CHANGING RURAL SPEED LIMITS – LEARNING FROM THE PAST

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ABSTRACT

New Zealand is currently reviewing its procedures for setting speed limits as part of the "Safer Speeds" component of the national road safety strategy. A big topic for discussion is the planned greater use of speeds limits below the standard 100 km/h rural or "open road" speed limit. Many people (including politicians, transport practitioners, and the general public) remain sceptical that reductions in the posted limit alone can have much effect on driver speeds and safety outcomes.

Fortunately, New Zealand has two past case studies from which to draw conclusions on this matter. Firstly, in 1973, the open speed limit was reduced from 55mph (88 km/h) to 50 mph (80 km/h), largely as a fuel conservation measure. Then in 1985, the 80 km/h open speed limit was raised to 100 km/h, partly to reflect prevailing operating speeds. In both cases, vehicle speeds and crash data were able to be monitored before and after these changes (as well as other trends in NZ transport) to determine any effects resulting from the open speed limit changes. Raw data indicates that speed and crash statistics decreased after the speed limit decreased and vice versa, but inferring conclusions from this is not so straightforward.

This paper draws on earlier studies of these NZ speed limit changes and re-analyses the findings in light of more recent research. The relationships between speed limits, road environments and speed compliance are compared with observed speed behaviour. The analysis also considers the safety effects of speed and assesses whether the observed changes in crashes, injuries and fatalities followed research findings elsewhere. Finally, the paper will reflect on the likely implications of these findings on future changes to rural speed limits.

1 INTRODUCTION

Speed has been identified as a significant factor affecting both the likelihood and severity of road crashes (ACC & LTSA 2000, OECD/ECMT 2006, Frith 2012). As a result, many jurisdictions internationally have implemented significant speed management regimes, such as 30 km/h urban zones and 70-90 km/h rural roads. For example, during 2008-09 Sweden introduced lower speed limits (typically 10-20 km/h lower) over 17,500 km of rural roads (Vadesby & Forsman 2014).

Speed was also one of the five high-priority areas listed in New Zealand's 2010-20 Road Safety Strategy (MOT 2010). However, as noted by Koorey (2011), speed was the only one of the five not to have any immediate "first actions" rolled out for implementation. Indeed, it was not until this year that national speed management guidelines were finally released (NZTA 2016), over six years after the Strategy's release.

New Zealand is currently reviewing its procedures for setting speed limits as part of the "Safer Speeds" component of MOT (2010). A big topic for discussion is the planned greater use of speeds limits below the standard 100 km/h rural or "open road" speed limit. Many people (including politicians, transport practitioners, and the general public) remain sceptical that reductions in the posted limit alone can have much effect on driver speeds and safety outcomes (e.g. Moir 2016).

Fortunately, New Zealand has two past case studies from which to draw conclusions on this matter:

- On 4 Dec 1973, the open speed limit was reduced from 55 mph (88 km/h), and in a few cases 60 mph, to 50 mph (80 km/h)[1], largely as a fuel conservation measure due to the international oil shocks at the time.
- On 1 July 1985, the 80 km/h open speed limit was raised to 100 km/h, partly to reflect prevailing operating speeds.

In both cases, vehicle speeds and crash data were able to be monitored before and after these changes (as well as other trends in NZ transport) to determine any effects resulting from the open speed limit changes. Raw data indicates that speed and crash statistics decreased after the speed limit decreased and vice versa, but inferring conclusions from this is not so straightforward.

This paper draws on earlier studies of these NZ speed limit changes, summarises their key findings, and re-analyses the findings in light of more recent research. While we are not likely to see blanket changes to our default rural road speed limit again in New Zealand, the findings still provide useful evidence for the likely effects of changing speed limits on localised road sections.

2 LITERATURE REVIEW

2.1 Effects of speed on safety

The OECD/ECMT (2006) found that reductions in average speed of approximately 5% would yield a reduction in fatalities of as much as 20%. Nilsson (2004) confirmed earlier studies of his that found that the injury crash rate changes with the square of the change in mean speed, with even higher exponents (typically about 3-4) valid for serious and fatal injuries.

Povey et al (2003) studied open road vehicle speeds between 1996-2002 in New Zealand and found a 12-13% reduction in fatal and injury crashes for every 1 km/h reduction in open road mean speeds. This reduction rate is higher than many overseas studies, and it was speculated that this reflected the poorer standard of many rural highways in New Zealand, relative to their overseas counterparts (e.g. the US interstate freeway network).

[1] At the time of the speed limit change in 1973, New Zealand was still using Imperial units for speed limits. The 50 mph limit was metricated to 80 km/h in 1975.

2.2 Changes in posted speed limits

Figure 1 shows a historical time series of annual road fatalities and injuries in New Zealand since 1950 (MOT 2016). The two changes in the open road speed limit are illustrated by the dashed vertical bars. It can be seen that both the fatality and injury numbers dropped significantly after the initial speed limit reduction and were higher after the subsequent limit increase.

