THE EFFECT OF INCREASING RURAL INTERSTATE SPEED LIMITS IN THE USA

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Abstract

Within a year of the repeal of the National Maximum Speed Limit in the United States of America on 28 November 1995, 23 states had raised their rural interstate speed limits to 70 or 75 mph. The effect on rural interstate fatalities was examined by modelling fatalities between 1992 and 1999 against the size of the new speed limit (no change, 70 mph and 75 mph), the period before and after the speed limit change (1992 to 1995 versus 1996 to 1999), and their interaction. Fatalities in the groups of states that raised their speed limits to 75 mph and 70 mph were 38% and 35%, respectively, higher than expected based on fatalities in the states that did not change their speed limits. Furthermore, the states that raised their speed limits to 75 mph had a higher rural interstate fatality rate before the speed limit was changed than the other groups of states. The changes in fatalities were less than those one would predict if the speeds had changed by the amount of the speed-limit change. This could be related to already-high speeds in the limit-changing states. This view is corroborated by some speed survey data and is consistent with the already higher crash rates of the limit-changing states.

The genesis of this analysis

For some years now the website www.publicpurpose.com, under the banner of the consultancy firm of Wendell Cox, has featured a page detailing interstate crash rates per million vehicle miles for a number of US states. These rates were classified according to whether they were before or after the removal of a 65-mph speed limit following the November 1995 lifting of a Federal requirement to have such a limit. This page remains on the website at http://www.publicpurpose.com/ic-speed.htm. It shows that the rates were analysed by averaging the rates for the states which did and those which did not raise their limits. The averaging process used is not clear as the numbers involved differ slightly from simple averages. It was found that, for states which raised their limits, the average of the crash rates rose by 2.5% and, for those which did not raise their limits, the average of the crash rates rose by 6.0%. The analysis also showed, but did not mention, that the average for the states which raised their limits rose from 1.71 to 1.74, while that for the states which did not raise their limits rose from 0.97 to 1.03. Simple inspection of these figures reveals that the states which did not raise their limits were generally much safer, both before and after the speed limit changes, than the states which did raise their limits.

This very simple analysis was causing concern in New Zealand as some people saw in it an implication that the changes in the speed limits had no negative effect on safety. There was in fact no detailed analysis available of the effect of the changes in limits on the rural interstate network, taking exposure to risk into account – the work available involved the entire urban and rural network. It thus seemed to us that a more detailed analysis was required, and this paper was written to provide such an analysis.

Introduction

In 1973 the United States of America set a National Maximum Speed Limit (NMSL) of 55 mph in an effort to conserve oil. The NMSL was raised to 65 mph on rural interstate roads between 1987 and 1995. During this time approximately 90 percent of the 34,000 rural interstate mileage was at the maximum 65 mph, and the remainder at a lower limit of 55 mph [National Highway Traffic Safety Administration, 1988]. Then, on 28 November 1995, the United States Congress repealed the NMSL, allowing states to set their own speed limits. Following the change several states raised their rural interstate speed limits (see Table 1), with one, Montana, removing daytime speed limits on its rural interstates altogether.

State	Date	New limit (mph)	State	Date	New limit (mph)
Alabama	9 May 96	70	Missouri	13 Mar 96	70
Alaska	15 Jan 88	65	Montana*	28 May 99	75 (trucks 65)
Arizona	8 Dec 95	75	Nebraska	1 Jun 96	75
Arkansas	19 Aug 96	70 (trucks 65)	Nevada	8 Dec 95	75
California	7 Jan 96	70 (trucks 55)	New Hampshire	16 Apr 87	65
Colorado	24 Jun 96	75	New Jersey	19 Jan 98	65
Connecticut	1 Oct 98	65	New Mexico	15 May 96	75
Delaware	N/A	N/A	New York	1 Aug 95	65
Dist. of Columbia	n/a	n/a	North Carolina	5 Aug 96	70
Florida	8 Apr 96	70	North Dakota	10 Jun 96	70
Georgia	1 Jul 96	70	Ohio	15 Jul 87	65 (trucks 55)
Hawaii	N/A	N/A	Oklahoma	29 Aug 96	75
Idaho	1 May 96	75 (trucks 65)	Oregon	27 Jun 87	65 (trucks 55)
Illinois	27 Apr 87	65 (trucks 55)	Pennsylvania	13 Jul 95	65
Indiana	1 Jun 87	65 (trucks 60)	Rhode Island	12 May 96	65
Iowa	12 May 87	65	South Carolina	30 Apr 99	70
Kansas	7 Mar 96	70	South Dakota	1 Apr 96	75
Kentucky	8 Jun 87	65	Tennessee	25 Mar 98	70

