Discussion of road safety related trends influencing the Queensland 2010 road toll: the lowest since 1952

by S Bailey

Transport and Main Roads, Queensland Government[*]*, 2012*

Abstract

In 2010 Queensland experienced a sudden and significant reduction in road fatalities. While this result occurred despite the absence of any concomitant widespread policy intervention it did, however, occur in the wake of the Global Financial Crisis. This paper describes a preliminary investigation of road safety related trends to understand both immediate and long term changes that culminated in the 2010 road toll. Accordingly, routinely collected data were extracted and visually examined by plotting percentage change trends over time. Effects of vehicle and road infrastructure improvements were also estimated. Results showed reductions in travel and general alcohol consumption as well as increases in unemployment that are likely to have affected the road toll. Differential fatality trends were seen across target/risk groups after accounting for exposure, with the greatest changes seen in the alcohol and speed related trends. Relative decreases were also seen for young driver/riders, particularly males, in both exposure and risk. Increasing trends were seen in enforcement activity, vehicle improvements and infrastructure spending. In the absence of statistical modelling "causal" links could not be determined. Nevertheless, results suggested that the 2010 road toll reduction was due in part, but not solely, to the Global Financial Crisis.

Keywords: Drink Driving, Speed Enforcement, Road Infrastructure and Vehicle Safety.

Introduction

In 2010 Queensland experienced 26.3% reduction in fatalities compared with 2009 and the lowest annual fatality rate (5.53 per 100,000 population) since accurate records began in 1952. This result was achieved in the absence of a concomitant significant state wide intervention, however, it did coincide with a significant change in the broader social environment; the Global Financial Crisis circa 2008. Therefore, the purpose of this project was to conduct a preliminary investigation of trends in road safety related factors, to identify changes that may have contributed to the 2010 road toll reduction.

Past research has shown that the causes of road crashes are multifactorial and influenced by person, vehicle and environment related factors, as well as random variation. Speed has also been shown to be a factor in crashes as it relates to people, vehicles and the environment before, during and after a crash (Elvik, Christensen & Amundsen, 2004; Haddon, 1980). Person related factors include such things as age, gender, personality and impairment related to alcohol/drug consumption and fatigue (Peden, Scurfield, Sleet, Mohan, Hyder, Jarawan, Mathers, 2004). Vehicle related factors include age, type, size and crashworthiness of the vehicle (Peden, et al., 2004; Newstead, Watson & Cameron, 2010).

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[*] *Views expressed in the report are those of the author only and not to be considered official Transport and Main Roads policy. Similarly, analysis and interpretation of Queensland Police Service data are not to be considered official Queensland Police Service opinion or policy.*

Environmental factors include the immediate road and roadside environment as well as the social, particularly economic, environment (Tziotis, 1993; Scuffham & Langley, 2002; Vulcan & Corben, 1999). Changes in economic activity (for example, unemployment) have been found to not only affect exposure (due to decreased travel) but also, levels of general alcohol consumption, which are related to levels of drink driving. Sudden increases in unemployment have been found to be related to decreases in road trauma trends, albeit delayed by 9-12 months (Scuffham & Langley, 2002). In the wake of the 2007 Global Financial Crisis, road fatalities have shown marked and record declines worldwide, with few increases (International Transport Forum, 2011; Longthorne, Subramanian & Chen, 2010). Police enforcement also represents an environmental factor of some import, as Random Breath Testing (RBT) and speed management represent the largest and most significant enforcement activities in Queensland.

Speed is primarily controlled by posting speed limit signs, supplemented with enforcement. The evidence for the effectiveness of speed cameras is substantial (Wilson, Willis, Hendrikz, Le Brocque, & Bellamy, 2010). Results from the highly rated evaluation of the Victorian speed camera program by Newstead, Mullan and Cameron (2010) showed significant reductions in crashes linked to increases in Traffic Infringement Notices (TINs) issued and increased publicity. Significant reductions in severity were also found to be related to increases in TINs issued and speed camera operation hours. Interestingly, TINs issued had the greatest effect upon crash incidence, whereas operation hours had the greatest effect upon crash severity. Small temporal and spatial halo effects were also found in a number of studies.

