to 1988 is not the best way to evaluate the effect of a change in the speed limit, or any intervention. Methods that control for the many other factors which affect fatality and injury levels should be used. It is unfortunate that a companion series could not be found in this study for the various injury categories to provide the needed control.

One could, however, reason indirectly that the increases in injuries are, at least in part, attributable to the 65 mph speed limit. It has been shown here and in other work that there is statistical evidence for believing that fatalities have increased as the result of the 65 mph speed limit. Since injuries are the result of the same events that cause fatalities, it seems likely that injuries also have significantly increased. Thus, there is a wider effect that the new speed limit has had on highway safety that has not previously been incorporated into the total costs of increasing speeds. Caution, however, should be used in interpreting the exact quantitative amount.

Path of Increase

The final part of this study is to try and provide some insight into the way that the 65 mph speed limit has acted upon highway fatalities and injuries. Segmentation was used to try to find homogeneous groups of fatalities and injuries which had relative differences in the amount of change. Such searching is *ad hoc* and destroys the possibility of applying statistical tests because if enough searching is done some relative differences will be found if only by chance.

The authors have segmented the fatality and injury data by on other characteristics besides age. One such characteristic was vehicle weight. It seemed possible that weight might be a factor in the way vehicles performed relative to safety at the higher speed limit. However, this and other segmentations were not successful in detecting the possibility of any meaningful change.

One segmentation produced a result worth reporting. The injury distribution was segmented into four age categories for 1988 as shown in Table 8.

Table 8: Injury Distribution by Age -- 1988

Age	Fatal	Inc.	Non-Inc.	Maybe	No
0-18	337	401	269	120	169
19-40	1199	605	414	223	585
41-60	483	191	131	72	275
61+	367	140	51	26	70

Table 9 gives the same age breakdown of injury severity for 1986.

Table 9: Injury Distribution by Age -- 1986

Age	Fatal	Inc.	Non-Inc.	Maybe	No
0-18	216	219	156	63	91
19-40	907	458	292	150	449
41-60	326	128	106	60	194
61+	285	90	51	32	54

Table 10 gives the percentage changes form 1986 to 1988.

Table 10: Yearly Percentage Change

Age	Fatal	Inc.	Non-Inc.	Maybe	No
0-18	56%	83%	72%	91%	86%
19-40	32%	32%	42%	49%	30%
41-60	48%	49%	24%	20%	42%
61+	29%	56%	0%	-19%	30%

The percentage increases are largest among those occupant 18-years old and younger.

Summary

This study has shown that there is statistical evidence that fatalities on Rural Interstates increased after the implementation of the 65 mph speed limit in 40 states in 1988. Fatalities, on average, were 20 percent higher in 1988 in those 40 states than would have been expected. A 95 percent confidence interval for the 20 percent average effect places the fatality increase between 8 and 32 percent.

Undoubtedly, differences exist among states in regards to fatality changes. Some states may have not experienced any change in fatalities on their Rural Interstates.

The implementation of the 65 mph speed limit has likely brought increases in all categories of injuries. In fact, it is likely that incapacitating and non-incapacitating injuries have increased more than fatalities. No shifts in the injury distribution were found.

Finally, it is likely that the fatalities, and particularly injuries, have increased most among those 18 years-old and younger -- at least in 1988.

Notes

[1] Among these studies were two which were done through grants for the National Highway Safety Administration (NHTSA). Three other grants were given by NHTSA to study the safety effects of the 65 mph study. However, those three studied did not simultaneously consider the experience of all states.

[2] The study "The Effects of the New 65 mph Speed Limit on Rural Highway Fatalities: A State-By-State Analysis, by Steven Garber and John D. Graham, uses data for some states through November of 1988.