Fatality Rates

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ABSTRACT

Using the state of Victoria as an example, the paper shows:

1) How a quarterly measure of vehicle-kilometres travelled (vkt) can be generated from fuel sales data. The measure weights different vkt by their fatality risk (safety-weighted vkt). Dividing the number of fatalities by safety-weighted vkt gives a quarterly fatality rate.
2) How the three main safety measures during the period (seat belts, random breath testing and speed cameras) have developed, and
3) How they can be incorporated into a simple model that can be used to keep road authorities up-to-date with what is happening per quarter, and which allows projection of the effects on fatalities of further safety measures.

1. INTRODUCTION

The number of deaths from accidents on Australian roads has fallen to a third of the number 40 years ago. 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. And it is this *rate* that is the major indicator of the pay-off to safety measures introduced during this period.

The following analysis, using the state of Victoria as an example, 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). The present methodology extends this method, 1) in time (monthly state petrol, LPG and diesel sales back to 1965 have been assembled from historical paper records), and 2) in detail (a method of breaking down the estimate of total state vkt into vehicle types allows for risk weighting to calculate "safety-weighted vkt').

The method of getting from fuel sales to state total safety-weighted vkt had four 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Economics (BITRE) has developed annual estimates of state-level vkt by vehicle type from 1967 to present (BITRE unpublished).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. The annual automotive fraction of fuel use by fuel type was estimated, by assigning national fuel intensity per vehicle kilometre to SMVU vehicle kilometres travelled and calculating the implied automotive fuel use. These fractions were interpolated between SMVUs.

3) Working backward by fuel type to light vehicle vkt (cars, light commercial vehicles (LCVs) and motorcycles) and heavy vehicle vkt (rigid trucks, articulated trucks and buses) and dividing annual automotive fuel sales by the fuel intensity series (again interpolated between SMVU surveys) gives estimates of annual vkt from fuel sales. Figure 1 shows the agreement between the BITRE (actual) and fuel-sales-derived annual estimates for total vehicle kilometres travelled for Victoria.

4) Finally, use of *quarterly* fuel sales allowed the calculation of *quarterly* estimates of vkt. This quarterly vkt by vehicle type estimated from fuel sales was then weighted by assumed risk factors. The weightings assigned were: cars 1.0, LCVs 1.0, motorcycles 26.0, rigid trucks 1.5, articulated trucks 3.0 and buses 1.5. The weightings were suggested by the Road Safety Branch of the Federal Department of Infrastructure, Transport, Regional Development and Local Government.
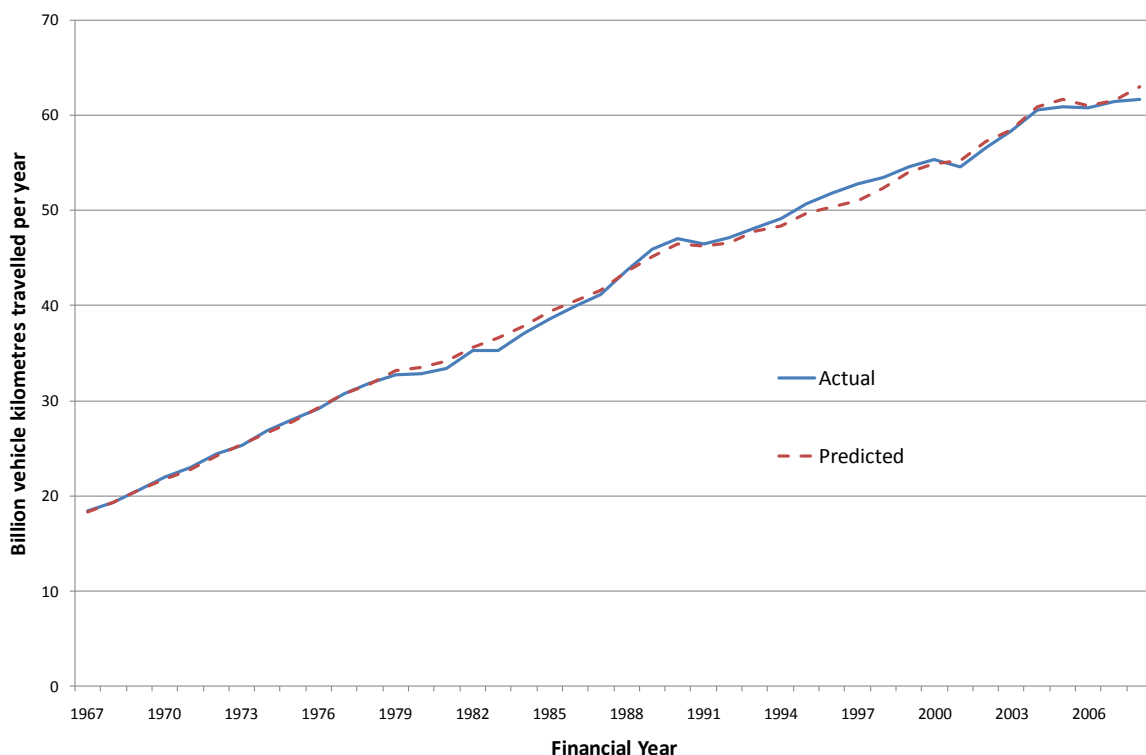