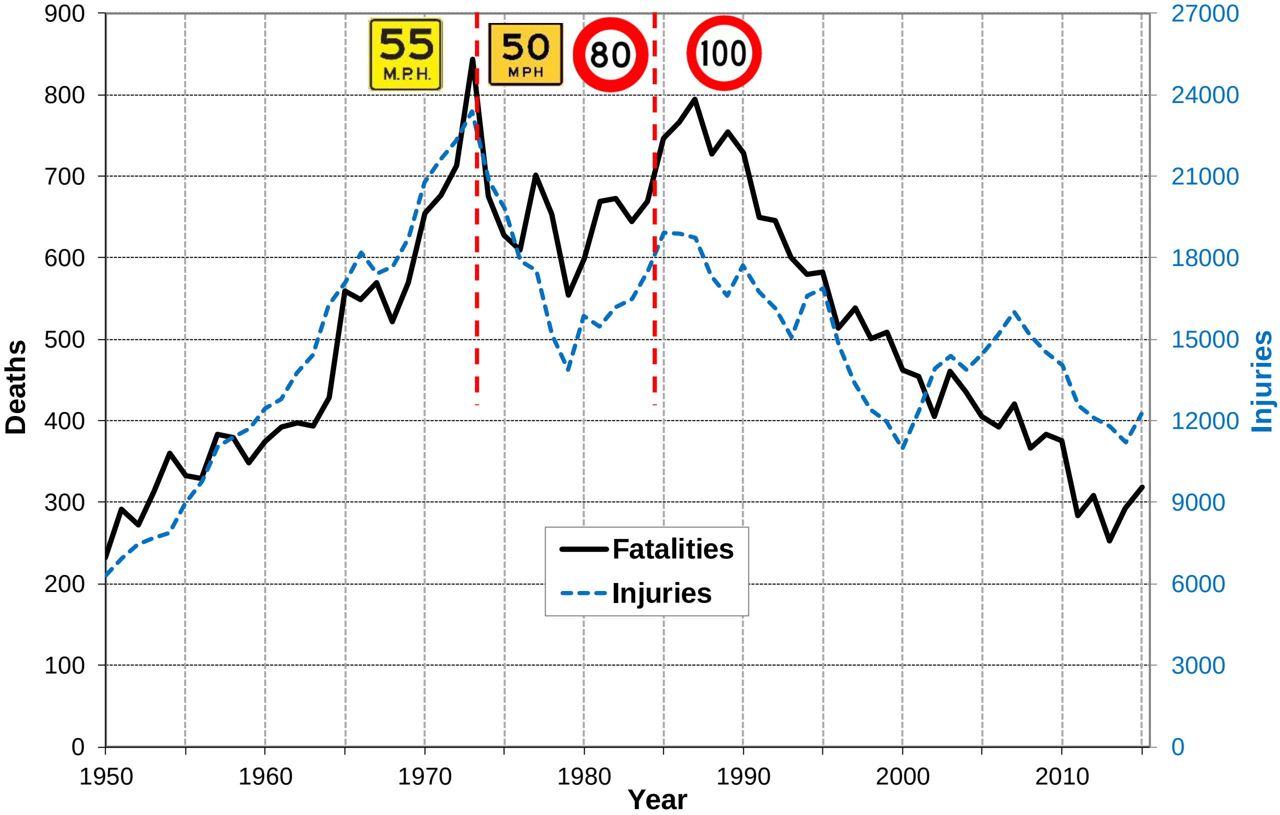

Figure 1: Time series of road deaths and injuries in New Zealand (adapted from MOT 2016)

However, this simple overview of the road casualty statistics is not sufficient to infer cause-and-effect, for a number of reasons:

- The data includes casualties from both rural and urban areas, but only the open-road speed limit was only changed, not the urban limit.
- The data does not say anything about the actual changes in observed speeds following the speed limit changes, which would be a truer indicator of crash risk
- The data does not indicate what happened to traffic volumes during these periods, a key measure of crash exposure risk.
- The data does not consider any other significant road transport policy and regulation changes that may have occurred around the same time.

Frith & Toomath (1982) noted that many other jurisdictions introduced similar speed limit reductions around the same time as New Zealand in 1973, including Australia, the UK and USA. In all cases, studies of these speed limit changes found positive safety benefits at least in the short term.

Patterson et al (2002) investigated the effects of the 1995 repeal of the National Maximum Speed Limit in the US (previously 65 mph), after which 23 states increased their rural interstate speed limits to 70 or 75 mph. Fatalities in the groups of states that raised their speed limits were 35-38% higher than expected based on fatalities in the states that did not change their speed limits. The changes in fatalities reflected observed changes in mean traffic speeds, which typically increased by 2-3 mph.

2.3 Relationship between posted, environmental, and observed speeds

Two key physical factors can be seen to influence observed free speeds by motorists:

- The legally posted speed limit, and
- The surrounding road environment (including land use development, roadway alignment and cross-section, surfacing and markings, etc), which suggests an "appropriate environmental speed" for the given conditions.

When speed limits are changed, or the surrounding road environment is altered, it is not always clear what the effect will be on the observed road user speeds. Motorists have the choice of taking more notice of the posted speed limit or what they think is an appropriate speed given the surrounding road environment. Which one they tend towards depends on societal factors such as the level of speed enforcement and respect for legislation and authority, and whether or not they actually notice a change in the posted limit or road environment.

Consider the following speed related parameters:

- The **"posted speed"** V_p : This is in theory simply the legal speed limit for the road section of interest, and hence is a fixed value. However, it does rely on drivers knowing what the current posted speed limit is (not always the case).
- The **"environmental speed"** V_e : This represents the speed that seems most appropriate to the driver for the road in question (in absence of any speed limit information), based on the geometry and design of the road (e.g. road width, surface texture, presence of islands and traffic calming features) and the surrounding environment (e.g. adjacent land uses, frequency of parking, weather, presence of trees and vegetation). While it is likely that different road users will have different views on what is the most appropriate speed, a fixed value will be assumed for the *mean* environmental speed.
- The **"observed speed"** V_o : This can be determined by recording actual free speeds observed for a sufficient sample of vehicles. In practice, a distribution of observed speeds is likely (often approximating a Normal or Gaussian distribution); V_o can therefore be represented by the mean observed speed. The relative spread of observed speeds would reflect variations in people's perceptions of other parameters discussed here.

Having defined these three speed parameters, consider now how they may be related:

- It is likely that the observed speeds are influenced by both the posted speed ***and*** the environmental speed. If V_p and V_e are different, it is reasonable to assume that V_o lies somewhere ***in between*** these two values, regardless of which one is higher.
- The degree to which road users are influenced by V_p and V_e is somewhat dependent on the degree that posted speeds are accepted and adhered to. This is a function of both the level of enforcement (e.g. presence of traffic police and speed cameras, penalties for speeding) and the level of compliance (e.g. general societal/cultural norms for respecting laws).
- The effect of this can be represented by a "coefficient of compliance" k_c. If there is no compliance (i.e. k_c = 0%) then road users would pay no attention to posted limits and drive only to the road conditions represented by the (higher or lower) environmental speed. If there is total compliance (i.e. k_c = 100%) then road users would travel exactly at the posted speed limit, regardless of the road conditions presented to them. In practice, actual driving behaviour in most places is likely to be somewhere in between, thus k_c will be somewhere on the continuum between 0% and 100%.

If we assume a linear relationship between compliance and the two extremes of environmental and posted speed, then the relationship with observed speed can be seen in Figure 2 (note that observed speed is represented by a single point; however, as discussed earlier, the complete set of observed speeds is likely to be a distribution of varying values, as indicated by the Normal curve).

This relatively simple relationship between the three speed parameters and the coefficient of compliance can form the basis of determining the effect of changing one or more of the key parameters, while holding the others steady.

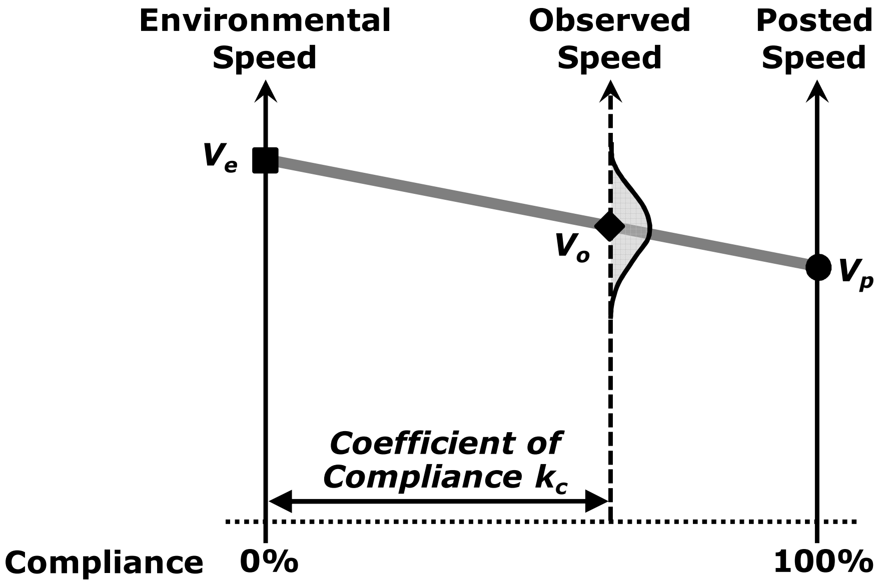

Figure 2: Relationship between Environmental, Posted and Observed Speeds

Consider the case where a posted speed limit is changed on a road, but no changes are made to the road environment or the levels of enforcement or driver compliance. If we observe the change in observed speeds following this, we can infer the relative influence of compliance on road users.