State	Date	New limit (mph)	State	Date	New limit (mph)
Louisiana	15 Aug 97	70	Texas	8 Dec 95	70 (daytime only)
Maine	12 Jun 87	65	Utah	1 May 96	75
Maryland	1 Jul 95	65	Vermont	21 Apr 87	65
Massachusetts	5 Jan 92	65	Virginia	1 Jul 88	65
Michigan	1 Aug 96	70	Washington	15 Mar 96	70 (trucks 60)
Minnesota	1 Jul 97	70	West Virginia	25 Aug 97	70
Mississippi	29 Feb 96	70	Wisconsin	17 Jun 87	65

Table 1. The date each State last introduced a new Rural Interstate speed limit and the size of the new limit

Notes: * Montana initially introduced an unlimited daytime limit on 8 Dec 95
Source: Insurance Institute for Highway Safety [2001] and National Highway Traffic Safety Administration [1998].

Literature review

The National Highway Traffic Safety Administration [NHTSA, 1998] conducted a preliminary investigation into the effect of the change in speed limits on interstate fatalities in thirty-two states that increased their speed limits late in 1995 or during 1996. The proportion of interstate fatalities in these states was modelled from 1991 to 1995 to determine the predicted number of fatalities in 1996. This predicted number was then compared to the actual number experienced in 1996. The analysis revealed that the group of states that increased their speed limits in late 1995 and 1996 experienced at least 350 more fatalities on interstate highways in 1996 than predicted. This was at least 9% greater than would have been expected if previous trends had continued.

Farmer et al. [1997] also conducted a preliminary study on the effect of the change in speed limits. They compared the change in fatalities in 12 states that raised their speed limits between 8 December 1995 and 1 April 1996 with 18 states which either did not raise their maximum speed limits in 1996 or raised them on less than 10 percent of their urban interstate mileage. They found a significant 12% increase in fatalities on interstates and freeways (urban and rural) during the last 9 months of 1996 in the 12 states that raised their speed limits when compared with the 18 that did not. When adjusted for increases in vehicle miles of travel, the estimated effect of raising speed limits was even higher (17%). For rural interstates alone the effect was a statistically-significant 11% increase in fatalities.

More recently Farmer et al. [1999] examined the change in motor vehicle occupant fatalities and fatality rates (fatalities per billion vehicle miles) in 24 states that raised their interstate speed limits between December 1995 and September 1996. The states were divided into four groups depending on when their speed limits were raised (that is, last quarter 1995, first quarter 1996, second quarter 1996 and third quarter 1996). For each group, the number of occupant fatalities on interstates (rural and urban) and freeways in the quarter following the group's speed limit increase was higher than during the same quarter in the previous seven years. For example, for the group of states which raised their speed limits in the last quarter of 1995, the number of fatalities in the first quarter of 1996 was 428, compared with 343 fatalities in the first quarter of 1995. In comparison, the group of seven states which did not raise their maximum speed limits between 1990 and 1997 did not show an increase or decrease in the number of quarterly fatalities over time.

Farmer et al. modelled occupant fatalities and fatality rates on interstates (urban and rural) for each quarter between 1990 and 1997 by time, number employed in the state and state group (including the comparison group of seven states). The model also included an indicator variable which allowed each state to be part of the comparison group until the quarter in which the state raised its speed limit. The model demonstrated that, after accounting for economic effects, the raised speed limits were associated with a 15 percent increase in interstate fatalities and a 17 percent increase in interstate fatality rates.