Figure 1   Comparison of BITRE (actual) and fuel-sales-derived annual estimates of vehicle kilometres travelled

The result is a quarterly exposure variable for each state that gives "safety-weighted quarterly vkt", allowing calculation of quarterly fatality *rates* that lag only about 2 months

behind "real time". Figures 2 to 4 show seasonally adjusted quarterly fatalities, seasonally adjusted quarterly safety-weighted vkt and the resulting seasonally adjusted quarterly Victorian fatality rate to December 2008. 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 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.
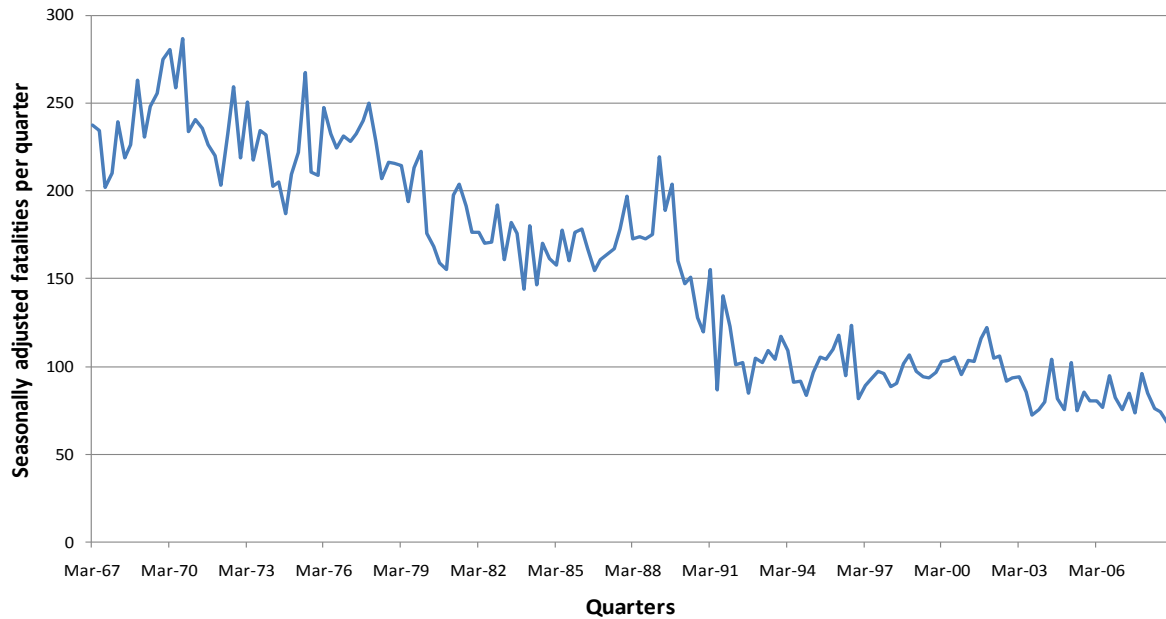