Figure 3 summarises the hypothetical situation when a speed limit is increased from V_p to V'_p. The observed speed V_o is also observed to increase somewhat to V'_o, while the environmental speed V_e and compliance coefficient k_c remain unchanged. The same principle would apply if the speed limit was decreased instead, resulting in a likely decrease in observed speed.

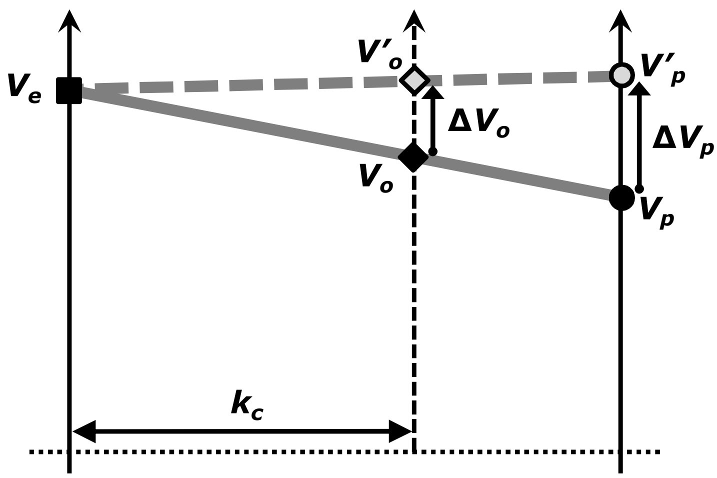

Figure 3: Effect of Changing a Speed Limit

If we determine the relative changes in observed and posted speeds, ΔV_o & ΔV_p respectively, then k_c can be determined by the following relationship:

$$k_c = \Delta V_o / \Delta V_p \quad (1)$$

The new *Speed Management Guide* (NZTA 2016) does not explicitly mention a speed management effect of changing a posted speed limit, although parts of the text may be taken as implying such an impact may exist in certain circumstances. Studies in New Zealand and elsewhere have fairly consistently found small changes in observed mean speeds following a posted speed limit change, in the absence of any change in road environment, enforcement, or road user motivation. For example, a meta-analysis of over 200 speed limit change studies worldwide (Elvik *et al* 2004) found the average observed speed change to be 2.5 km/h for every 10 km/h of posted speed limit change. These may be higher-end estimates of what has happened, owing to publication bias, but they are still real changes happening in real situations. For example, Vadeby & Forsman (2014) found mean speed reductions of between 2.0-3.3 km/h for different categories of Swedish rural roads where posted speeds were reduced by 10 km/h (e.g. 90 km/h to 80 km/h). Patterson *et al* (2002) noted that 10 mph increases in US state speed limits saw mean speed increases of about 3 mph. Closer to home, Hamilton's *Safer Speed Areas* project introduced 40 km/h speed limits to some 50 km/h residential areas; aside from some threshold treatments nothing was done to the actual streets, resulting in 0-3km/h changes in mean speeds (Hamilton City Council 2012). All these findings would imply a typical k_c coefficient value of **20-30%**, i.e. a 2-3 km/h change in observed speeds for a 10 km/h change in posted speed limits.

The relative effect of different enforcement regimes could also be related to changes in the compliance coefficient k_c. For example, Povey et al (2003) estimated 0.7-0.8% reductions in New Zealand open road mean speeds with an increase of 10 000 speed infringements. If, say, the environmental speeds were typically 10% higher than the posted speed, that would suggest a change in k_c of about 7-8% from this change in speed infringements.

Clearly, there are additional complexities that could be introduced to this theory, and it becomes particularly trickier when multiple parameters vary at the same time. Nevertheless, this basic theoretical framework provides a simple way of considering speed behaviour, and will be used to assess the relative influence of the historical speed limit changes on observed behaviour.

3 ANALYSIS

The following sections review the findings from the previous two open road speed limit changes in New Zealand. Invariably, other external factors affect road casualty statistics over time, including changes to the roading standards, vehicle fleets, and enforcement practices. Therefore, an analysis of the effect of changing the posted speed limit has to confine itself to a relatively short time period either side of the change, to minimise the influence of other factors. We propose looking at no more than three years of data either side of the changes, to minimise these effects whilst still providing an adequate sample to analyse.

Two simple ratios will be considered to help control for other confounding factors:

- The ratio of open road to urban casualties (for fatalities, injuries and combined)
- The ratio of fatal to injury casualties (for urban and open road areas)

Unfortunately, detailed breakdowns in crash statistics by urban and open road locations are not readily available prior to 1980, limiting the available analysis for earlier changes. We were also unable to obtain traffic count indices to assess changes in traffic volumes during the 1980s.

3.1 1973 speed limit reduction

On 4 Dec 1973, the New Zealand open speed limit was reduced from 55 mph (88 km/h), and in a few cases 60 mph, to 50 mph (80 km/h), largely as a fuel conservation measure due to the international oil shocks. Frith & Toomath (1982) examined changes in vehicle speeds and safety following the 1973 speed limit reduction. Due to limited data available from this period, this study remains the primary source for analysis purposes.

Frith & Toomath (1982) documented the data collected either side of the 1973 speed limit change. They concluded that the reduction in road injuries in the year following the change was consistent with changes to the rural speed distribution, which included a sharp drop in rural mean speeds and a sharp contraction in the spread of these speeds.

Figure 4 shows the observed change in mean free speeds on rural roads before and after the posted limit change. Frith & Toomath (1982) noted that the initial substantial speed reduction (8-10 mph) appears to have been achieved largely through concerted peer pressure on drivers to obey the limit, inspired by fears of fuel shortages encouraged by the media. Even a person travelling slightly above the speed limit was labelled "greedy" or "anti-social" and was liable to receive disapproving signs from other motorists he passed.

Excluding the initial large drop immediately after the speed limit change (which can be partly attributed to significant speed enforcement during this period), the average observed speed in the three years afterwards was approximately 5-6 km/h below the average results for the preceding three years. This is much greater than the typical expected change for an 8 km/h drop, which illustrates the strength of the "peer pressure effect" in this case. Applying the previously introduced theoretical framework (section 2.3), essentially this represents a coefficient of compliance closer to 70%. Although other trends, including speed "creep" (i.e. long-term gradual increases in driver speeds), may have started affecting the figures over time, it is notable that the observed mean speeds start to tend closer to a 3 km/h reduction after further time elapsed, suggesting a return to the 20-30% typical k_c figure previously suggested.

