Australian Government
Department of Infrastructure and Transport
Bureau of Infrastructure, Transport and Regional Economics

Effectiveness of measures to reduce road fatality rates

At a glance

- The absolute number of fatalities per quarter in Australia in 2010 was less than 40 per cent of that in the late 1960s. But the vehicle-kilometres travelled (vkt) on our roads have increased by three and a half times over this period. Thus the fatality rate—the number of deaths per billion vehicle kilometres driven—has fallen to about a tenth of its 1960s level.
- The results of the current analysis confirm earlier findings—that seat belt wearing, random breath testing (RBT) and speed cameras can explain almost all of the variation in fatality rates in all states since the late 1960s.
- The question then arises as to whether an expected, yet missing, downward trend in rates because of improvements in road infrastructure and vehicles is being counterbalanced by increases in driver distraction, dangerous driving, driving of unregistered vehicles, and the like.
- Further modelling, building on base-case projections from the work presented here, could seek to measure these effects over the last decades, and shed light on the likely contributions in the period of the next National Road Safety Strategy of its four major elements:
  1. Safer speeds
  2. Safer roads and roadsides
  3. Safer vehicles, and
  4. Safe road users and safer behaviour.

1. Introduction

An earlier paper (Gargett et al 2009) showed, by very preliminary analysis of the Victorian road fatality rate, that a combination of increased seat belt wearing, random breath testing (RBT) and speed cameras explained almost all of the reduction in the Victorian road fatality rate since the late 1960s. The current analysis 1) extends the analysis to all states, 2) uses new estimates of vehicle kilometres travelled to derive an 'exposure to death' variable and 3) includes actual measurements of state rates of seat belt wearing, as well as RBT and speed camera enforcement back to the inception of the programs in each state. The results of the analysis confirm the findings of the earlier paper—seat belt wearing, RBT and speed cameras can explain almost all of the variation in fatality rates in all states since the late 1960s.

The fatality rate—the number of deaths per billion vehicle kilometres driven—has fallen to about a tenth of its 1960s level. And it is this rate that is the major indicator of the pay-off from safety measures introduced during this period. The following analysis shows how state fatality rates can be estimated and used.

2. A quarterly measure of exposure

Vehicle kilometres travelled (vkt) are the best available measure of exposure, with which to transform fatalities into a rate. The use of fuel sales to estimate state vkt is not new (Newstead 1995). Recent BITRE research (BITRE forthcoming) extends this method, 1) in time (monthly state petrol, LPG and diesel sales back to 1965 have been assembled), and 2) in detail (a breakdown of total state vkt into vehicle types allows for risk weighting to calculate 'safety-weighted vkt'). The method had three steps:

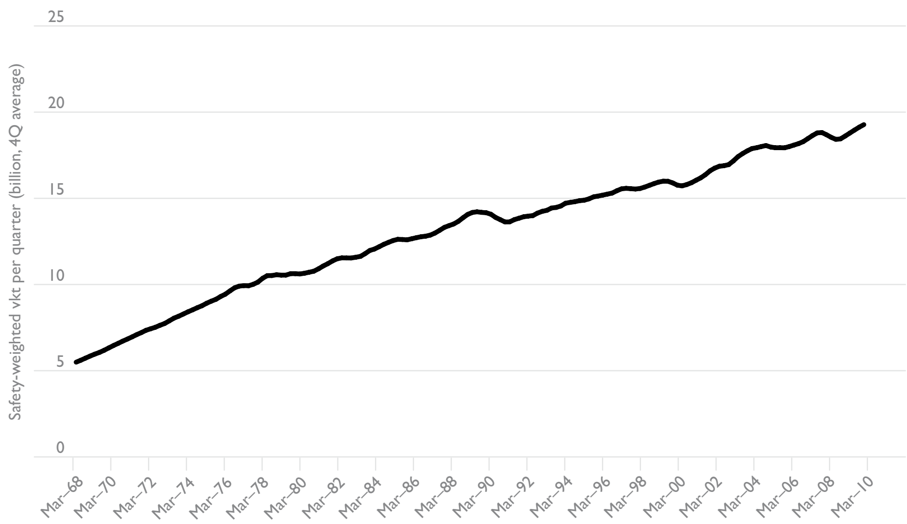
1. The Bureau of Infrastructure, Transport and Regional Economics (BITRE) has developed annual estimates of state-level vkt by vehicle type from 1967 to present (BITRE unpublished). These were based on interpolation of past Survey of Motor Vehicle Use (SMVU) data (Australian Bureau of Statistics 2008 and earlier) using trends in vehicle use per capita and economic activity.
2. A second series of annual vkt estimates were derived from fuel sales data. Annual estimates of the fraction of each vehicle type powered by different fuel sources was derived from detailed SMVU tables back to 1971 and applied to the vkt by vehicle type to get vkt by vehicle type by fuel type. Similar series for fuel intensity (litres per 100 kilometres) by vehicle type by fuel type were derived from the same source. Multiplying these series together and summing by fuel type gave an estimate of annual use in transport of the various fuel types (petrol, diesel, etc). Comparing these to total fuel sales series from the Department of Resources, Energy and Tourism gave the fraction of each fuel used in transport. Then the process was reversed to get quarterly estimates of state vkt by vehicle type from quarterly fuel sales.
3. Finally, vkt by vehicle was weighted by risk factors: cars 1, LCVs 1, motorcycles 26, rigid trucks 1.5, articulated trucks 3 and buses 1.5 (from the Federal Department of Infrastructure and Transport, based on fatal accident rates by vehicle types).

The result is a quarterly exposure variable for each state that gives 'safety-weighted quarterly vkt'. This series basically measures the growth in traffic that gives rise to an increase in fatality exposure. Dividing the absolute level of fatalities by the safety-weighted vkt allows the calculation of quarterly fatality rates (deaths per billion vkt) that lag only about 2 months behind "real time". Figures 1 to 3 show seasonally adjusted quarterly fatalities, seasonally adjusted quarterly safety-weighted vkt and the resulting seasonally adjusted quarterly Victorian fatality rate to June 2010.

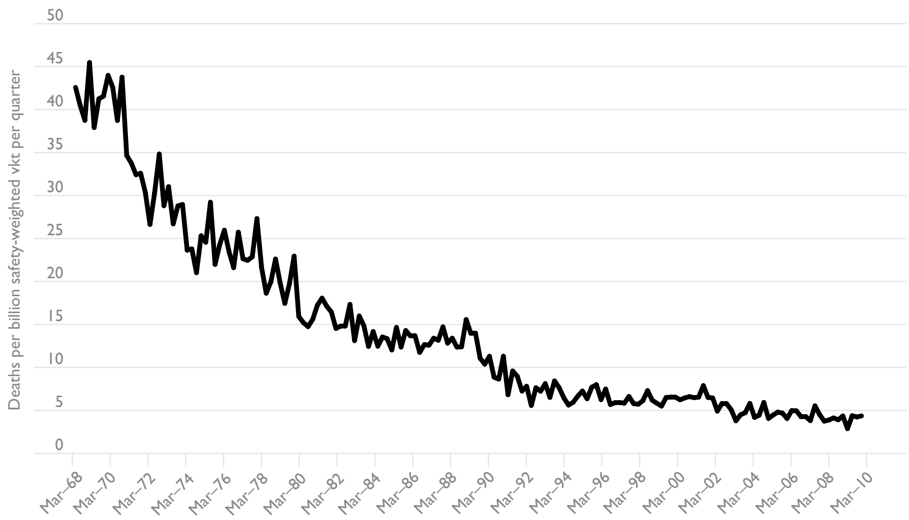
F1 Seasonally adjusted fatalities in Victoria

The seasonal factors were calculated using the Regression Analysis for Time Series X-11 program. The seasonal factors derived were multiplicative, and significantly smoothed the fatality series. For example, the seasonal factor for the December quarter 2008 for Victoria was 1.11. This means that, in each December quarter, Victoria can expect about 11 per cent more fatalities than the year average simply because of the time of year.