There has been some disagreement as to whether or not raising the speed limit in some states following the repeal of the NMSL actually had a negative effect on road safety in those states (e.g. Moore, 1999). However, there appear to have been no scientific studies conducted that have shown the 1995/1996 speed limit changes either had no effect or were associated with a decrease in fatality rates.

Moore [1999] challenged the findings of Farmer et al. [1999] and an earlier version of Farmer et al. [1997] for not including in the analyses all of the states that raised their speed limits. However, the states that were excluded had only raised their speed limits on selected segments of their interstates. Since the fatality and vehicle miles-travelled statistics are not separated by interstate segments, the true effect of the raised speed limits in these states could not be examined. Therefore these states were excluded to avoid masking any overall change in the number of fatalities due to raising the speed limit.

Moore [1999] also criticised the studies by Farmer et al. for only examining the roads on which the speed limits were raised rather than all of the roads in a state. Moore's rationale was that, when a speed limit was raised on a road, drivers would move from other roads to the higher speed limit road. Hence the increased travel on the higher speed limit roads might lead to an increase in the number of fatalities on those roads. In comparison, on the other roads where there was less travel, there might be a reduction in the number of fatalities, leading to little change when all roads were examined. However, the increased travel on the raised speed limit roads was taken into account in the 1999 study by Farmer et al., by examining fatality rates (fatalities per million vehicle miles). Furthermore, the 1997 study examined fatalities on the other roads and found there was no evidence of a change in fatalities on these roads after the speed limit was raised.

Since the study by Farmer et al. [1999] more years of data have become available, allowing a longer-term investigation into the effect of raising the speed limits. The following analysis will investigate the effect of raising rural interstate speed limits on the number of rural interstate fatalities between 1992 and 1999, taking into account vehicle miles on these roads.

Data sources

Data: The number of fatalities and vehicle miles travelled (VMT) on rural interstates between 1992 and 1999 was obtained from the Office of Highway Policy Information (OHPI) Internet site [2001]. Changes in the number of fatalities can be expected to be more sensitive to changes in speed than changes in fatal crashes as higher speeds produce more fatalities per crash. Data for other highways, such as urban interstates, were not used because the speed limit changes on these highways often did not occur consistently across the entire state, whereas the rural interstate speed limit changes tended to apply to the entire rural interstate network in a state.

Design: The states were divided into three groups depending on the time when their speed limits changed following the repeal of the NMSL (see Table 2). The "no-change 65 mph" group consisted of the states that, prior to the repeal of the NMSL, had a rural interstate speed limit of 65 mph and did not raise their rural interstate speed limits after the repeal. The "change 70 mph" group consisted of the states that raised their rural interstate speed limits from 65 mph to 70 mph in December 1995 or during 1996. The "change 75 mph" group consisted of the states that raised their rural interstate speed limits from 65 mph to 75 mph in December 1995 or during 1996. States were excluded from the groups if their rural interstate speed limits changed between 1992 and November 1995 or between 1997 and 1999. Texas was also excluded from the analysis because the speed-limit change in that state was limited to the daytime [NHTSA, 1988]. At night-time the speed limit on Texas' rural interstate reverted to the old limit of 65 mph. Furthermore, those states without a rural interstate were not included.