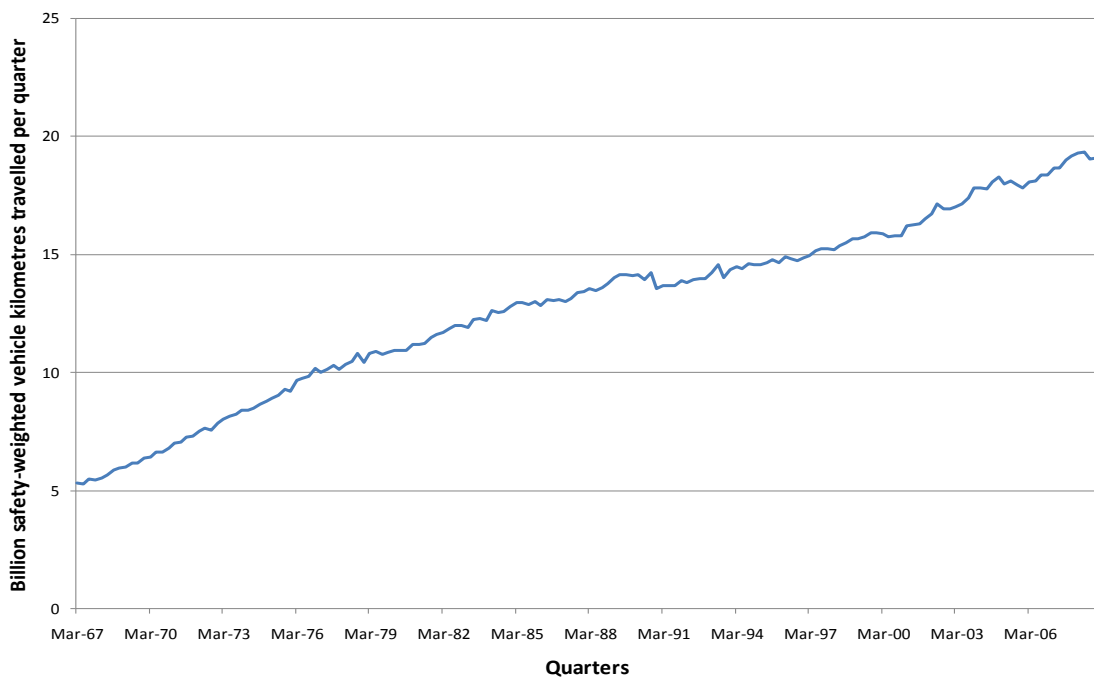Figure 2 Seasonally adjusted fatalities in Victoria