F2 Seasonally adjusted safety-weighted vehicle kilometres travelled, Victoria



F3 Victorian fatality rate

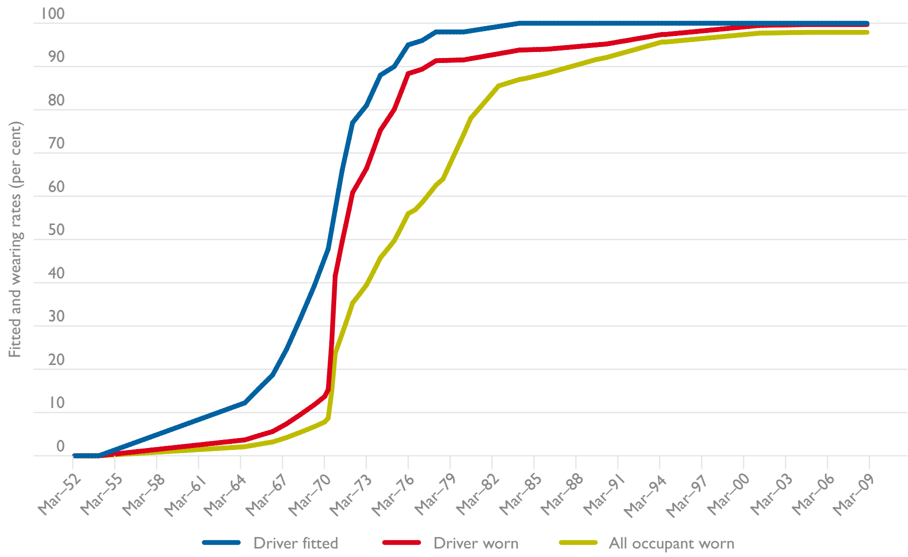


3. Forty years of road safety measures

Three main safety measures have progressively improved road safety in the forty years since the late 1960s: seat belts, random breath testing (RBT) and speed cameras.

Seat belts began to be fitted to new vehicles in the 1950s. In 1970, their use in fitted vehicles was made compulsory. Yet surveys of usage show that the public lagged behind for decades before wearing became almost universal. Figure 5 shows estimates of Victorian seat belt rates.

F4 Seat belt rates for Victoria



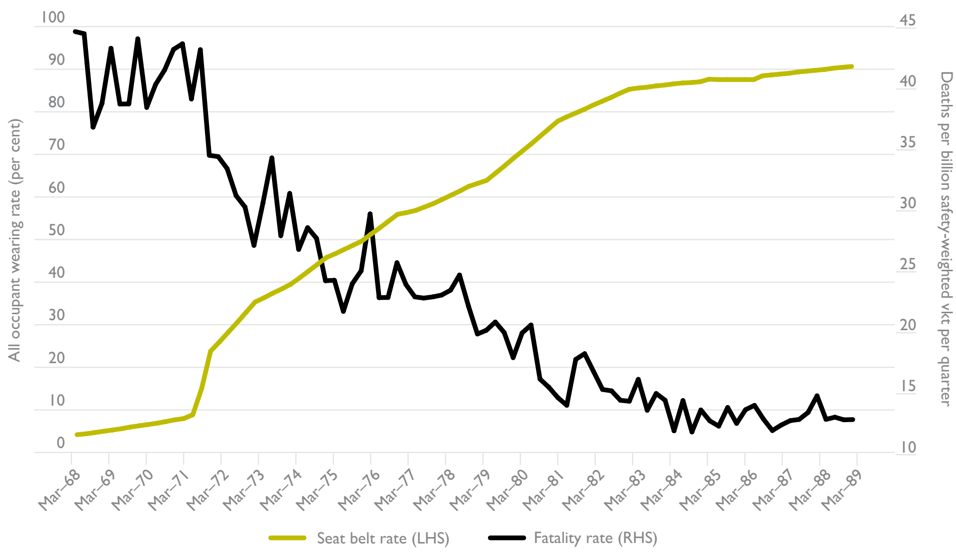
The rates in Figure 4 are derived from a variety of sources, principally Milne (1979), Heiman (1988), Diamantoploulou et al (1996) and personal communication NSW Roads and Traffic Authority 2009. Table 1 shows that the lags between the driver fitted, driver wearing and all occupants wearing rates were substantial. Ninety-five per cent rates were reached after 1970 with lags of 6 years for driver fitted, 19 years for driver wearing and 23 years for all occupants wearing.

T1 Seat belt rates in Victoria

	Date 10% rate	Date 95% rate	Lag 95% from 1970
Driver fitted	September 1962	March 1976	6 years
Driver wearing	September 1968	September 1989	19 years
All occupants wearing	September 1970	September 1993	23 years

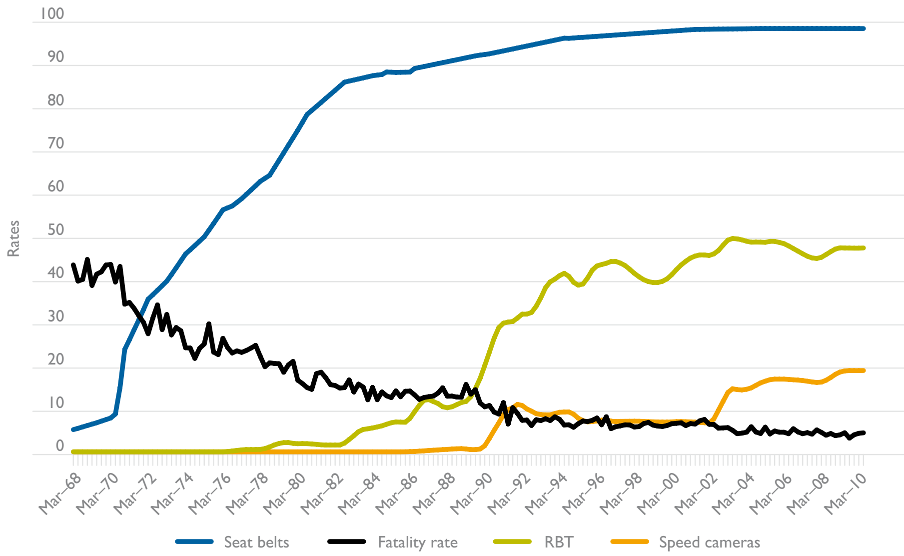
The rate relevant to fatality analysis is the all occupant wearing rate. A plot of that seat belt wearing rate against the fatality rate for Victoria is shown in Figure 5. There is an almost perfect inverse relationship between the two from the late 1960s until the late 1980s (a period when seat belts were the only principal influence on fatality rates—see later analysis).

F5 All-occupant seat belt wearing rate versus Victoria's fatality rate



From the late 1980s on, two further safety measures make an appearance on the road safety scene. Random breath testing in Victoria (measured by tests per quarter) started in the early 1980s, but increased markedly in the period 1989 to 1991. Some time after the start of random breath testing, speed cameras were introduced. Speed camera coverage (measured as fines per quarter) remained stable through the 1990s, before a major expansion took place from 2002 to 2003, roughly in conjunction with the introduction of a 50 kilometre per hour default urban speed limit. Figure 6 shows the evolution of RBT and speed camera coverage in Victoria (rates per billion vkt). Current estimates are based on Thoresen et al (1992), Newstead et al (1995), Vulcan et al (1996), Delaney et al (2005) and D'Elia et al (2007) and police data.

F6 Seat belt wearing, RBT and speed cameras rates versus Victoria's fatality rate



4. Simple models of state road fatality rates

Using the state fatality rates (5-quarter centred moving averages) as the dependent variables, simple regression models were developed to explain the influence of the three safety measures - all occupant seat belt wearing rate (SB), the random breath testing (RBT) tests rate index, and the speed camera (SC) fines rate index. The number of RBT tests per quarter and the number of traffic infringement notices for speeding were converted to rates by dividing by the relevant state safety-weighted quarterly vkt estimates. The RBT rate was amended to be the higher of the current or 5-year average levels, as drivers tend to maintain adjustment to previous enforcement levels, even if RBT effort is reduced for a while.

The following table of equations shows the regression results for each state, using the variables as defined above. All three variables are consistently negatively related to the fatality rate. The statistical significance level (in per cent) is shown in brackets beneath the coefficient and the centred R^2 to the left (for the full 42 years, then the last 20). One dummy variable (d110K) is known to be related to Victoria raising and then lowering the highway speed limit. The reason for the rest of the dummies is unknown.