RBT involves roadside screening of road users for illegal levels of BAC and is generally assumed to function under the principles of general and specific deterrence. General deterrence deters potential offenders through fear of punishment, whereas specific deterrence deters offending though the experience of prior punishment (Delaney, Diamantopoulou, & Cameron, 2006). The results of a meta-analysis of 39 studies of RBT effectiveness show significant inverse relationships between RBT activity and crashes of all types (Elvik, 2001, cited in Wundersitz & Woolley, 2008). However, some controversy exists regarding the degree to which enforcement should be "targeted" to maximise detection or more general (Harrison, Newman, Baldock & Mclean, 2003, cited in Wundersitz & Woolley, 2008; Homel, 1988, cited in Watson & Freeman, 2007).

Estimates of the effectiveness of general infrastructure improvement suggest that for every $142 million (2010 dollar value, ±30% error) spent per annum on new general road construction projects, at least 1.5 less fatalities per annum could be expected (Vulcan & Corben, 1999). Research evidence into the effectiveness of Black Spot and route treatment programs, suggests that for the same dollar amount at least 20 less fatalities per annum could be expected (Vulcan & Corben, 1999). Vulcan and Corben postulated the accuracy of the combined estimates to be ±20%.

In summary, in 2010 Queensland road related fatalities dropped significantly. In the absence of a significant global intervention and the presence of the recent Global Financial Crisis, one might initially conclude that the reduction was due to economic changes alone. However, a review of the literature showed that the causes of crashes are multifactorial and can be broadly classified into person, vehicle and environmental factors. Therefore, the following factors were examined: exposure (Vehicles Kilometres Travelled, VKT), unemployment rates and general alcohol consumption, to examine the impact of economic changes on road safety; trends in fatalities by target/risk groups, to investigate the nature of changes in exposure and risk, and whether changes were uniform across groups; environmental changes related to enforcement activity (speed and RBT), as well as the impact of long term changes in vehicle safety and road infrastructure improvements.

Method

Licensing, infringement, crash and police enforcement activity data routinely collected by the Queensland Police Service (QPS) and Transport and Main Roads (TMR) were collated for examination, as well as data obtained from the Australian Bureau of Statistics (ABS). The following data were examined: Average Annual Daily Traffic (AADT) counts; unemployment rates and alcohol sales (ABS); road fatalities and fatalities by high risk groups/behaviours and per VKT (sourced from TMR Road Crash database and AADT); licensure by age and gender (TMR Transport Registration and Integrated Licensing System); RBT and speed radar enforcement activity[†] (QPS Traffic Returns Analysis and Complaints System and the Traffic Camera Office Master Stats Workbooks, respectively); numbers of police officers primarily dedicated to traffic enforcement (QPS Policy and Workforce Planning); vehicle safety improvements and road infrastructure spending estimates (TMR Systems Applications Programs database). To facilitate visual comparisons raw data for most variables was converted into percentage change scores from the index year/period.

Results

Data was obtained from the relevant systems and agencies. Only fatal crash data was obtained since full data was not yet available. In most cases trends (~1999-2010) are presented in percentage changes from the reference year to allow comparisons between variables.

Figure 1 below shows trends in annual fatalities 1999 to 2010 by high risk behaviours and at risk groups: total, involving non alcohol and non speed (non-alc/spd); alcohol or speed; young drivers (17-24yrs); motorcycles (m/c); heavy freight vehicles; and drink drivers. Figure 1 shows an overall slight upward trend to 2007, followed by a gradual then sudden decline (in 2010). Noteworthy, the high risk alcohol or speed and young driver/rider involved groups showed more sustained declines, with motorcycle and heavy freight vehicles also showing a decline from 2008 and 2009, respectively. This is in contrast to the more moderate but variable decline in non-alcohol and non-speed related fatalities.

[†] Only preliminary speed camera data was available (these data had not been classified and collated in accordance with nationally accepted statistical guidelines) therefore trends are indicative only. Official QPS statistics are published in the QPS Annual Statistical Reviews and Annual Reports.

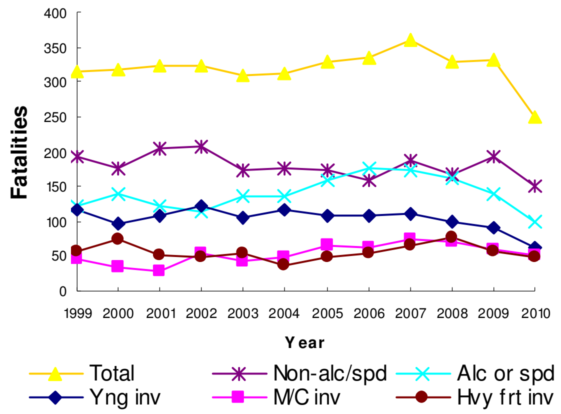


Figure 1. Annual fatalities 1999-2010.