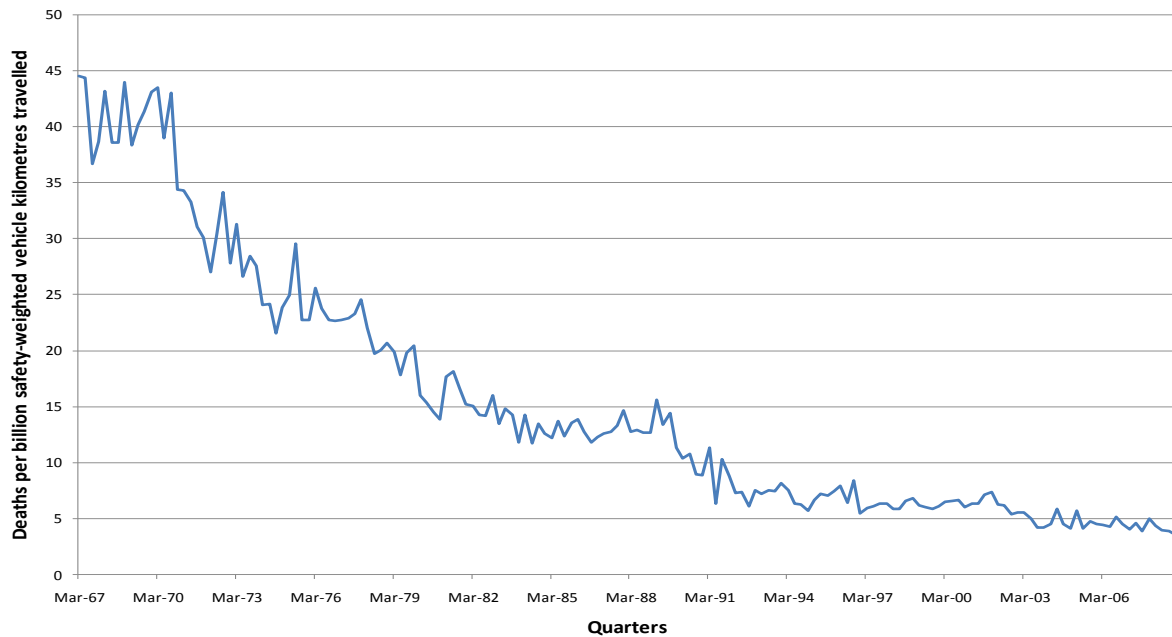Figure 3 Seasonally adjusted safety-weighted vehicle kilometres travelled, Victoria

Figure 4 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.
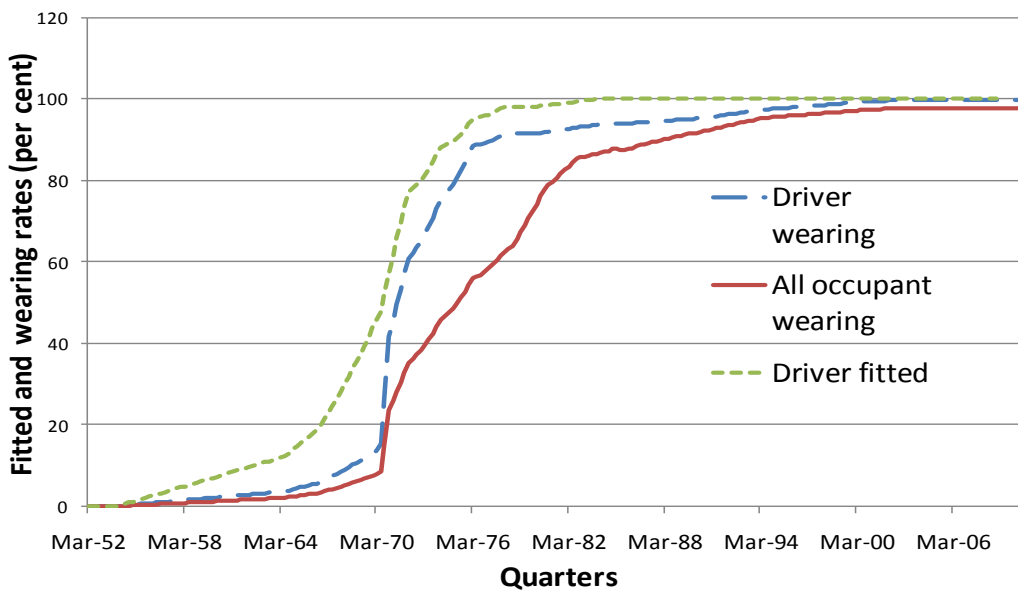

Figure 5 Seat belt rates for Victoria

The rates in Figure 5 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.