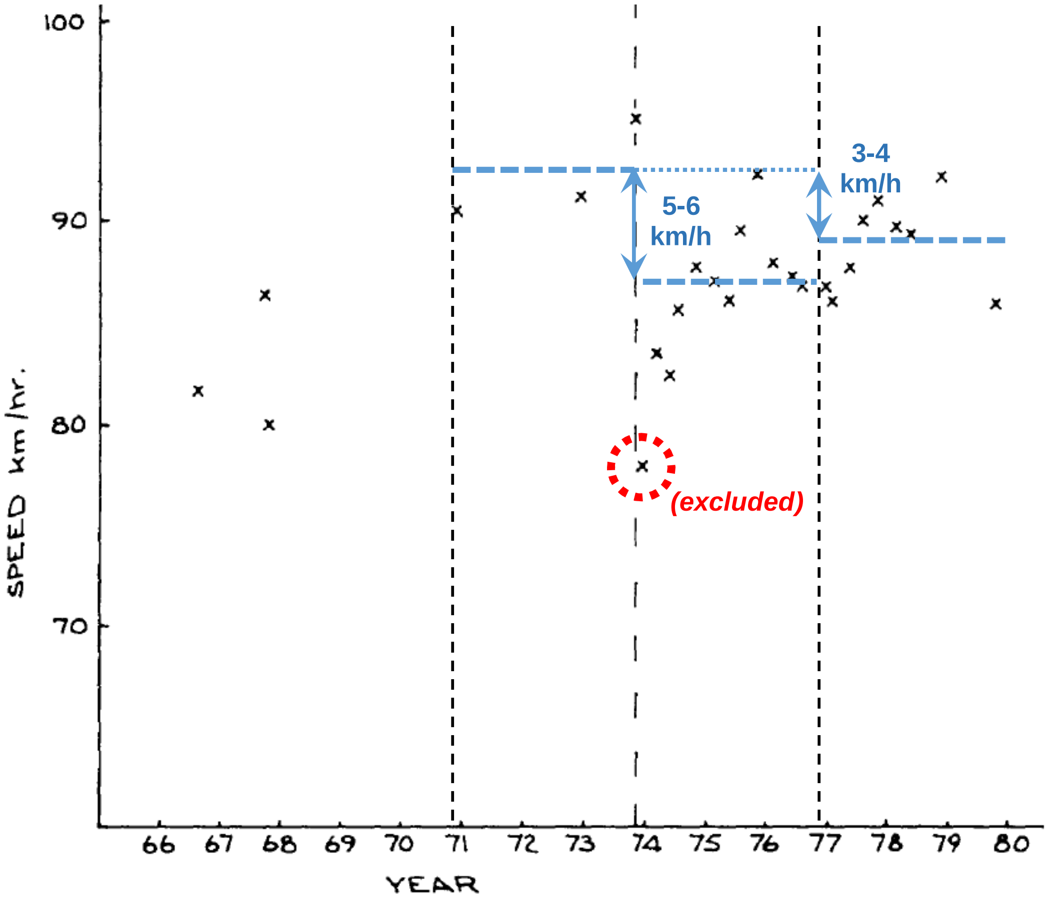

Figure 4: Time series of observed free speeds on rural roads (Frith & Toomath 1982)

Figure 5 illustrates the effect of the speed limit change on the proportion of drivers observed exceeding 100 km/h. This time, the effect is even more stark, with the proportion of high speed offenders dropping from a typical 25-35% to about 5-15% in general. This highlights a commonly found effect of speed reduction treatments, generally greater decreases observed by the fastest speedsters (e.g. Povey *et al* 2003).

Frith & Toomath also evaluated the effect on road safety, and compared the changes on rural sealed state highways (RSSH) with what occurred in urban areas during the 12 months either side of the speed limit change. Table 1 summarises the results; it is clear that the crash reductions in the rural areas are considerably greater than in urban areas, particularly for fatalities. The proportion of fatalities occurring in rural areas fell from 51.5% of the total to 44.0% (and all rural casualties fell from 25.4% of the total to 21.6%). The ratio of fatal to injury casualties for rural crashes changed from 1:13.5 before to 1:16.5 after (an 18% reduction), suggesting that overall crash severity also reduced following the speed limit change.

Injuries	Fatal		Serious		Minor	
	Urban	RSSH	Urban	RSSH	Urban	RSSH
Before (Dec ’72 - Nov ‘73)	347	368	4923	2300	10331	2652
After (Dec ’73 - Nov ‘74)	294	231	4480	1743	9909	2070
Absolute change	*-53*	*-137*	*-443*	*-557*	*-442*	*-582*
Percent change	*-15.3%*	*-37.2%*	*-9.0%*	*-24.2%*	*-4.1%*	*-21.9%*

Table 1: Injuries before and after 1973 speed limit change (Frith & Toomath 1982)

NB: RSSH = “rural sealed state highways”