T2 State regression results for fatality rates

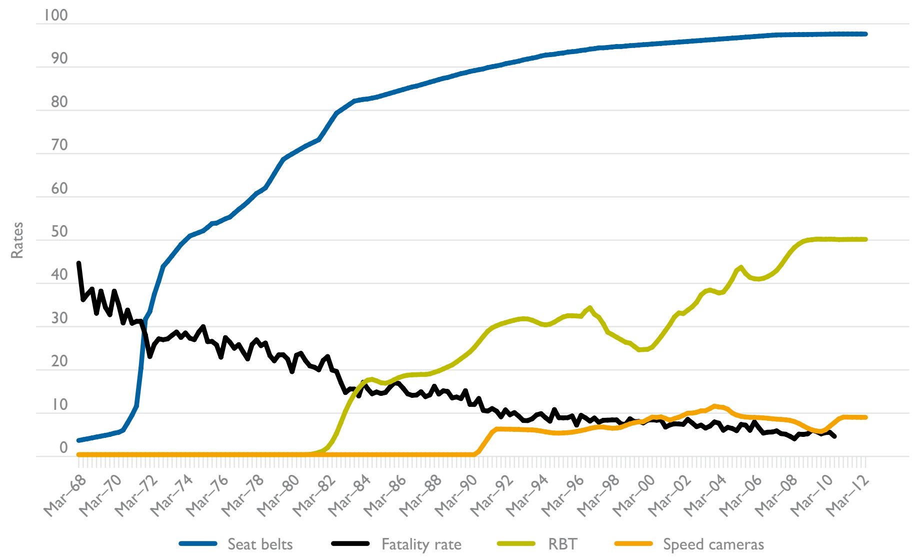
State	const	SB	RBT	SC	d7382	d0206	d110k	d09on	dless74	d9300
NSW	36.081	–.229	–.120	–.403	+2.349	+1.352				
.993/.962	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)				
VIC	42.722	–.331	–.070	–.154			+1.624			
.995/.927	(0.0)	(0.0)	(0.0)	(0.0)			(0.0)			
QLD	41.357	–.336	–.050	–.171				–1.142		
.988/944	(0.0)	(0.0)	(0.0)	(0.4)				(9.3)		
SA	31.002	–.193	–.059	–.238						
.969/.844	(0.0)	(0.0)	(0.8)	(0.0)						
WA	29.878	–.210	–.023	–.103				–1.130	+4.603	+.924
.985/.928	(0.0)	(0.0)	(0.0)	(0.0)				(0.7)	(0.0)	(0.0)
TAS	42.620	–.297	–.049	–.229						
.942/.581	(0.0)	(0.0)	(0.8)	(0.6)						
NT	52.733	–.293	–.102	–.269						
.819/.441	(0.0)	(0.0)	(0.9)	(0.7)						
ACT	25.349	–.177	–.126	–.119						
.886/.285	(0.0)	(0.0)	(0.0)	(0.2)						

The following figures show for each state 1) the evolution of the safety measures relative to the fatality rate and 2) the relative contribution (calculated from the equations) of the three measures. Before the late 1980s, the effect is attributed entirely to progressive increases in seat belt wearing. Thereafter, both RBT and speed camera measures kick in. In the second figure for each state, the 'BELTSpred' line shows the contribution of just seat belts. The 'RBTpred' line adds in the effects of RBT. The 'CAMpred' adds the speed camera effect to the belts and RBT effects, and represents the predicted fatality rate in normal periods. Finally, the 'Temporary' line adds in the effects of the dummy variables.

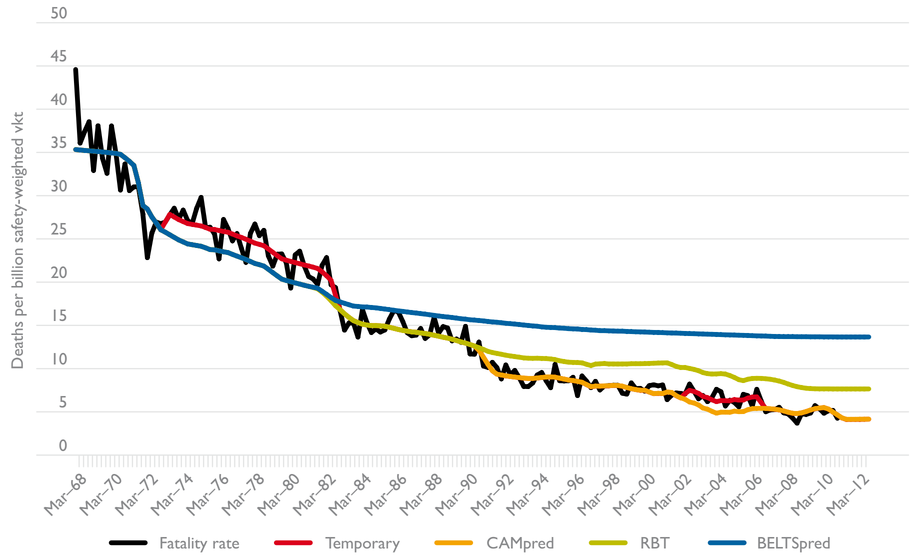
Projections in the Figures are 'naive' in that, except in the case of NSW speed cameras, the enforcement and seat belt wearing rates have been held constant at current levels. The NSW speed camera rate is assumed to regain its 2008 level post June 2010, with the reintroduction of mobile speed cameras.

The structure of the models is also currently naive. The equations imply that if RBT in NSW were doubled, we would start to see births instead of deaths on NSW's roads. Now there are births on NSW roads, but they are few and far between, and are not caused by elevated levels of random breath testing. To adequately deal with prediction as the fatality rate goes toward zero, it will be necessary to fit a different model structure.

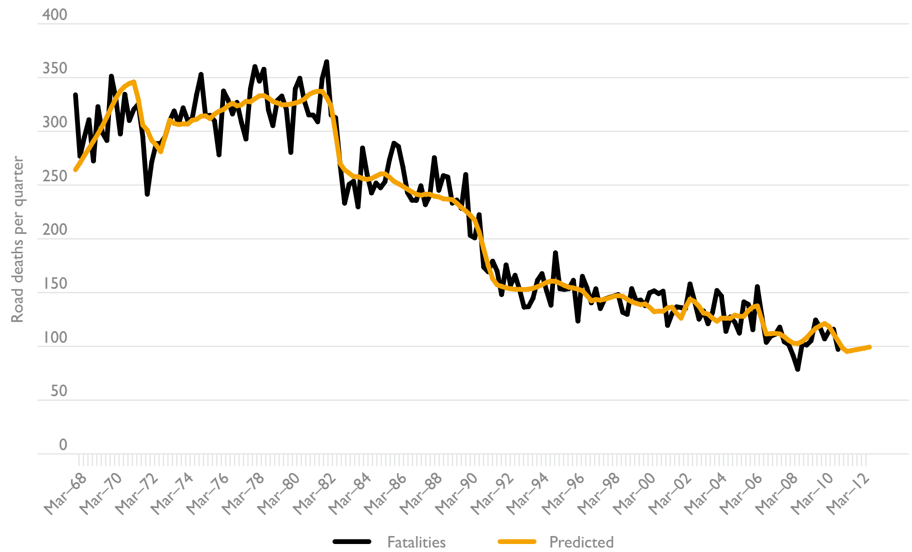
F7.1 Seat belt wearing, RBT and speed cameras rates versus **NSW's** fatality rate



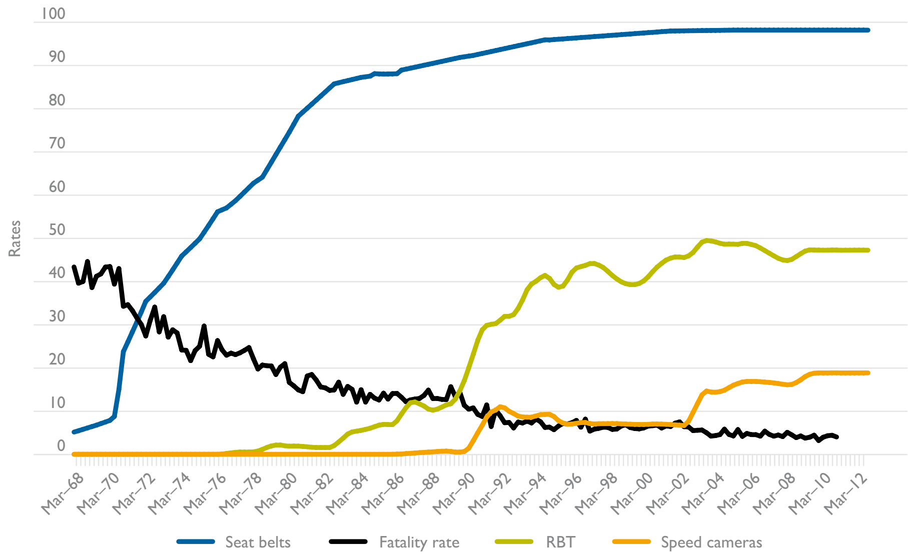
F7.2 Effects of seat belt wearing, RBT and speed cameras on **NSW's** fatality rate