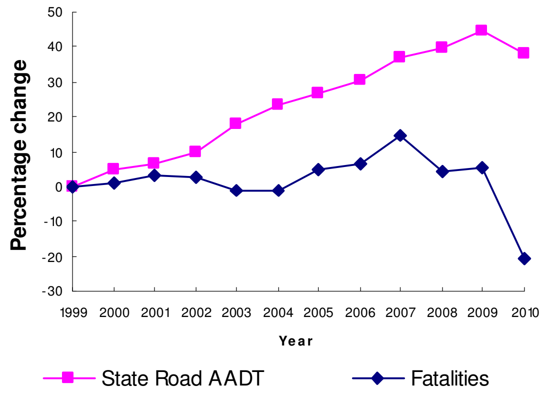


Figure 2. Percentage change in AADT* and Total fatalities1999-2010 (*preliminary for 2010).

Environmental changes related to the economy

Figure 2 above shows the percentage change in state road Annual Average Daily Traffic[‡] counts and fatalities compared to the 1999 index year. In 2010, Queensland shows a 4.6% reduction in VKT and a 24.8% reduction in fatalities compared to the previous year. Thus, if all other variables remained constant (which is likely NOT the case), 18.5% of the 2010 reduction could be attributed to reduced exposure alone.

Figures 3 and 4 show trends in unemployment and road fatalities, and general alcohol consumption and drink driving fatalities.

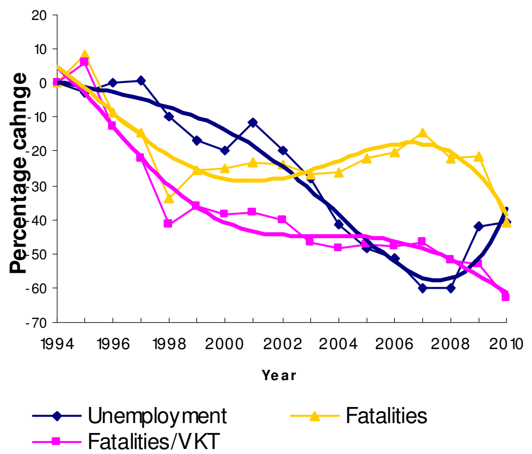


Figure 3. Annual change in total Queensland unemployment, fatalities, and fatalities per VKT, 1999-2010.

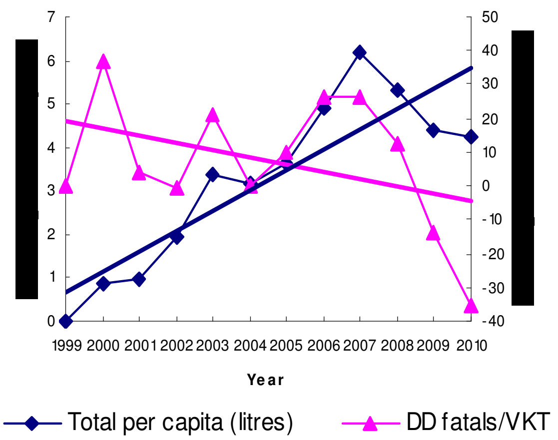


Figure 4. Annual change in the apparent consumption of alcohol and DD related fatalities per VKT, 1999-2010.

Figure 3 shows a sharp increase in unemployment in 2009 that was sustained with a slight increase in 2010. Polynomial trend lines suggest an inverse relationship not only between unemployment and fatalities but also, fatalities per VKT.

[‡] Total state traffic Vehicle Kilometres Travelled (VKT) was not available for 2010. However, 1999-2009 trends of AADT and ABS derived estimates of VKT were compared and found virtually identical. Therefore state road AADT estimates (preliminary for 2010) were used as proxy for changes in state VKT.

This suggests that the effects of the economic downturn are not confined to reduced driving exposure alone and may well result in reductions in high risk behaviours whilst travelling, such as drink driving. Interestingly, the increase in unemployment in 2009 did not coincide with a drop in VKT, or fatalities (absolute or per VKT), in that same year.