No change 65 mph	Change 70 mph	Change 75 mph	Excluded
Alaska	Alabama	Arizona	Connecticut
Illinois	Arkansas	Colorado	Delaware
Indiana	California	Idaho	District of Columbia
Iowa	Florida	Nebraska	Hawaii
Kentucky	Georgia	Nevada	Louisiana
Maine	Kansas	New Mexico	Maryland
New Hampshire	Michigan	Oklahoma	Massachusetts
Ohio	Mississippi	South Dakota	Minnesota
Oregon	Missouri	Utah	Montana
Vermont	North Carolina	Wyoming	New Jersey
Virginia	North Dakota		New York
Wisconsin	Washington		Pennsylvania
			Rhode Island
			South Carolina
			Tennessee
			Texas
			West Virginia

Table 2: The three groups of states and those excluded from a group

Analysis

Figure 1 displays the fatality rates for each speed-limit change group from 1992 to 1999 and Figure 2 displays the vehicle miles travelled for each group. Figure 1 indicates that the "no-change 65 mph" group consistently had a lower fatality rate between 1992 and 1999 than the "change 70 mph" group. The "change 75 mph" group consistently had the highest fatality rate.

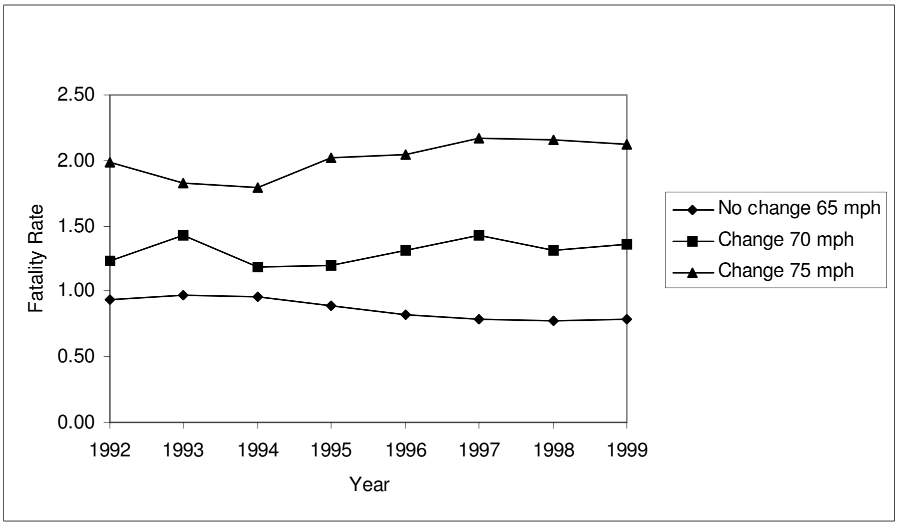

Figure 1: Fatality rates by speed-limit change group

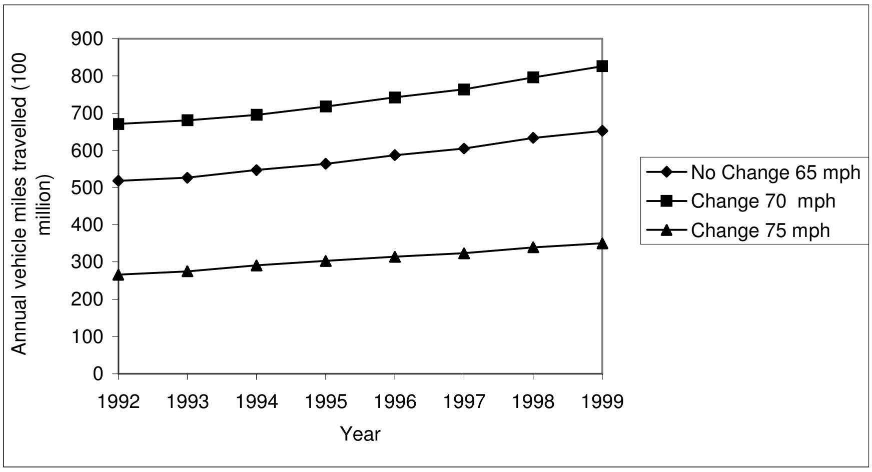

Figure 2: Total annual vehicle miles travelled by speed-limit change group

Figure 1 also indicates that the difference between the groups appears larger from 1996 onwards when compared with the previous four years. To determine if this difference was significant a regression model was fitted to the data. As fatalities, unlike crashes, are not independent, some extra-Poisson variation was expected in the count data. The negative binomial distribution assumed for the fatality counts takes this added variation into account by allowing an estimate of variance which may exceed the mean. Thus, annual fatalities per state were modelled assuming a negative binomial distribution with mean μ and variance μ + kμ^2, as follows:

$$\ln(\mu) = \alpha + \beta_1 GE1996 + \beta_2 YEAR + \beta_3 GROUP + \beta_4 (GE1996 * GROUP) + \ln(VMT) \quad \text{.........} \ (1)$$

where GE1996 is a dummy variable for the speed-limit change, taking value 0 before 1996 and 1 during and after 1996; YEAR is the year of the fatality data, 1992-1999; GROUP is a dummy variable for the speed-limit change group; GE1996*GROUP is the interaction term for the speed-limit change dummy variable and the speed-limit change group; VMT represents vehicle miles travelled and α, β_1, β_2, β_3 and k are constants to be fitted. Ln(VMT) was included as an offset term (with coefficient equal to one), as fatalities were expected to be directly proportional to VMT. When this assumption was checked by refitting the model allowing the coefficient of ln(VMT) to vary, the coefficient did not differ significantly from one.

The model fitted to the annual fatality data from 1992 to 1999 found YEAR did not have a significant effect on fatalities (p=0.52), and including YEAR did not improve the fit of the model significantly ($F_{(1,265)}$=0.173). That is, there was no evidence of an overall trend between 1992 and 1999. A check revealed there was also no evidence of a trend within each group of states. That is, the variable YEAR*GROUP did not have a significant effect on fatalities. Since there was no evidence of a significant trend in fatalities between 1992 and 1999 the variable YEAR was excluded from the model and the following model fitted:

$$\ln(\mu) = \alpha + \beta_1 GE1996 + \beta_2 GROUP + \beta_3 (GE1996 * GROUP) + \ln(VMT)_i \quad \text{.........} \quad (2)$$

Model 2 was found to describe the data reasonably well (see Appendix A for the model parameters). The ratio of the deviance to the degrees of freedom was close to one (305.8/266=1.15), consistent with a good fit. Table 3 summarises the estimated changes in fatalities associated with the speed-limit change compared with the group of states that did not change their speed limits.

Group	Percentage change	95% confidence interval
Change 70 mph	35%*	(6%,72%)
Change 75 mph	38%*	(8%,78%)

**indicates statistically significant increase at the 5% level*

Table 3. Summary of estimated changes in fatalities in the groups that increased their speed limits compared to the "no-change 65 mph" group

There was a statistically-significant increase in the fatality rate in the "change 75 mph" group compared with the "no-change 65 mph" group (p=0.012). That is, in the four years following the speed-limit increase, the number of fatalities in the "change 75 mph" group was estimated to be 38% higher than would have been expected based on the number of fatalities in the "no-change 65 mph" group. Since the "change 75 mph group" had 2,818 fatalities from 1996 to 1999, there were estimated to be approximately 780 more fatalities associated with this speed-limit increase.

The increase in the fatality rate in the "change 70 mph" group compared with the "no-change 65 mph" group was also statistically significant (p=0.015). In the four years following the speed-limit increase, the number of fatalities in the "change 70 mph group" was estimated to be 35% higher than would have been expected based on the number of fatalities in the "no-change 65 mph" group. Since the "change 70 mph" group had 4,222 fatalities from 1996 to 1999, there were estimated to be approximately 1,100 more fatalities associated with this speed-limit increase. The model did not, however, detect a statistically-significant difference between the changes in fatality rates in the two groups that raised their speed limits.

As well as finding statistically-significant changes for the two speed-limit groups, the model showed a statistically-significant 19% reduction in the fatality rate in the "no-change 65 mph" group from the four years before 1996 to the next four years (p=0.022).