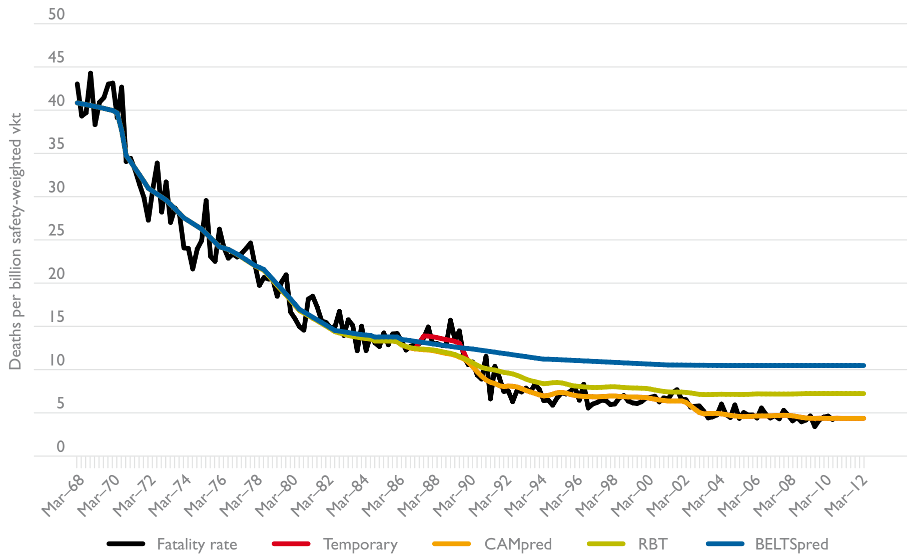
F7.3 Predicted road fatalities per quarter **NSW**



F8.1 Seat belt wearing, RBT and speed cameras rates versus **VIC's** fatality rate

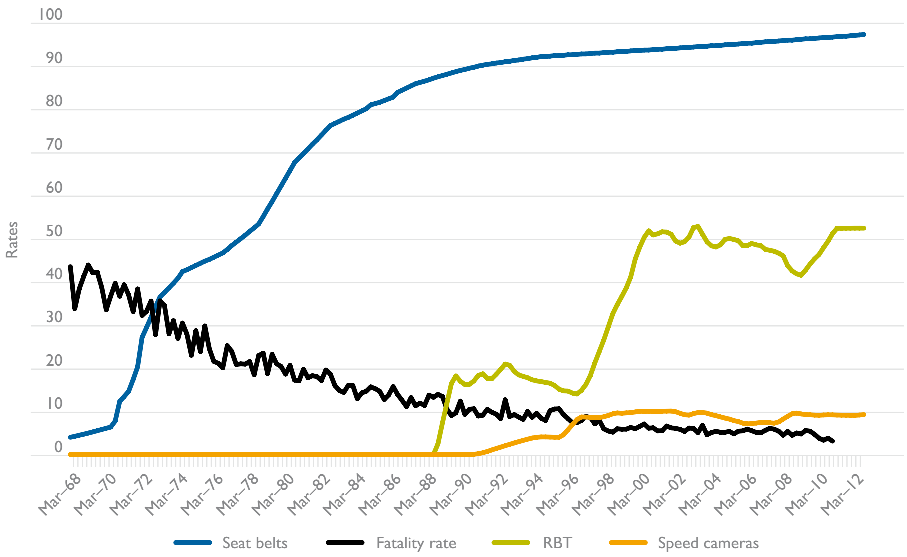


F8.2 Effects of seat belt wearing, RBT and speed cameras on **VIC's** fatality rate

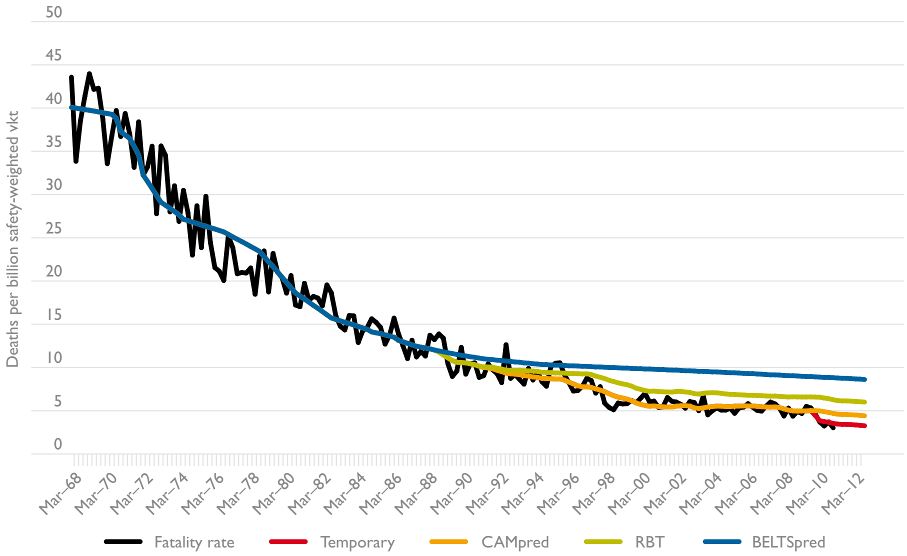


F8.3 Predicted road fatalities per quarter **VIC**

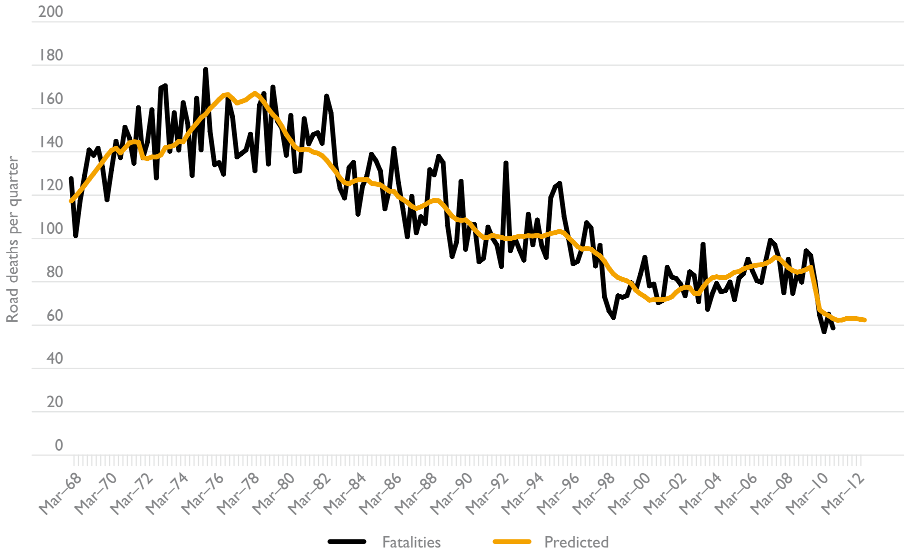
F9.1 Seat belt wearing, RBT and speed cameras rates versus **QLD's** fatality rate



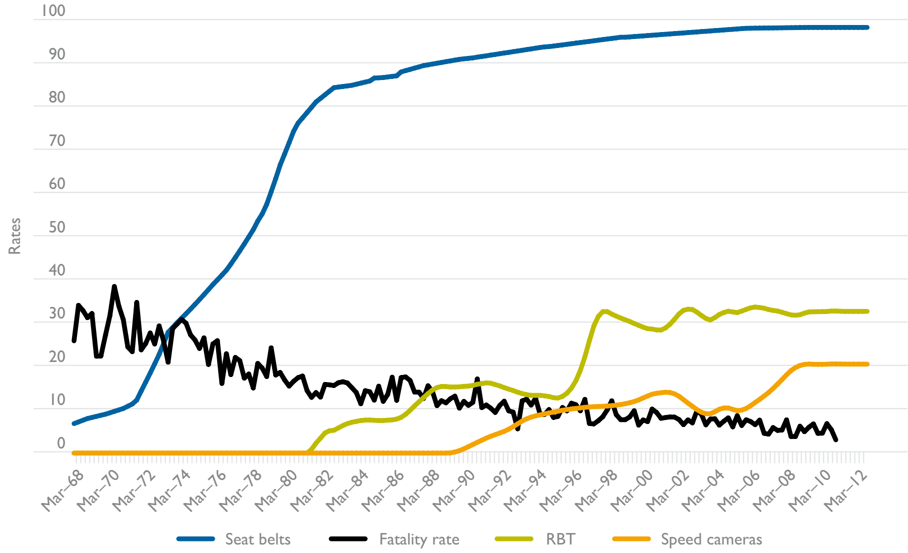
F9.2 Effects of seat belt wearing, RBT and speed cameras on **QLD's** fatality rate