Table 1 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 6. 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).
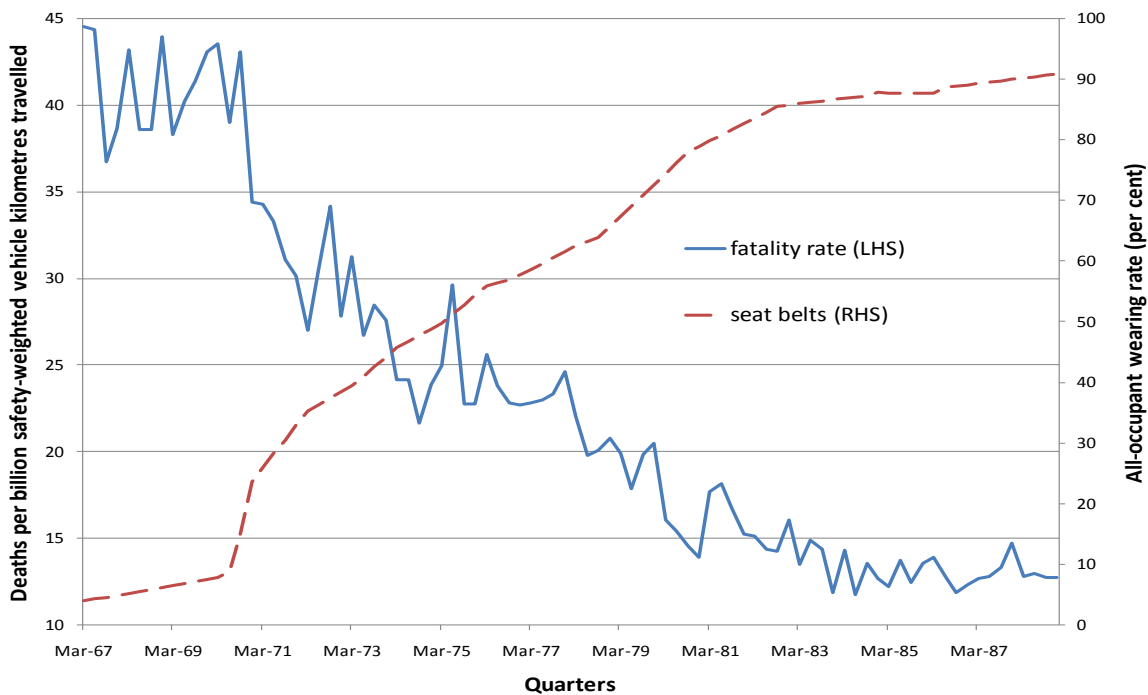

Figure 6 All-occupant seat belt wearing rate versus Victoria's fatality rate

From the late 1980s on, two further safety measures make an appearance on the road safety scene.

Random breath testing in Victoria (as measured by traffic infringement notices per quarter) started about 1986, but increased markedly in the period 1989 to 1991. Figure 7 shows how random breath testing evolved in Victoria.
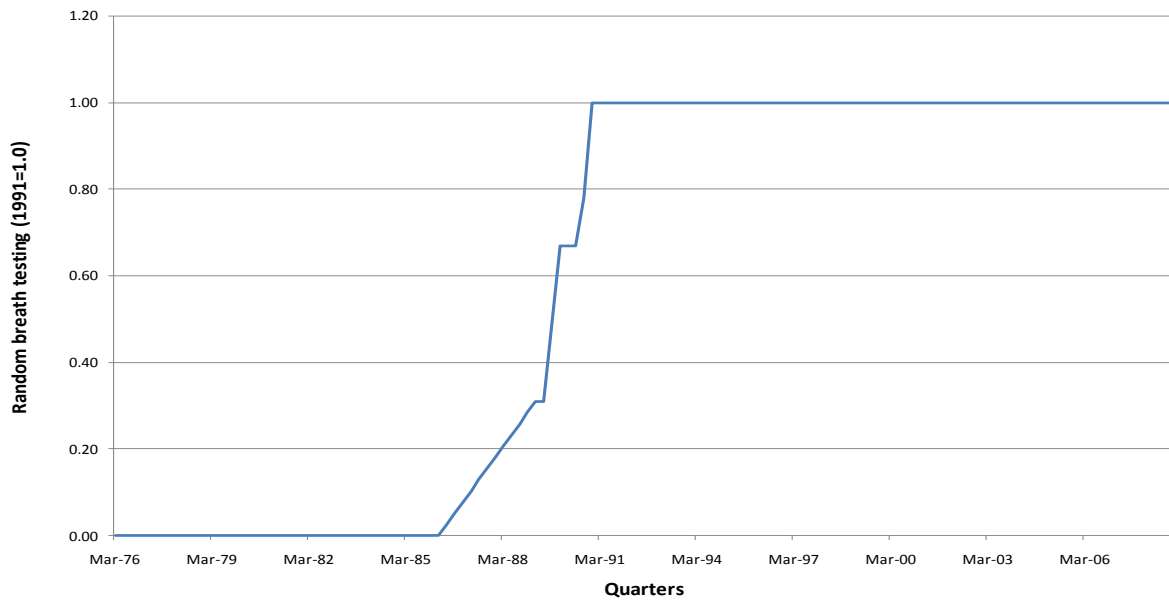
Figure 7 Random breath testing in Victoria