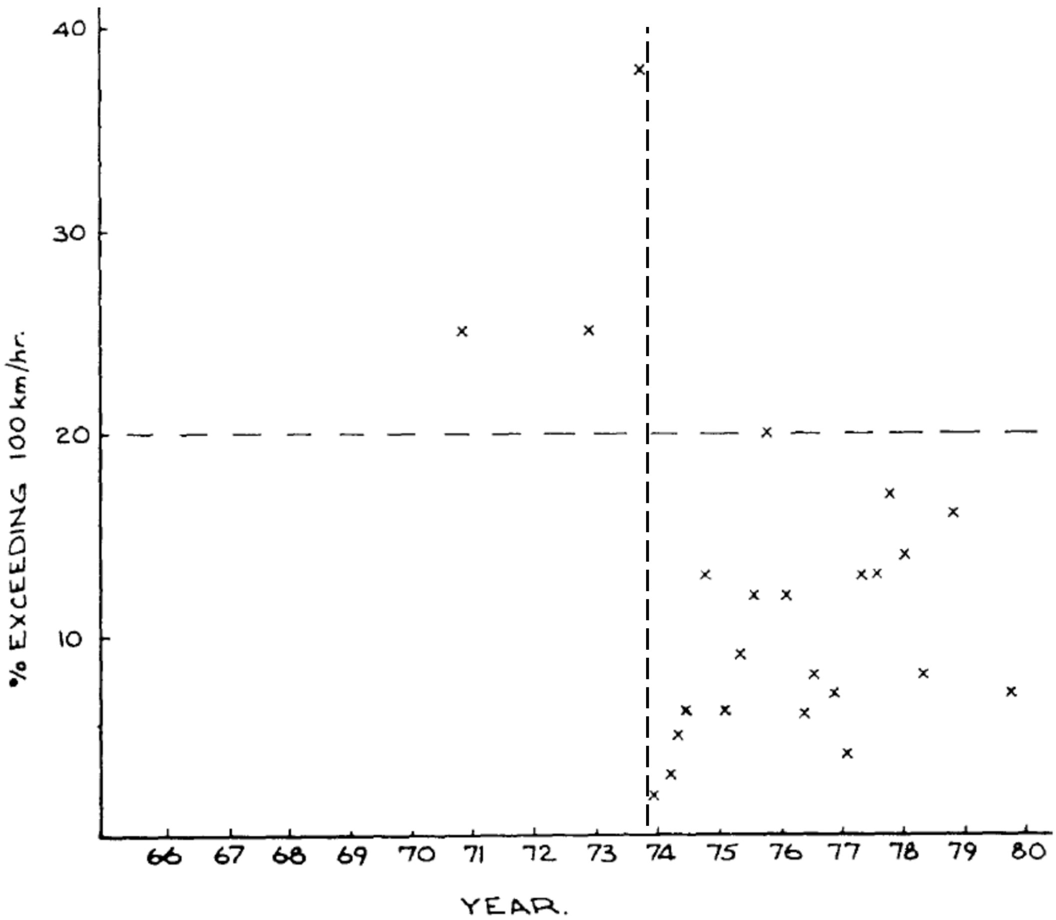

Figure 5: Time series of observed vehicles on rural roads exceeding 100 km/h (Frith & Toomath 1982)

The amount of driving undertaken is the other factor that could have influenced crash statistics over time. Figure 6 summarises the time series of traffic growth based on state highway count data. It can be seen that traffic volumes fell flat in 1974-75 (but did not appreciably decline), possibly influenced by concerns of fuel shortages. While it is expected that this might stall the previous rapid growth in road casualty numbers, it does not explain the notable rural road casualty reduction observed.

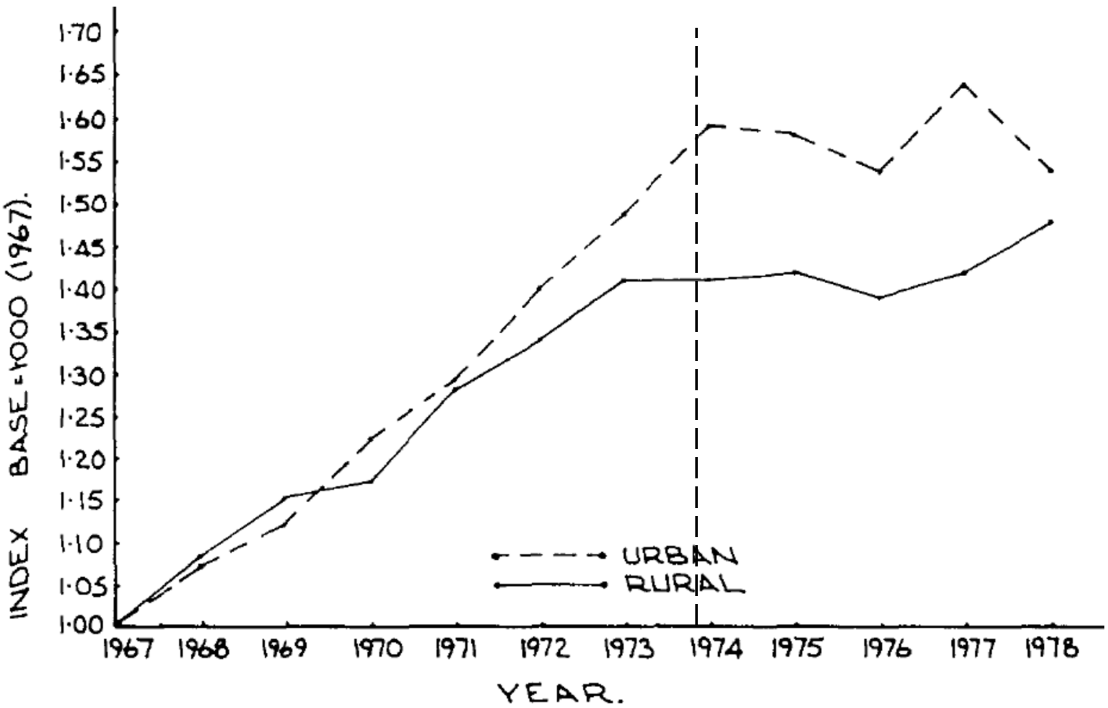

Figure 6: Time series of traffic volume indices (Frith & Toomath 1982)

It would be desirable to examine a longer time period before and after the speed limit change. Data is not readily available for the annual split in casualties by urban and rural areas prior to 1975. However, there is annual data on the numbers of injuries and fatalities overall (MOT 2016), as well as data on population and vehicle numbers. Taking the end of 1973 as the simple dividing line between the before and after periods, Table 2 compares the numbers of fatalities and injuries in the three years prior to and after the speed limit change.

	All Fatalities	All Injuries	Ratio: Fatal/Injury
Before: 1971-73	2233	67307	0.0332
After: 1974-76	1913	58563	0.0327
Percent Change	*-14.3%*	*-13.0%*	*-1.5%*

Table 2: Changes in ratios of fatal and injury casualties after 1973 speed limit change

The results indicate a considerable reduction in both fatalities and injuries following the speed limit reduction. Over the same period, the general population and vehicle numbers in New Zealand grew by 6% and 16% respectively, meaning even greater reductions per capita or per vehicle. The ratio of fatalities to injuries dropped slightly by 1.5%; however, the reduction is not statistically significant at the 95% level (1-tailed chi-square, p=0.312).

For context, the following other road transport related initiatives occurred around the time of this speed limit change (MOT 2016):

- 1971: A Speeding Infringement System was introduced.
- 1972: Compulsory testing for blood alcohol of crash victims at hospitals was introduced.
- 1972: Compulsory fitting and wearing of safety belts was required for certain drivers and front seat passengers 15 years and over in light vehicles registered since 1965.
- 1973: Safety helmets were made compulsory for motor cyclists and pillion riders at all speeds (previously only compulsory if travelling in excess of 30 mph).
- 1975: Seat belt requirements (see 1972 above) were extended to motor vehicles registered on or after 1 January 1955.

- 1975: Change over to metric speed limits and road signs.

Although many of these initiatives would have each contributed somewhat to reducing the overall casualty statistics, only some were significant in their own right. For example, motorcycle-related crashes contributed about 15% of the overall road toll in 1973, and many would have already been wearing helmets, so the effect of mandatory helmets would have been noticed but by less than this (Elvik *et al* 2009 cite an average motorcycle fatality reduction of 26% when a mandatory helmet law is introduced, which would equate to about 4% of the overall road toll). The most prominent initiative was the introduction of the compulsory seat belt requirements in 1972 and 1975. Toomath (1977) noted a driver seat belt wearing rate already over 60% prior to the speed limit change, which had climbed to over 85% by mid-1975. Elvik *et al* (2009) suggest that this would equate to a 7-8% reduction in light vehicle fatalities, or 4-5% of the overall road toll.