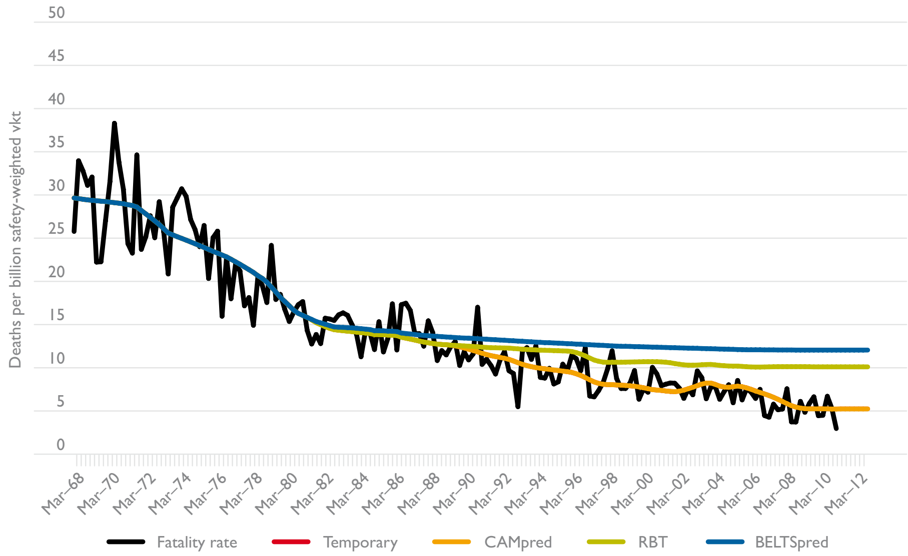
F9.3 Predicted road fatalities per quarter **QLD**



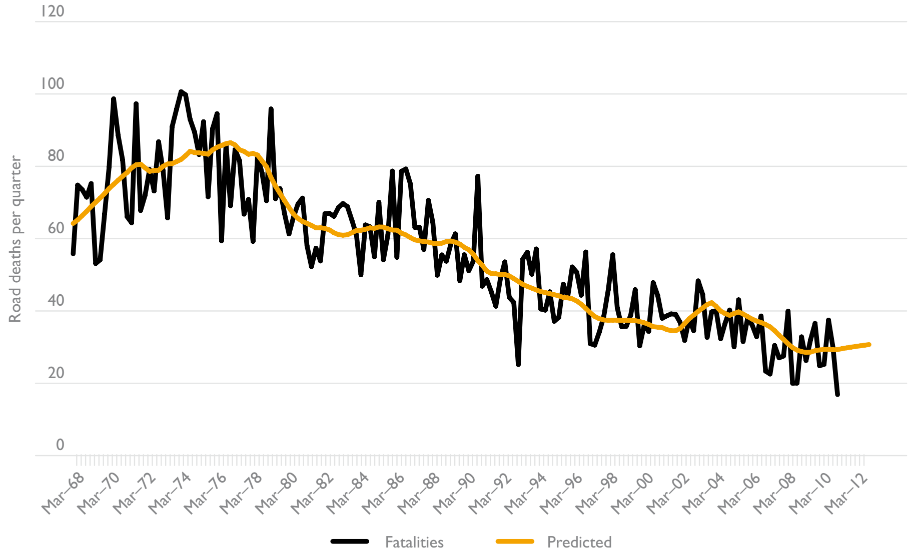
F10.1 Seat belt wearing, RBT and speed cameras rates versus **SA's** fatality rate



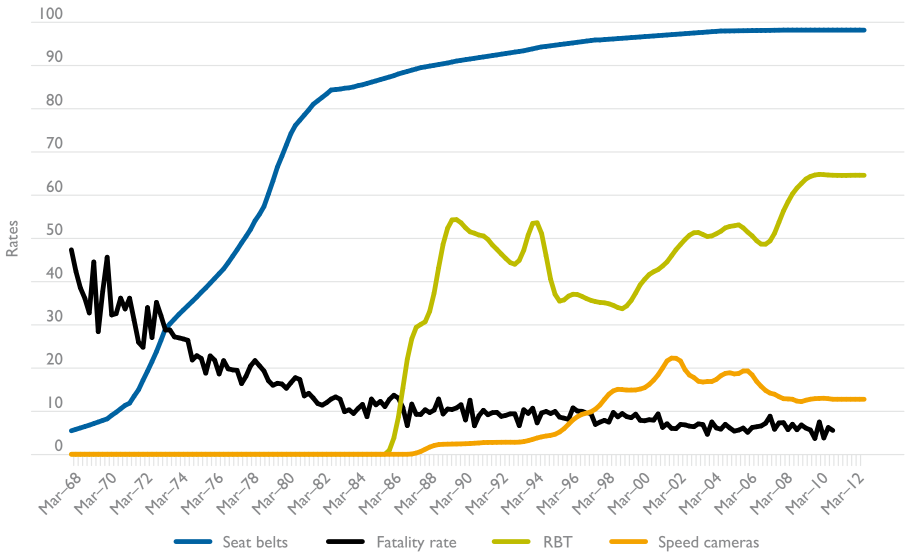
F10.2 Effects of seat belt wearing, RBT and speed cameras on **SA's** fatality rate



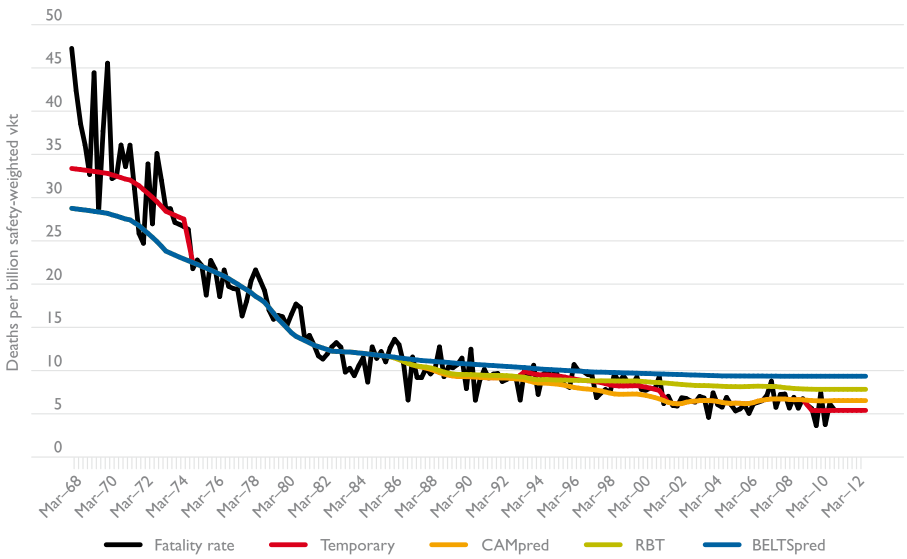
F10.3 Predicted road fatalities per quarter **SA**



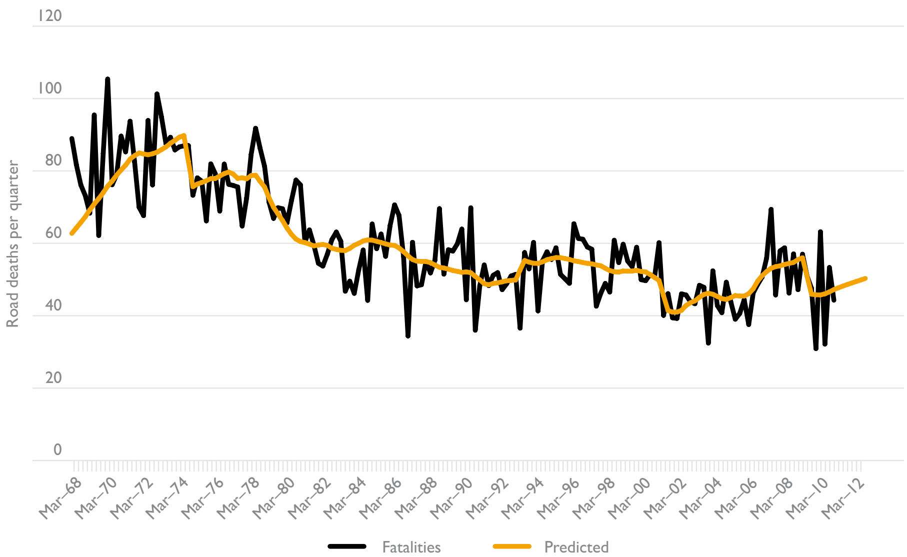
F11.1 Seat belt wearing, RBT and speed cameras rates versus **WA's** fatality rate