At almost the same time as random breath testing, speed cameras were introduced. From December 1989, much *publicity* was given to the speed camera system prior to roll-out. During the March and June quarters of 1990, this appears to have had half the effect on fatalities of the *actual* roll-out, which happened in the September quarter. Speed camera coverage 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 8 shows the evolution of speed camera coverage in Victoria. Both the random breath testing and speed camera indices are approximate and not based on the ideal measures (infringements rather than hours tested). Future modelling of all states in detail will derive better estimates. 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).
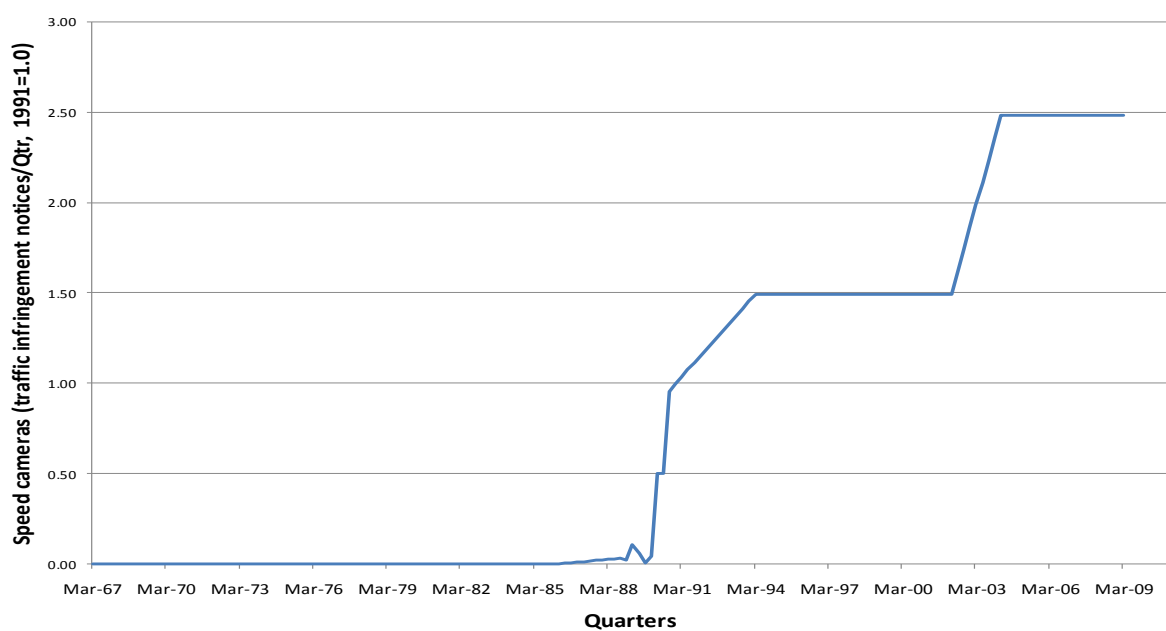