Figure 4 shows linear trends of apparent alcohol consumption (left Y axis) and drink driving related fatalities per VKT (right Y axis) moving in opposite directions. Encouragingly, this might suggest increased separation of drinking and driving over time or alternatively, a reduction in fatality risk associated with drink driving, possibly due to vehicle and road infrastructure improvements. However, divergences from the respective linear trend lines suggest that departures from the underlying trend in consumption are associated with similar changes in DD fatality risk; greater consumption associated with greater fatalities, and vice versa. Noteworthy is the sustained decrease in consumption from 2008, which may have been related to the economic downturn, and corresponding reduction in fatalities.

Changes in risk and exposure for target groups

To investigate changes in fatality risk after accounting for exposure, trends for key high risk groups per their respective VKT, were compared to total fatalities per VKT (see Figures 5-7, Figure 7 uses licence holders as the unit of exposure).

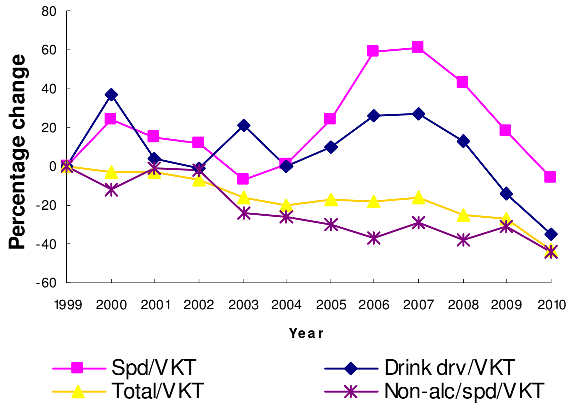


Figure 5. Annual fatalities per VKT involving speed, drink driving and non alcohol and non speed, 1999-2010.

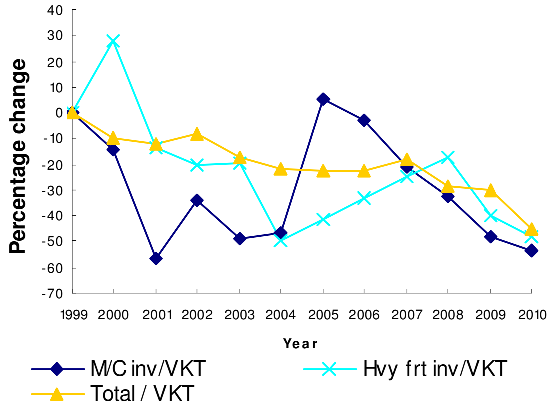
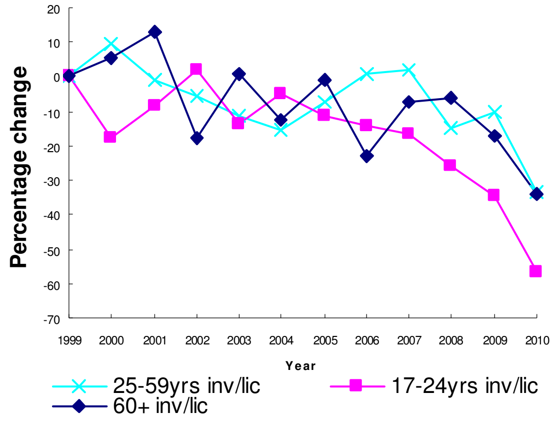


Figure 6. Annual fatalities per VKT involving motorcycles, heavy freight vehicle, 1999-2010.

Total fatalities per VKT show steady decline (Fig. 5). However, a different picture emerges for the high risk groups, which show a high degree of variability, most pronounced for drink driving and speed related fatalities per VKT. Motorcycle fatalities (Fig. 6) need to be interpreted with caution as estimates of motorcycle VKT may be unreliable and annual fatalities are highly variable, due to small sample sizes.

Noteworthy is the peak in drink driving fatalities per VKT in 2007 that corresponds with the peak in alcohol consumption shown in Figure 4, and that a sustained decline in alcohol and speed related fatalities per VKT is seen from 2008. Noteworthy, Figure 7 shows a more consistent and overall greater decline in crashes involving young drivers (17 to 24 year olds) per licence holder from 2005, compared to the other age groups. Figure 8 also reveals a change in the licensed population likely to contribute to a reduction in fatalities for younger driver/riders; the highest risk young male group showing the lowest proportional increase in licensure.