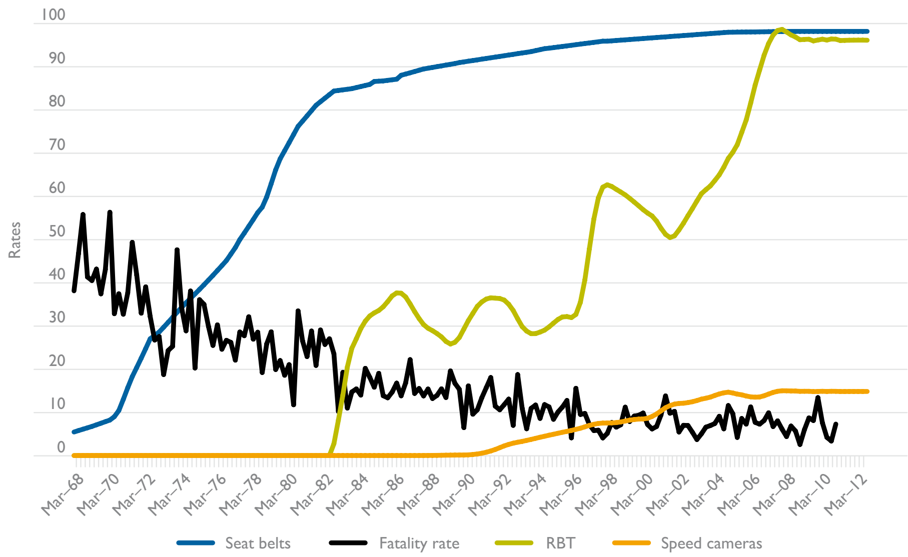
F11.2 Effects of seat belt wearing, RBT and speed cameras on **WA's** fatality rate



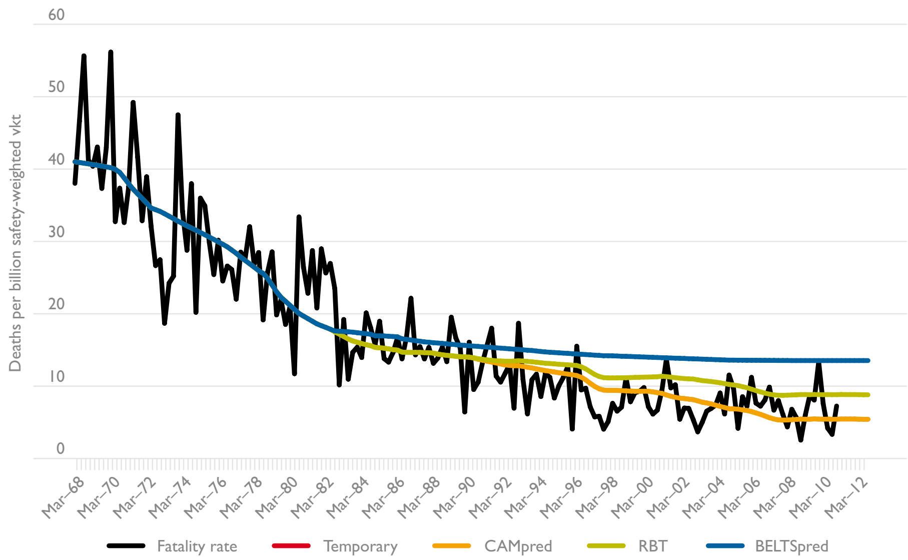
F11.3 Predicted road fatalities per quarter **WA**



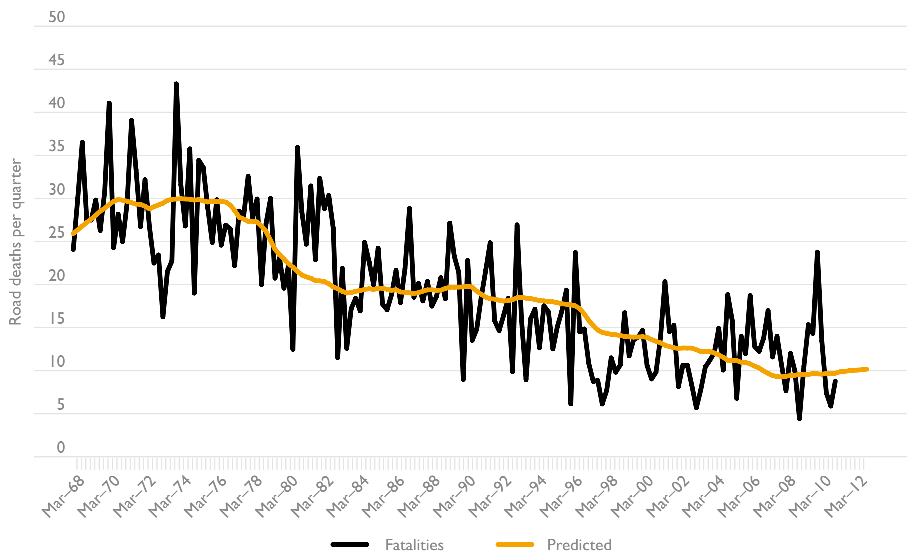
F12.1 Seat belt wearing, RBT and speed cameras rates versus **TAS's** fatality rate



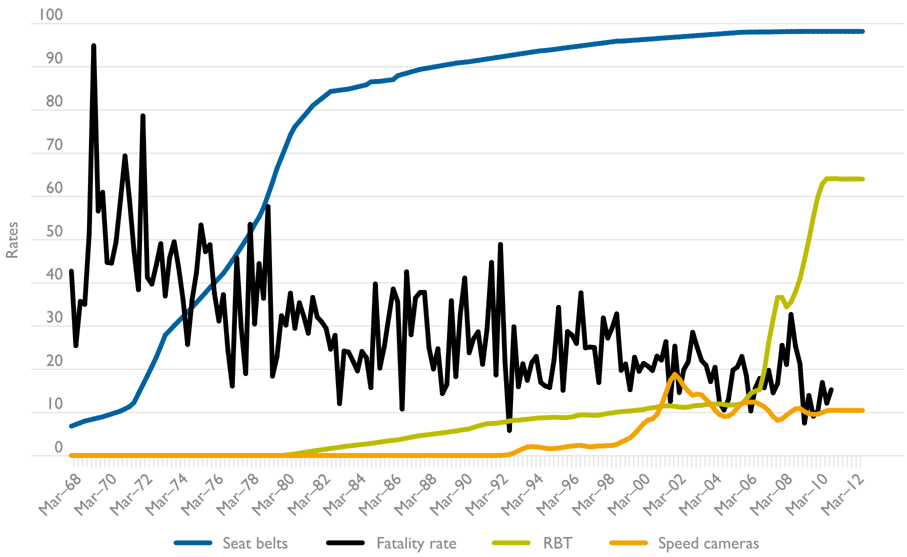
F12.2 Effects of seat belt wearing, RBT and speed cameras on **TAS's** fatality rate



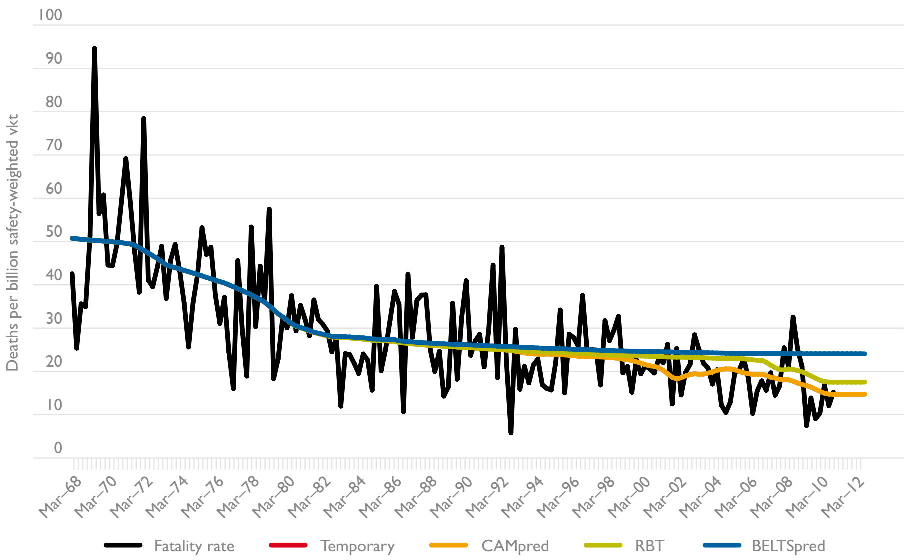
F12.3 Predicted road fatalities per quarter **TAS**