In summary, while factors such as flattening traffic volumes, conservative driving due to fuel shortages, and new seat belt and helmet requirements certainly helped stem the previously rising road casualty statistics in New Zealand, it would appear that the introduction of a lower open road speed limit in 1973 was still a major contributing factor to the subsequent drop in fatality and injury numbers over the subsequent years. The large immediate drop in observed mean speeds was a likely major contributor to these reductions, but appears to be a special case owing to the fuel shortage concerns at the time, and is not likely to be replicated to the same degree today from reductions in the current open road speed limit.

3.2 1985 speed limit increase

On 1 July 1985, the 80 km/h open speed limit was raised to 100 km/h for all vehicles except Heavy Motor Vehicles and articulated vehicles (raised from 70 to 90 km/h) and vehicles towing trailers (from 70 to 80 km/h). This change was partly to reflect prevailing operating speeds, which had been creeping up since the 1970s and were already close to 100 km/h, partly due to improving road and vehicle standards.

Two separate studies looked at the effects of the 1985 speed limit change. Barnes & Edgar (1987) looked at what the effect was on vehicle speeds, and Jones *et al* (1987) investigated whether raising the speed limit resulted in an increase in crash rates. Detailed crash data can also be obtained for this period from the NZTA Crash Analysis System (CAS).

Barnes and Edgar (1987) reviewed a series of bi-annual speed surveys at 30 unconstrained rural road sites around New Zealand. Table 3 summarises the main results. For both the 'winter' and 'summer' surveys, the mean free speeds increased following the increase in the posted speed limit in winter 1985. However, previous years had also seen increases in speeds, so it is arguable whether some of the change was "natural increase". The authors also noted that, on average, the highest increases in mean speeds occurred at the sites with the lowest mean speeds beforehand; this may reflect some "speed targeting" to try to follow the new raised speed limit (which was now *higher* than the mean speeds at these sites).

	'Winter' surveys	'Summer' surveys
Before mean speed (year)	99.7 km/h (1984)	96.4 km/h (1985)
After mean speed (year)	102.7 km/h (1986)	100.5 km/h (1987)
Change	*+3.0 km/h*	*+4.1 km/h*
Change for previous year	+2.0 km/h (1983-84)	+1.1 km/h (1984-85)

Table 3: Changes in observed free speeds before and after 1985 speed limit change

Barnes and Edgar also noted even greater increases in mean speeds around motorway sites in the three main centres (3.4-5.4 km/h in winter, 5.8-6.8 km/h in summer), with even greater increases at the 85th percentile level. This greater change in observed speeds was suggested as being due to the higher enforcement presence on these motorways (affecting observed speeds prior to the speed limit increase), which ties in with the model developed in Section 2.3.

CAS data has been examined on a month-by-month basis to identify any changes following the 1985 speed limit increase. Table 4 summarises the changes in fatal and injury casualties in the 12 months immediately before and after the speed limit change. While all numbers increased, clearly, much greater increases occurred in rural areas than urban ones, and for fatalities rather than injuries. If the data is extended out to three years either side of the change, similar patterns of increase remain, although rural injuries see a 19% increase in numbers. The relative ratios of increases, both in terms of rural vs urban and fatal vs injury are all statistically significant at the 95% level (1-tailed chi-square, p<.01).

	Rural Fatalities	Rural Injuries	Urban Fatalities	Urban Injuries
Before: Jul '84 - Jun '85	370	5757	280	12516
After: Jul '85 - Jun '86	456	6236	316	12780
Percent Change	*+23.2%*	*+8.3%*	*+12.9%*	*+2.1%*

Table 4: Changes in fatal/injury casualties before and after 1985 speed limit change

Jones *et al* (1987) explored the changes in crash numbers for New Zealand following the speed limit change, albeit only for the 18 months immediately after. They noted that there was an increase in fatal crashes following the speed limit change; however, the increase was not just confined to rural roads. The evidence observed, together with the small increases in speeds after the speed limit change noted above, led the researchers to be unclear as to the role played by the speed limit in the subsequent crash changes.

The "cusum" approach was used by Jones *et al* (1987) to detecting changes in fatal crash patterns. A cusum is a plot of the cumulative sums of the deviations of the variable of interest from a chosen target value. In this case, the target values were the computed means of the series in the period immediately before the change in the speed limit. Cusums are useful for picking out by eye a sudden change in the mean level of a time series (statistical tests are also available to confirm this numerically). A horizontal slope of the cusum between any two points in time implies little change from the target value whereas a positive (increasing) slope implies that the mean in that interval is greater than the target value.

Jones *et al* noted an increase in the slope of fatal crash cusums after the speed limit change, but also observed that this increase was evident in both rural and urban roads. However, a longer re-analysis of the data for fatalities (using the mean monthly number of fatalities for the three years prior to the speed limit change as the target value) reveals quite different patterns. Figure 7 shows the cusum plots for both rural and urban fatalities before and after the speed limit change; while mean urban fatalities did increase afterwards, it is clear that the increase in mean rural fatality numbers was sustained while the increase at urban locations was not. Note that the continuing upward slope does not mean that the rural fatality numbers continued to increase; rather that they continued to be above the target mean from prior to the speed limit change.