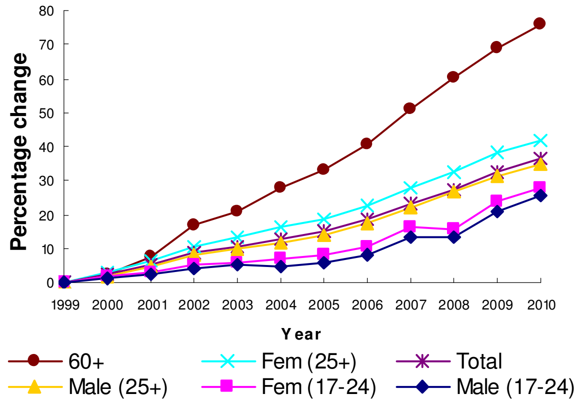


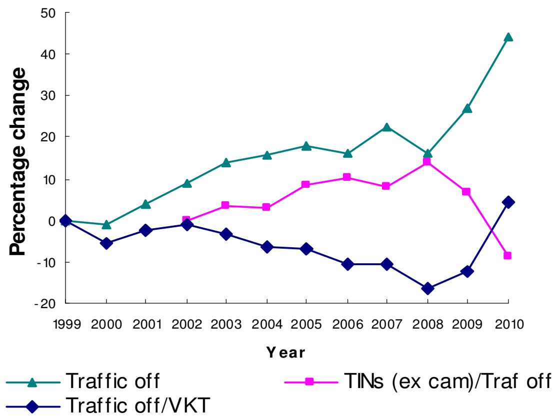
Figure 7. Annual fatalities per licence holder age group involving young, adult and older adult controllers, 1999-2010.

Figure 8. Annual change in licences on record by age and gender, 1999-2010.

Not shown here but examination of licence uptake of the eligible population over the corresponding period showed a reduction in licence uptake for young people generally (-7.8%), with the greatest reduction for young males (-5.6%). This is in contrast to an increase in uptake of 7.7% for females 25 years old and over (vs. 1.4% for similarly aged males), and 16.4% for people 60 years old and over. Thus, if we assume no change in VKT per licence holder over time, the reduction in fatalities involving young driver/riders seen in Figure 1 appears to be a result of reduced risk (as shown in Fig. 7) and exposure (Fig. 8), partly due to reduced licence uptake generally, and for males specifically.

Environmental changes related to enforcement

Figures 9 to 13 following show changes in police enforcement activity over time. Figure 9 below shows annual police traffic officer numbers, absolute and per VKT, and the corresponding changes in TINs issued per traffic officer (note, TINs data was available only from 2002). While the number of traffic officers increased, they declined relative to VKT, with the notable exception of 2009 and 2010. Noteworthy is what appears to be a negative correlation between TINs per traffic officer and traffic officers per VKT. One possible explanation is that as the number of officers went down (relative to VKT), and so general deterrence decreased, offending increased and so more TINs were issued per officer.



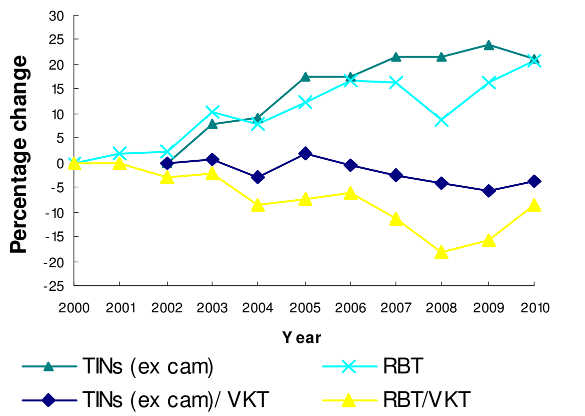


Figure 9. Annual change in traffic officers, absolute and per VKT, and TINs (excl. speed camera) issued per officer, 1999-2010.

Figure 10. Annual change in TINs (excl. speed cameras) issued and RBTs conducted, absolute and per VKT, 1999-2010.

Figure 10 above shows that while the absolute numbers of TINs issued (excluding speed cameras) and RBTs conducted increased, both showed a decline relative to VKT. However, these latter trends appear to have reversed in 2010 (from 2009 for RBT/VKT). However, Figure 11 below shows that the total number of TINs (police and speed camera combined), and total TINs per VKT increased from 2005 to 2010. This increase was largely due to the substantial increase in 2008 that corresponded with the introduction of the fixed speed camera program. Figure 12 shows the annual percentage change in speed camera hours, speed camera TINs and speed related fatalities per VKT, and speed camera TINs issued per vehicle monitored.