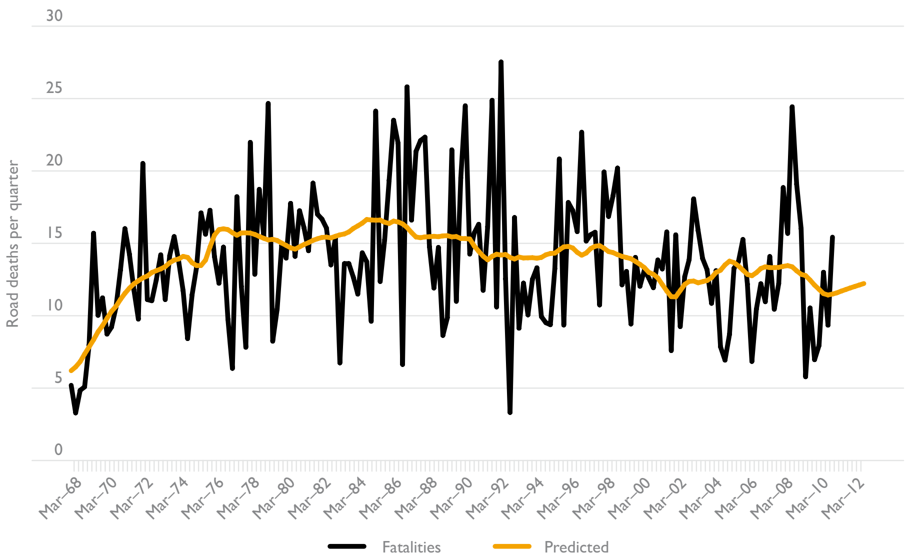
F13.1 Seat belt wearing, RBT and speed cameras rates versus **NT's** fatality rate



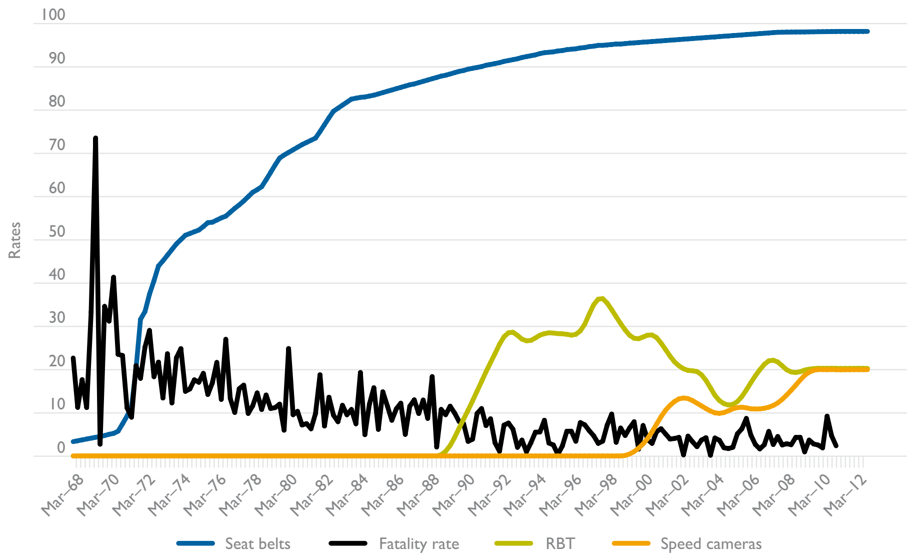
F13.2 Effects of seat belt wearing, RBT and speed cameras on **NT's** fatality rate



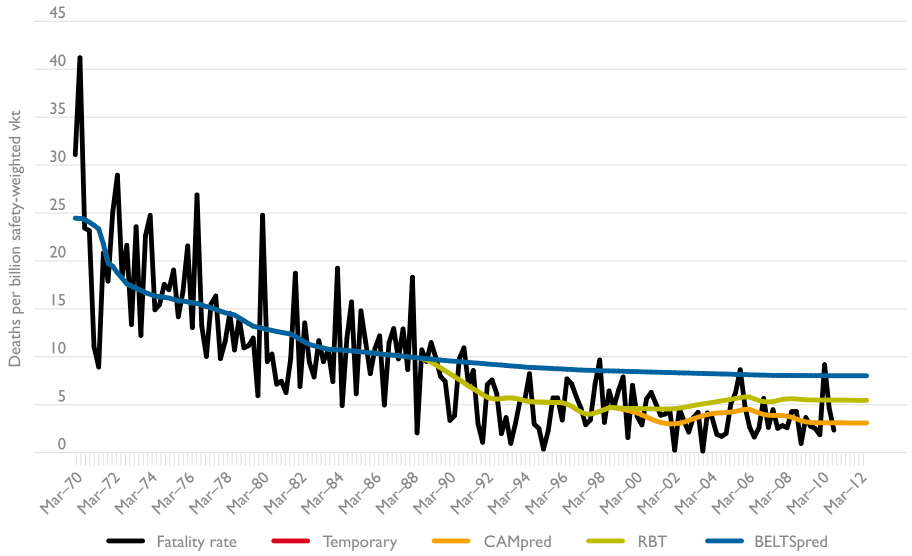
F13.3 Predicted road fatalities per quarter **NT**



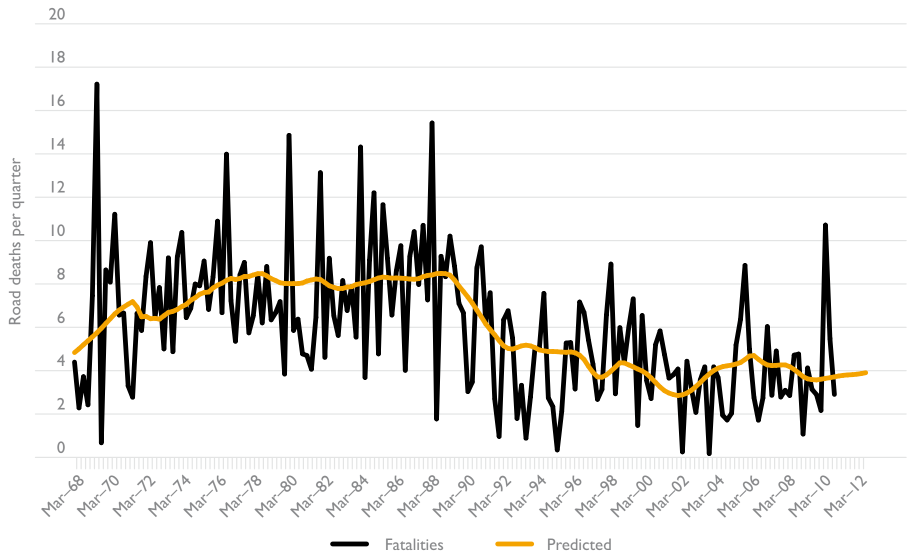
F14.1 Seat belt wearing, RBT and speed cameras rates versus **ACT's** fatality rate



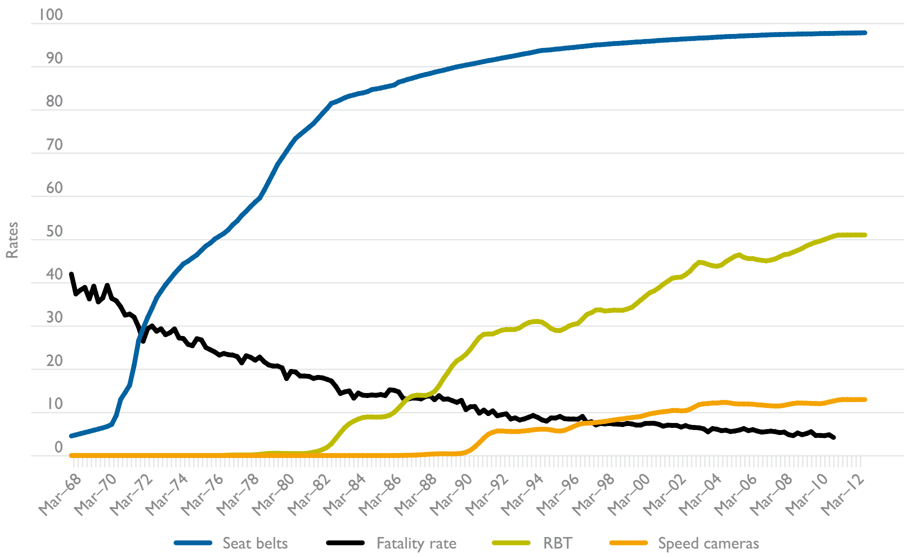
F14.2 Effects of seat belt wearing, RBT and speed cameras on **ACT's** fatality rate