Conclusions

In the four years following the elimination of the Federal mandate for the NMSL, the states that increased their rural interstate speed limits had higher fatality rates than would have been expected based on the fatality rates in the states that kept their rural interstate speed limits at 65 mph. In total there were estimated to be almost 1,900 more fatalities than expected in the states that increased their speed limits to 70 or 75 mph between 1996 and 1999, associated with the speed limit increases.

The raising of the rural interstate speed limits is the most likely explanation for the higher than expected increase in the number of fatalities in the states that raised their speed limits, particularly as annual vehicle miles travelled (see Figure 2) were taken into account in the model. However, there are other possible explanations. For example, the analysis assumed that the number of fatalities in the states that raised their speed limits to 70 or 75 mph would show a similar trend to that in the states which kept their speed limits at 65 mph. However, these states tended to be in the north east whereas those which raised their limits to 70 mph tended to be in the south; and those which raised their limits to 75 mph were all in the west. Therefore there may have been regional factors which accounted for the change in fatalities. More detailed analyses with regional data are needed to test whether there were regional factors which accounted for some or all of the change in fatalities.

Although there was an increase in the fatality rates in the states which raised their speed limits, the increase was not as great as would be predicted by the size of the speed-limit change. For example, Finch et al. (1994) estimated that "for every 1 mph rise in the mean traffic speed, the percentage change in [crashes] rises by about five percent" (p.18). A possible explanation for the lower than expected increase in fatalities may be that the drivers in the states which raised their speed limits did not comply with the speed limits before they were raised. That is, they travelled at high speeds before the speed-limit change and, when the speed limits were raised, they did not change their vehicle speeds substantially. There is some evidence for this hypothesis in the change 75 mph group from the model estimates. That is, the change 75 mph group had a significantly higher fatality rate before and after the speed limit change than the other two groups. Hence it appears that the states which had the poorest road safety record on rural interstates, in terms of fatality rates, tended to raise their rural interstate speed limits, whereas those which had a relatively 'good' road safety record tended not to increase their rural interstate speed limits.
Furthermore, speed surveys conducted immediately before and after the change tend to support this hypothesis. For example, Retting and Green [1997] examined the changes in car and truck speeds on four rural interstates in New Mexico, one month before and one month after the speed limit was raised from 65 to 75 mph. They found that mean car speeds increased by 3 mph to 72 mph, and remained at the increased level three months after the change. Similarly, the 85th percentile of car speeds increased by 2 mph to 76 mph. The mean and 85th percentile of truck speeds showed similar increases.

NHTSA [1998] also conducted preliminary evaluations of changes in traffic speeds on rural interstates following the repeal of the NMSL. In Idaho, where the speed limit was raised from 65 mph to 75 mph, it was found that the mean traffic speed increased by 3 mph after the change. In Missouri, where the speed limit was raised to 70 mph, the average speed increased by 4.6% and the 85th percentile speed by 1.5%. In Texas, where the daytime speed limit for cars was raised to 70 mph and that for trucks to 60 mph (the night-time speed limit for cars was 65 mph and for trucks 55 mph), the average speed increased from 64 mph to 66 mph and the 85th percentile speed from 72 mph to 74 mph.

The studies by Retting and Greene [1997] and NHTSA [1998] indicate that, despite large speed-limit changes, mean speeds did not change substantially immediately after the states raised their speed limits. This is the likely reason that the number of fatalities in the states which raised their rural interstate speed limits did not increase dramatically following the speed-limit changes. Nevertheless, it is the increase in speeds following the speed-limit increases that is the most likely explanation for the finding that the number of fatalities increased significantly in states that raised their speed limits when compared with the states that did not change their speed limits.