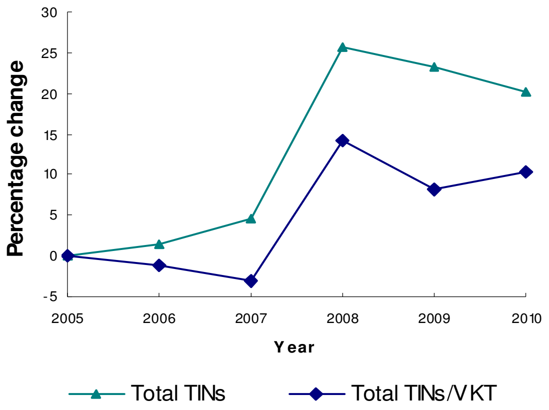


Figure 11. Annual change in TINs (incl. speed camera) issued, absolute and per VKT, 2005-2010.

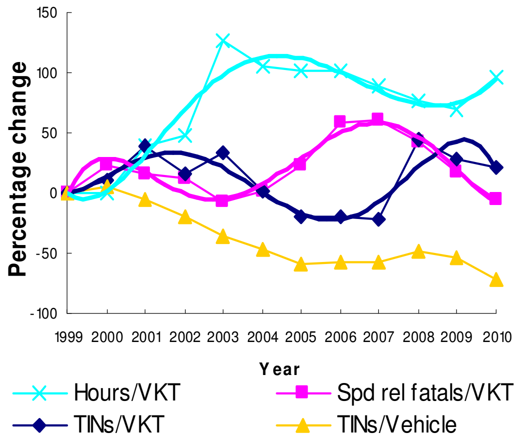


Figure 12. Annual change in speed camera hours, speed camera TINs and speed related fatalities per VKT, and camera TINs issued per vehicle monitored, 1999-2010.

The trends of hours of operation and TINs issued per vehicle monitored might be indicative of an inverse relationship; reduced speeding being associated with increased monitoring (general deterrence). However, this would appear to more accurately describe overall trends rather than immediate (annual) relationships. For example, the large increase in monitoring hours in 2003 was not accompanied with a large decrease in TINs issued per vehicle. As expected, trends also seem to suggest an inverse relationship operation hours per VKT and speed related fatalities per VKT.

Trends in TINS per VKT and speed related fatalities per VKT also suggest a long term inverse relationship. For example the sustained increase in TINs issued per VKT from 2008 appears to correlate with a sustained decline in speed related fatalities from the same year. Thus it appears that the levels of both general and specific deterrence may be related to fatalities. However, it is important to remember that media campaigns related to speed enforcement, as well as other environmental factors examined earlier, are likely to influence the relationship between trends.

Figure 13 below shows the annual percentage change in Drink Driving (DD) TINs issued per RBT and VKT, illegal BAC readings ('positives') per RBT, DD related fatalities and RBTs per VKT from 2002 to 2010. Changes in DD related fatalities appear to most closely aligned with changes in the ‘hit’ rate (positives/RBT), suggesting that as DD increases, so too do the rates of illegal BAC detections and drink driving fatalities. Interestingly, the relationship between DD fatalities and DD TINs/RBT is less pronounced than for the hit rate, suggesting the hit rates are more indicative of DD behaviour than DD TINs. This may be due to logistical and legal processes that lead to some drink drivers avoiding prosecution. Also noteworthy is the somewhat inverse relationship between DD fatalities and RBTs/VKT over the period, particularly from 2009, suggesting that as general deterrence increased, DD decreased. However, the decrease in general alcohol consumption from 2008 shown earlier is also likely to have made a contribution.

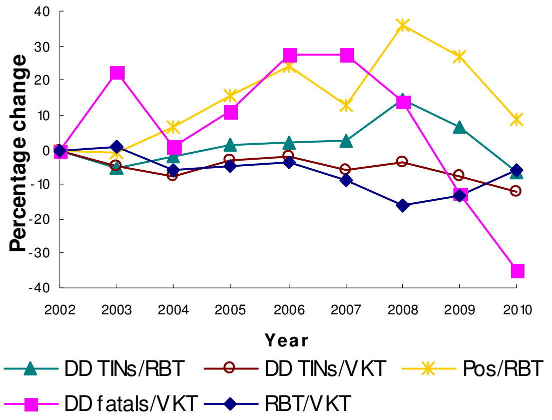


Figure 13. Annual change in Drink Drinking (DD) TINs issued per RBT and VKT, positive readings per RBT, and DD related fatalities and RBTs per VKT, 1999-2010.