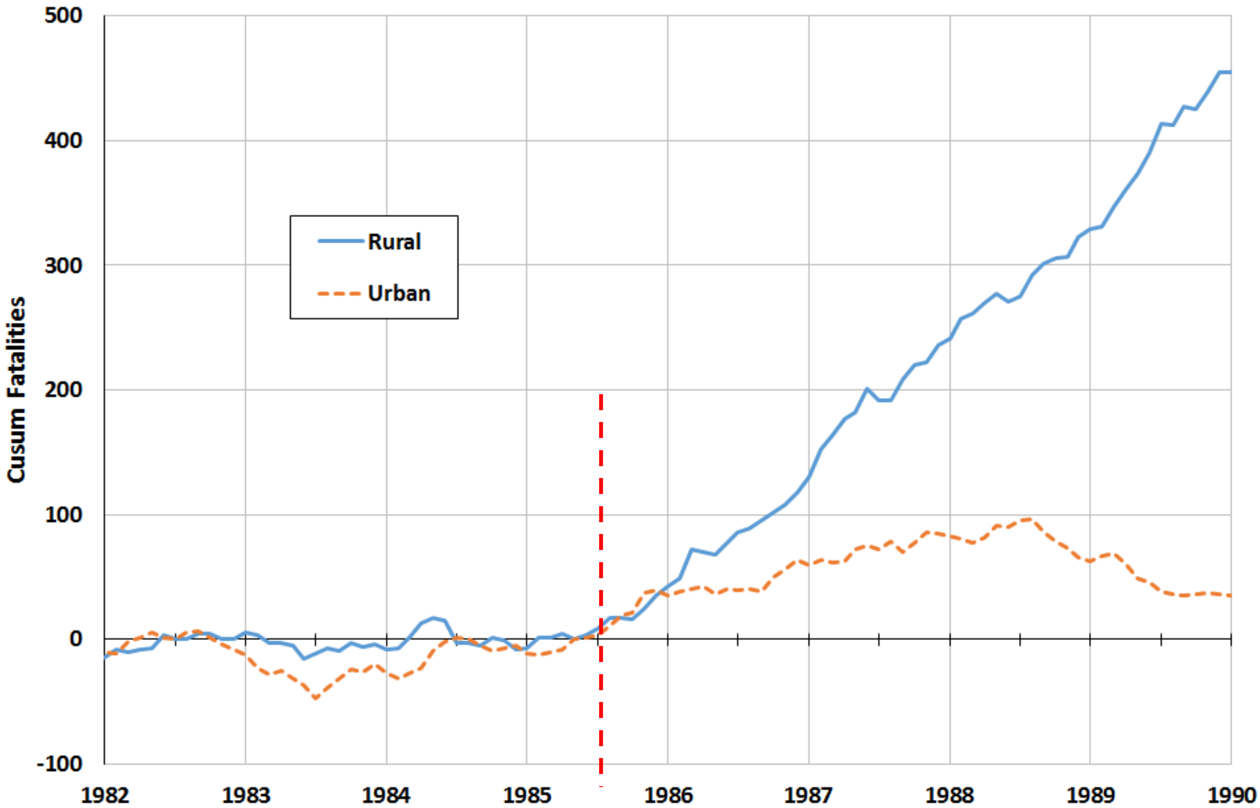

Figure 7: Cusum of fatal casualties before/after the 1985 speed limit change

Figure 8 shows the changes in the ratios of rural to urban casualties before and after the speed limit change. The ratios are based on rolling 12-month averages (e.g. the figure at June 1984 is for the period July 1983 – June 1984); the shaded section indicates the period when there is data from both before and after the speed limit change and has thus been ignored.

It can be seen that there is a distinctive increase in the ratio of fatal casualties after the speed limit change; the ratio jumps from 1.32 for the 12-month period immediately prior to the change to 1.44 for the 12-month period immediately afterwards (9.2% increase). The ratio for injuries increases as well but only by 6.1%, although within that group the ratio for serious injuries increased by 10.5%. This highlights the greater effect of speed changes on deaths and serious injuries. The average ratios for the three years either side of the speed limit change (July '82 - June '85 and July '86 - June '89) reveal even greater changes in the rural/urban casualty ratios (+18% and +17% respectively), although there may be other external factors that start to affect these figures.

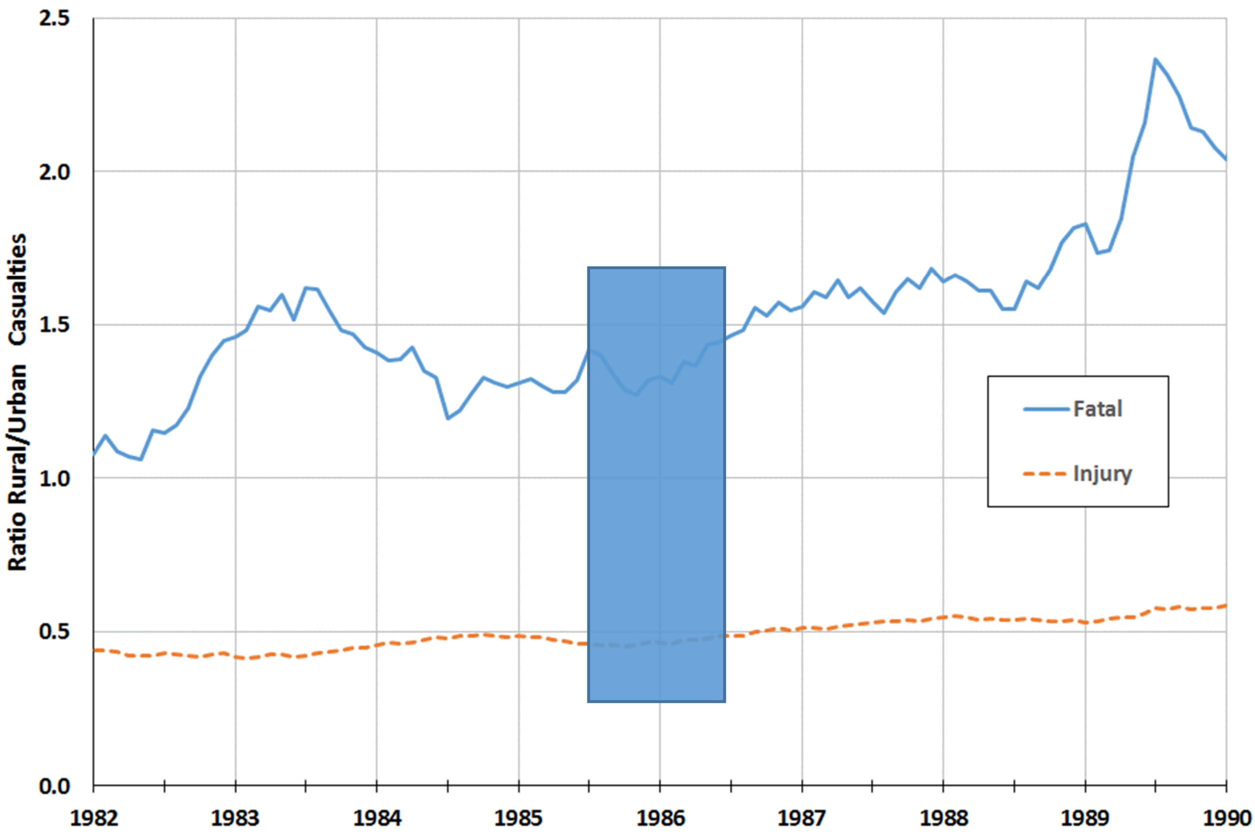

Figure 8: Change in ratios of rural/urban casualties (12-month rolling average)

A similar pattern occurs when the ratios of fatal to injury crashes are examined. Figure 9 shows the change in ratios for rural and urban areas before and after the speed limit change; again, a shaded section indicates the period with data from both before and after the change.

The previously decreasing trend for the ratio of rural fatal to injury casualties is abruptly halted after the speed limit change; there is an immediate 13.8% increase between the 12-months periods immediately before and after the change (0.064 to 0.073) and no further decline. The urban fatal/injury ratio also increased immediately after by 10%; however, over the three-year periods either side of the speed limit change, the average urban ratios were identical.