Implications for New Zealand

These findings reinforce a long-established pattern in which increases in speed limits have been associated with crash increases, and decreases with the reverse. Although speeds have not always been measured it would be unlikely for such changes to happen without changes in speed. Evidence not previously mentioned in this paper includes the following:

- Between 1987 and 1988, 40 States in the United States of America raised the speed limit on interstate highways from 55mph (88km/h) to 65mph (104 km/h). This resulted in an increase in average car speeds of about 3mph (5km/h). Over the same period there was an increase in fatalities on these roads of between 20 and 25 percent.
- During the 1973 fuel crisis, the New Zealand Government reduced rural speed limits from 55 mph (88 km/h) to 50 mph (80 km/h). Due to concern over fuel shortages, many people complied with the new speed limit – there was an 8-10 km/h reduction in average rural speeds. The drop in speeds led to a significant drop in injuries compared to roads unaffected by the speed limit change (urban roads).
- In Australia the speed limit on Melbourne's rural and outer freeway network was increased from 100 km/h to 110 km/h in 1987 and then changed back to 100 km/h in 1989. Compared to a control group (an area where the speed limit remained the same), the injury crash rate per kilometre travelled increased by 24.6% following the change from 100 to 110 km/h, and decreased by 19.3% following the change back to 100 km/h.
- A review of the studies on speed limit changes from several countries (South Africa, Belgium, Finland, France, Great Britain, Germany, USA, and New Zealand) where a speed limit was reduced or established prior to 1981 found a reduction in road crashes ranging from 8% to 40%.
- Nilsson combined a number of evaluations of increases and decreases in speed limits in Sweden between 1968 and 1972 to validate a model for estimating the effect of changes in traffic speed on road safety. The model was further validated by applying it to data from other studies of speed limit changes in Sweden, Denmark, and the USA. The model used the law of physics relating to kinetic energy (the energy that something has by virtue of being in motion) – that is: kinetic energy = ½ *x* mass *x* (speed). This law is based on the following probabilities:
  - The probability of a personal injury accident in the road system reported by the police is proportional to the square of the speed (v^2), which is a shortened formula for the kinetic energy.
  - The probability of a fatal accident resulting from a personal injury accident is also proportional to the square of the speed (v^2), which means that the number of fatal accidents is proportional to the fourth power of the speed (v^4).

The application of the results of these studies to the New Zealand situation indicates that, if the average speed on New Zealand's rural roads was reduced by just 4 km/h, for instance, it is estimated that the road toll would decrease by about 15% and the number injured by about 8% – this means that about 60 fatalities and 920 reported injuries would be saved. Thus there are still many deaths and injuries which can be avoided in New Zealand by reducing speeds, and this area continues to be a challenge to road safety professionals.

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Appendix A

Table A-1 displays the raw estimates obtained from fitting the following model to the fatality data, annual fatalities per state, assuming a negative binomial distribution with mean μ and variance=$\mu+k\mu^2$.

$$\ln(\mu) = \alpha + \beta_1 GE1996 + \beta_2 GROUP + \beta_3 (GE1996 * GROUP) + \ln(VMT) \quad \text{......... (2)}$$

where:

GE1996 is a dummy variable for the speed-limit change, taking value 0 before 1996 and 1 during and after 1996;

GROUP is a dummy variable for the speed-limit change group, representing 0 for the change 75 mph group, 1 for the change 70 mph group and 2 for the no-change (65 mph) group;

GE1996*GROUP is the interaction term for the speed-limit change dummy variable and the speed limit change group;

ln(VMT) is an offset as fatalities were expected to be directly proportional to VMT;

α, β_1, β_2, β_3 and k are constants to be fitted.

Parameter	Level	df	Estimate	Standard Error	Chi-square	Pr > ChiSq
Intercept		1	-4.5370	0.1015	1997.17	<0.0001
GE1996		1	-0.2109	0.0920	5.26	0.0218
Group	0	1	0.5617	0.1215	21.39	<0.0001
Group	1	1	0.0999	0.1265	0.62	0.4297
Group	2	0	0.0000	0.0000		
GE1996 * Group	0	1	0.3253	0.1289	6.37	0.0116
GE1996 * Group	1	1	0.3000	0.1235	5.90	0.0151
GE1996 * Group	2	0	0.0000	0.0000		
k (dispersion parameter)		1	0.1435	0.0285		

Deviance=305.8182 with 266 degrees of freedom

Table A-1: Model 2 raw estimates.