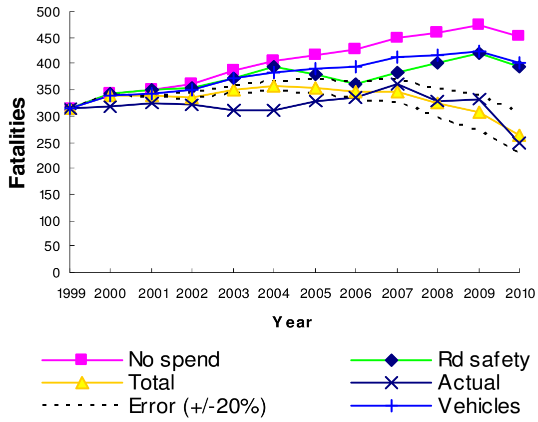


Figure 14. Annual change in fatalities per VKT, with the estimated effects of vehicle safety and road infrastructure (road safety targeted and total)improvements, 1999-2010.

Changes in vehicle safety and the road environment

Research by Newstead, Watson and Cameron (2010) estimated the impact of changes in vehicle safety design over time after controlling for a number of confounding variables (driver age, gender, crash speed zone and location). Results were combined with the average age of Queensland registered vehicles (9.65 years) to derive an estimate of 2.9% average annual reduction in crash severity risk over the period. Figure 14 above shows the estimated driver fatality savings for vehicle improvements from 1999 relative to the increase in VKT to 2010, assuming all other factors remained constant. Note the projected estimate does account for reductions for passengers and therefore is a conservative estimate of total fatality savings.

Table 1 shows the estimated cumulative annual fatality savings per infrastructure spend by calendar year, as per the estimates derived by Vulcan & Corben (1999). To account for the long times needed to complete major projects, the effectiveness of infrastructure spending was assumed to be zero in the year of implementation, 50% in the following year, with full affect from year two.

Figure 14 shows estimated annual savings (labelled “Total”) subtracted from the projected annual VKT growth fatalities (labelled “No spend”) to estimate the expected fatalities resulting from the total road infrastructure improvements (that is, road safety targeted and general improvements). The isolated effects of the federally funded Black Spot and Safer Roads Sooner programs (labelled “Road Safety”) are also estimated separately.

Noteworthy, a substantial portion of the overall reductions over the period are accounted for by the road safety targeted funding. While the projects represent only 1.7% of total infrastructure spending, they account for 13.7% of the estimated fatality savings. Estimates map the actual fatalities quite closely. However, given the large increase in funding to major capital projects in the latter part of the period, it is possible that the effects of the general spending are overestimated towards the end of the period, especially when considering the increases in vehicle improvements and enforcement and shown earlier.

Table 1. Cumulative annual fatality savings per infrastructure spending (adjusted to 2010 dollar values). *effect of 1999 spend.

Calendar Year	Road Safety Spend ($m)	Lives Saved	Total Spend ($m)	Total Lives Saved
2000	0	0	1,210	3*
2001	0	0	1,165	13
2002	9	0	1,116	25
2003	14	1	1,104	38
2004	12	2	1,214	51
2005	37	4	1,542	65
2006	68	8	1,929	83
2007	66	15	2,387	108
2008	57	24	3,197	140
2009	57	33	3,586	177
2010	59	37	3,455	198
Total	379	124	21,905	903

Discussion

In 2010 Queensland experienced a significant reduction in road fatalities. Trends for factors identified in the literature and for which Queensland data is routinely collected were examined. Results suggested that the 2010 road toll was a culmination of not only recent changes in the macro environment related to the Global Financial Crisis but also, changes in exposure and risk, some of which may be related to long term intervention activities. Each factor is discussed following.

Consistent with previous research the 2010 road toll appeared to be related to the change in economic activity, that appeared to have reduced not only exposure but also risk, through changes such as reduced general alcohol consumption and possibly even speeding behaviour (due to the relatively lower affordability of speeding fines). For example, 18.5% of the 24.8% drop in fatalities in 2010 could be explained by reduced VKT alone. Noteworthy, consistent with past research, was the apparent 12 month delay between the sharp 2009 increase in unemployment and 2010 road toll drop.

While the non risky behaviour related fatalities per VKT showed a rather uniform decline over the 10 year period (40%), the trends in alcohol, speed, motorcycle and heavy freight vehicle related fatalities per VKT showed far greater variability, peaking circa 2006-2007 then uniformly declining to 2010. Speed related fatalities showed the greatest increase (60% in 2007) declining in 2010 to similar levels of 1999. DD related fatalities showed a less pronounced increase (25%) followed by a substantial 60% decline, resulting in approximately 35% overall reduction.