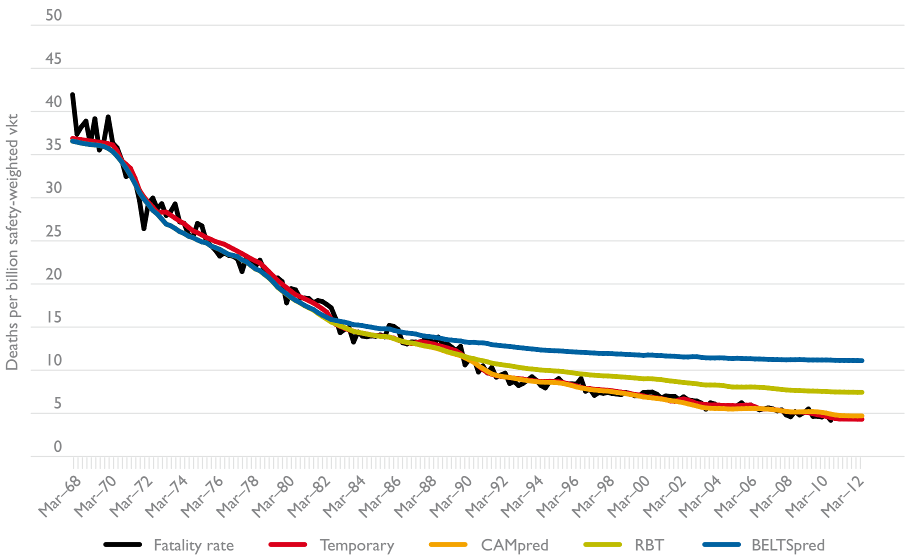
F14.3 Predicted road fatalities per quarter **ACT**



F15.1 Seat belt wearing, RBT and speed cameras rates versus **Australia's** fatality rate



F15.2 Effects of seat belt wearing, RBT and speed cameras on **Australia's** fatality rate



F15.3 Predicted road fatalities per quarter **Australia**

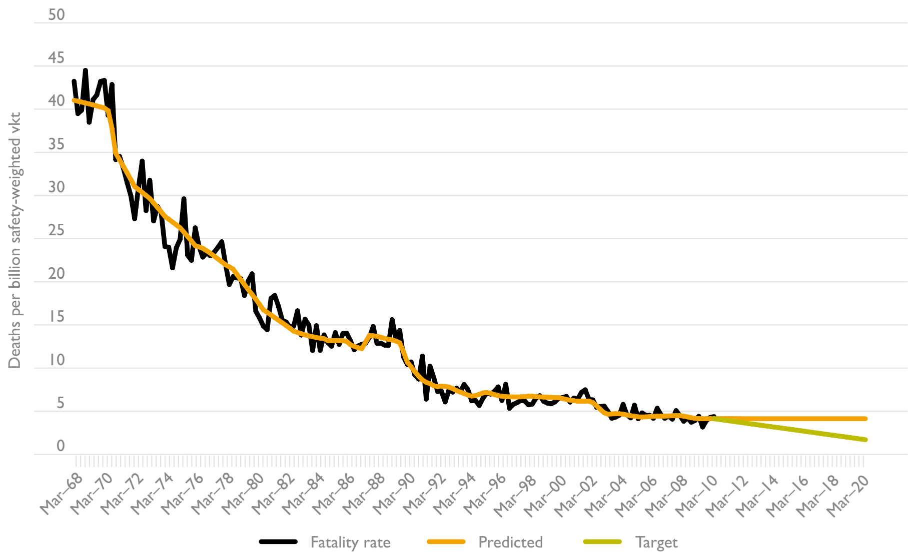
5. Uses of the modelling

The first advantage of the methodology lies in the almost "real time" updating of the fatality rate and exposure data. Fuel sales and fatality data become available with about a two months lag.

So, by early November 2010, the September quarter data was able to be added to the database. This allows the fatality rate to be calculated and compared to the expected rate. Especially in the smaller states where the rate is noisy, as in Tasmania, the Northern Territory and the ACT, this allows policy makers some perspective on where the rate actually is, and where the trend might be heading in the short term.

Beyond the short term, the equations can also be used to inform the setting of road safety policy goals. For example, if it was desired to cut the number of Victorian road deaths in half by 2020, the equation can point to the magnitude of fatality rate reduction this implies. As safety-weighted vkt is forecast to rise 25 per cent by 2020, halving the absolute number of fatalities means that the fatality rate will have to fall to 1.7 per billion vkt. The different path implied for the fatality rate is shown in Figure 16.

F16 Implications of a policy of halving the number of Victorian fatalities by 2020



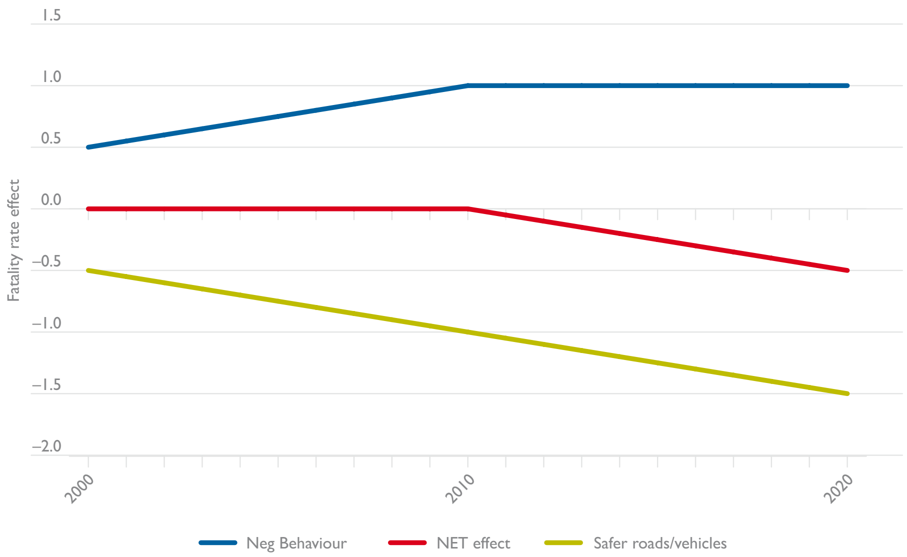
The results of the analysis presented above confirm the findings of an earlier paper—seat belt wearing, RBT and speed cameras can explain almost all of the variation in fatality rates since the late 1960s. Yet, when considering the longer term outlook, an important question arises as to whether an expected, yet missing, downward trend in rates because of improvements in road infrastructure and vehicles is being counterbalanced by increases in driver distraction (e.g. mobile phones), dangerous driving, driving of unregistered vehicles, and the like.

In the last five years, seat belt wearing has probably peaked at a high 90 per cent level in most states. Thus if RBT and speed camera enforcement grows only enough over the next decade to accommodate traffic growth, then the forecast is for fatality rates to remain constant.

But if the absence of a downward trend has been due to negative trends in driver behaviour balancing improvements in roads and vehicles, that analysis might change. Because if it is assumed that negative trends like mobile phone usage are near some saturation point, then positive trends in road and vehicle safety (e.g. electronic stability control) may come through in the next decade unmasked, as shown schematically in Figure 17.

In addition, if negative driver behaviours can in fact be reduced through enforcement efforts, this could make the expected downward trend in the net effect even more pronounced than shown.

F17 Balancing of fatality-raising driver behaviour with fatality-lowering road and vehicle safety



Summary

The methodology presented here allows fatality rates to become the proper measure of state safety campaigns, by allowing exposure (vkt) to be calculated based on a regular quarterly data source (fuel sales). The three major road safety programs of the past 40 years were measured and their impact modelled. The modelling concluded that seat belts, random breath testing and speed cameras were effective in significantly reducing road fatality rates. The overall effect of the three countermeasures was truly tremendous. The absolute number of fatalities per quarter in Australia in 2010 was less than 40 per cent of the number per quarter in the late 1960s. This was in the face of traffic growing by a factor of more than three and a half times. Thus the fatality rate has fallen to about 1/10 of its value in the late 1960s. Another way of saying this, is that the absolute number of road deaths per quarter would be 10 times the current value, if these successful countermeasures had not been put in place.

The modelling of that process of fatality reduction presented here shows promise in allowing an understanding of the short-term dynamics of state fatality rates, as well as of the implications for long-term policy targets.

Prepared by David Gargett. Acknowledgements to staff of safety data gathering organisations past and present, the road safety fraternity, state safety officers, and police officers from every state and territory. For further information on this publication please contact: David Gargett (david.gargett@infrastructure.gov.au).

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