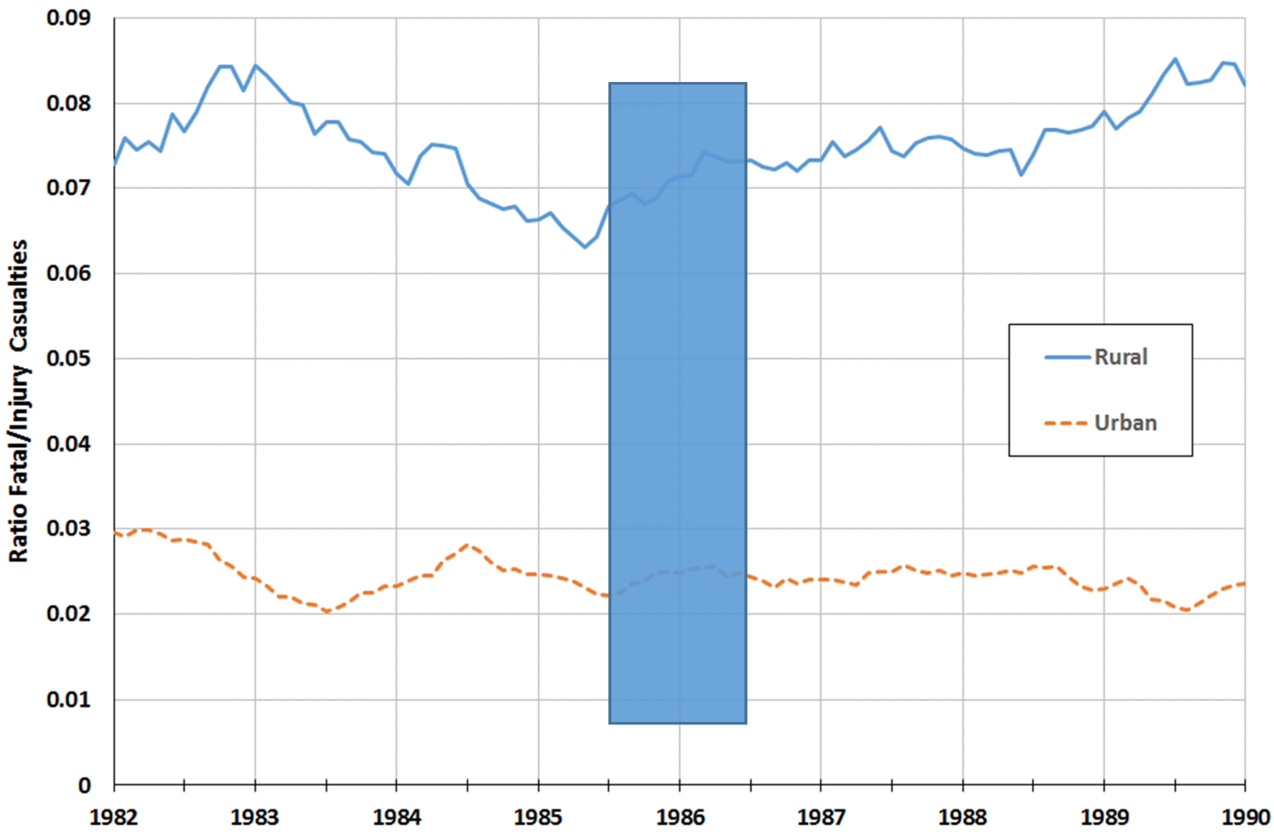

Figure 9: Change in ratios of fatal/injury casualties (12-month rolling average)

Overall, the results indicate a considerable increase in both rural fatalities and injuries following the speed limit increase, particularly the former. Over the same period, the general population and vehicle numbers in New Zealand grew by 2% and 6% respectively, thus reducing the increases per capita or per vehicle slightly but not changing the overall conclusions. Unfortunately, no convenient time series of traffic volume data has been found for the analysis period.

For context, the following other road transport related initiatives occurred around the time of this speed limit change (MOT 2016):

- 1983: The 150-km rail protection began to be phased out, which allowed the use of road transport for long-distance freight haulage.
- 1983: Courts were allowed to make an order requiring a person, convicted twice or more in a five-year period of specific alcohol or drug related traffic offences, to attend an Assessment Centre and for disqualification from holding or obtaining a driver's licence.
- 1984: Regulations governing the approval and use of child restraints introduced.
- 1986: Staggered relicensing of motor vehicles and provision for lifetime drivers' licences was introduced.
- 1986: Strict liability for carriage of insecure loads came into effect.
- 1987: Increased powers of arrest for traffic officers, new driving hours and logbook requirements for professional drivers, graduated licensing system and increased penalties for unlicensed driving introduced (1 August).

The removal of the rail protection legislation in 1983 could have been expected to have had an adverse effect on rural casualty statistics, but it was not evident in the data prior to the speed limit change. Other changes listed were more of a minor nature and not particularly targeted at rural roads.

1988-89 was also notable for a raft of measures, presumably responding to the 1987 peak of 795 road fatalities. These included: lowering the legal breath alcohol level from 500 µg/l to 400 µg/l, increased maximum penalties and infringement fees for a wide range of traffic offences, and increased powers for enforcement officers dealing with offenders who fail to stop. These and many other initiatives certainly did make a worthwhile contribution to lowering the casualty statistics over the ensuing years. One wonders though, whether even greater gains could have been made had the open road speed limit not gone up prior to this.

4 CONCLUSIONS

This paper serves as a reminder that widespread changes in speed limits in New Zealand are nothing new, and lessons should be taken from these “natural experiments”. Although the vagaries of the available data at the time make it slightly difficult to tease out all the relative changes in rural vs urban and fatal vs injury casualties, the overall findings seem quite clear:

- A reduction in the open speed limit, as seen in 1973 was accompanied by a notable reduction in rural fatalities and injuries relative to their urban counterparts.
- An increase in the open speed limit, as seen in 1985, was accompanied by a notable increase in rural fatalities and injuries relative to their urban counterparts.

In the first case, the change in the limit was accompanied by strong social pressure to travel more slowly for fuel conservation purposes but the reduced limit gave this social pressure official backing and allowed strong compliance to occur. In the second case, the change clearly was taken as a licence to travel faster by motorists, even when the previous mean speeds were below the new speed limits. In both cases, the effect was particularly noticeable on the numbers of fatalities and more severe injuries; this aligns with the evidence found elsewhere (such as Nilsson 2004). Given New Zealand’s current focus on deaths and serious injuries, this reinforces speed management as an important tool to reduce their numbers.

While we are not likely to see wholesale changes to our default rural road speed limit again in New Zealand, the findings still provide useful evidence for the likely effects of changing speed limits on localised road sections. It must be remembered that in the 1970s the road network was of a much lower overall standard than that which prevails now. The change to 80 km/h would have given many lower standard roads a safer and more appropriate speed environment, which the subsequent 1980s increase would have disturbed. The new speed management guidelines (NZTA 2016), through their targeting to risk, provide an opportunity to place lower speed limits on higher risk roads. Their effectiveness will be greater when the environmental speed of a road closely matches the posted limit (with physical changes if necessary to achieve this).

Therefore, now that they have the tools available to implement them, it is an appropriate time for New Zealand road controlling authorities (RCAs) to consider the role of lower speed limits, particularly in parts of their rural networks, as a means of reducing the road casualty statistics in their districts. The NZ Transport Agency, through the guidance, community engagement and legislation surrounding the setting of speed limits, need to ensure that it is easier for RCAs to implement such measures where appropriate.

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