Motorcycle related fatalities per VKT appeared to have reduced by 50% however; VKT for motorcycles is difficult to reliably estimate. Heavy freight vehicle involved fatalities per VKT also showed a decline of more than 45%. Noteworthy, these groups/behaviours have been targeted by policy and enforcement initiatives over the period. However, it is likely that they also have been impacted by changes in the economy, as well as the cumulative benefits of vehicle and road infrastructure improvements. Nevertheless it appears that all these high risk groups have somewhat regressed-to-the-mean number of fatalities per VKT by 2010.

Age and gender trends in licensure and fatalities showed reductions in exposure and crash risk for young and young male drivers/riders since 2000 (for licensure) and 2003-2005 (for crash risk per licence holder and per VKT). While licence holders 60 years old and over showed the greatest increase over the period, fatality risk per licence holder appeared no higher than for the safest age group; 29-59 year olds. Thus, encouragingly, reductions in fatalities involving younger licence holders have remained greater than the mean since 2005.

The 2010 road toll drop may have been a culmination of increased enforcement activity; police officers, speed infringement notices issued per VKT from 2008 onwards (corresponding to the introduction of the fixed speed camera program), and increases in the number of RBTs conducted per VKT in 2009-2010. This is consistent with previous research evidence that clearly supports the effectiveness of these interventions.

Trends in speed camera enforcement and speeding related fatalities appeared consistent with previous research that shows increases in TINs issued and operation hours are related to significant decreases in crashes and crash severity. Similarly, the inverse relationship suggested between RBTs and DD fatalities per VKT are consistent with previous research. However, the sustained decline in DD fatalities per VKT appears more consistent with the 2007 peak and then sustained reduction in general alcohol consumption to 2010.

Results suggested that increases in both general and specific speeding and drink driving deterrence might be related to decreases in offending and related fatalities. Results also demonstrate the need to consider enforcement activity related to increases in VKT and not only in absolute terms; absolute increases in activity can result in relative reductions, which may lead to increases in offending/fatalities.

Estimates of vehicle safety improvements suggested a substantial impact upon road fatalities over the period (29% over 10 years). Similarly, the estimates of effects for road infrastructure spending were substantial and appeared to follow actual fatalities closely. While a large portion of post 2005 spending may have gone to a relatively few number of high cost projects, spending estimates still appeared to map the actual fatality rates quite closely prior to 2005. There was also a substantial increase in road safety targeted spending which suggested a significant impact on road fatalities, especially considering the empirical evidence of the effectiveness of these programs.

Limitations include the limited number of factors examined. Associations were drawn using separate data sets (for example, speed TINs and fatally trend) and unverified by statistical modelling. Data availability also dictated that a range of different time periods were compared, further making direct comparisons of trends difficult. Therefore conclusions are tenuous only and causal links cannot be determined. Also, the effects of changes in speed limits, licensing requirements and heavy vehicle regulations were not considered. The degree to which Australian alcohol consumption figures are representative of Queensland is unknown. Fatigue was not examined; changes in the economy may have had an impact due to changes work hours. Traffic policing is not limited to specialist traffic officers alone and trends in general officer numbers that may also have had an impact were not considered. However, only traffic officer numbers were considered as it was assumed that they would have the greatest impact on road user behaviour.

Conclusion

The 2010 road toll appears to have been the culmination of a number of person, vehicle and environment related factors. Major factors appear to have been changes in exposure and crash risk related to changes in the global economy from 2007 (particularly from 2009), including reduction in alcohol consumption and high risk driving behaviours (DD and speeding) and fatalities related to high risk road user groups (motorcycles and heavy freight vehicles). These changes appear to coincide with substantial increases enforcement, particularly the number of dedicated traffic officers as well as relative increases in speed management and RBT program activity. These increases appear to have been underpinned by the results of long term strategy initiatives such as gradual improvements in road infrastructure and vehicle safety design. Nevertheless, while the significant reduction in fatalities is encouraging expectations of continued reductions must be tempered with expectations of regression to the mean.

Future Research

A formal evaluation of the entire current Queensland road safety strategy using statistical modelling would allow reliable inferences to be made regarding the relative effects of not only major programs but also the overall strategies in place over the 1999-2010 period. The evaluation should include estimates of the impact of aggregate and localised road infrastructure improvements, particularly in relation to differential effects for non-risky/risky (that is, speeding and DD) behaviour.

Acknowledgements

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