Figure 8 Speed camera tests in Victoria

4. A SIMPLE MODEL OF THE VICTORIAN ROAD FATALITY RATE

Using the fatality rate shown in figure 4 as the dependent variable, a simple regression model was developed to explain the influence of the three safety measures (all occupant seat belt wearing rate, random breath testing (RBT) traffic infringement notices index, and speed camera tests index). Equation 1 shows the regression results from a regression in EXCEL, using the variables as defined above. As expected, all three variables are negatively related to the fatality rate. The seat belt and speed camera variables are statistically significant (probabilities in brackets). The RBT variable is not, but has been left in the regression pending the assembly of better data.

Equation 1

Fatality Rate = 42.618-0.334*Seat Belt Rate-0.527*RBT-1.891*Speed Cameras

$R^2 = 0.98$ (0.00)   (0.00)   (0.31)   (0.00)

Figure 9 shows the fit of the predicted fatality rate to the actual rate. The fit is good over a period of 40-plus years since the late 1960s.
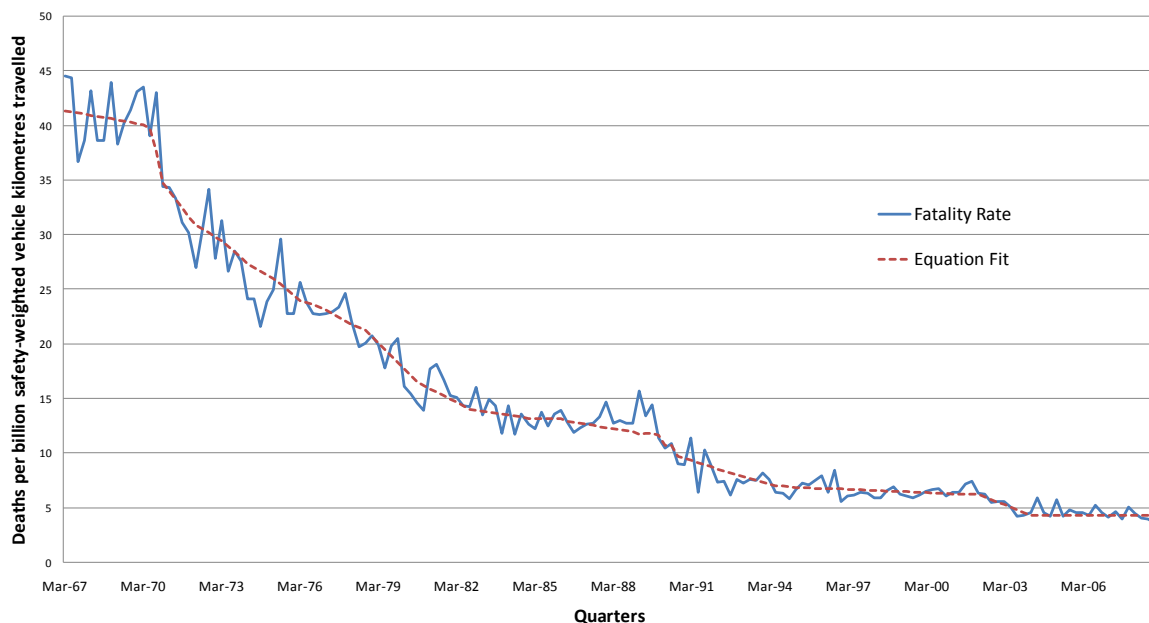

Figure 9   Fitted versus actual Victorian fatality rate

Figure 10 shows the relative contribution (calculated from the equation) 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. The latest major drop-down in the Victorian fatality rate in 2002 to 2003 is related to the substantial expansion in speed cameras (roughly in conjunction with the introduction of a 50 kilometre per hour default urban speed limit).
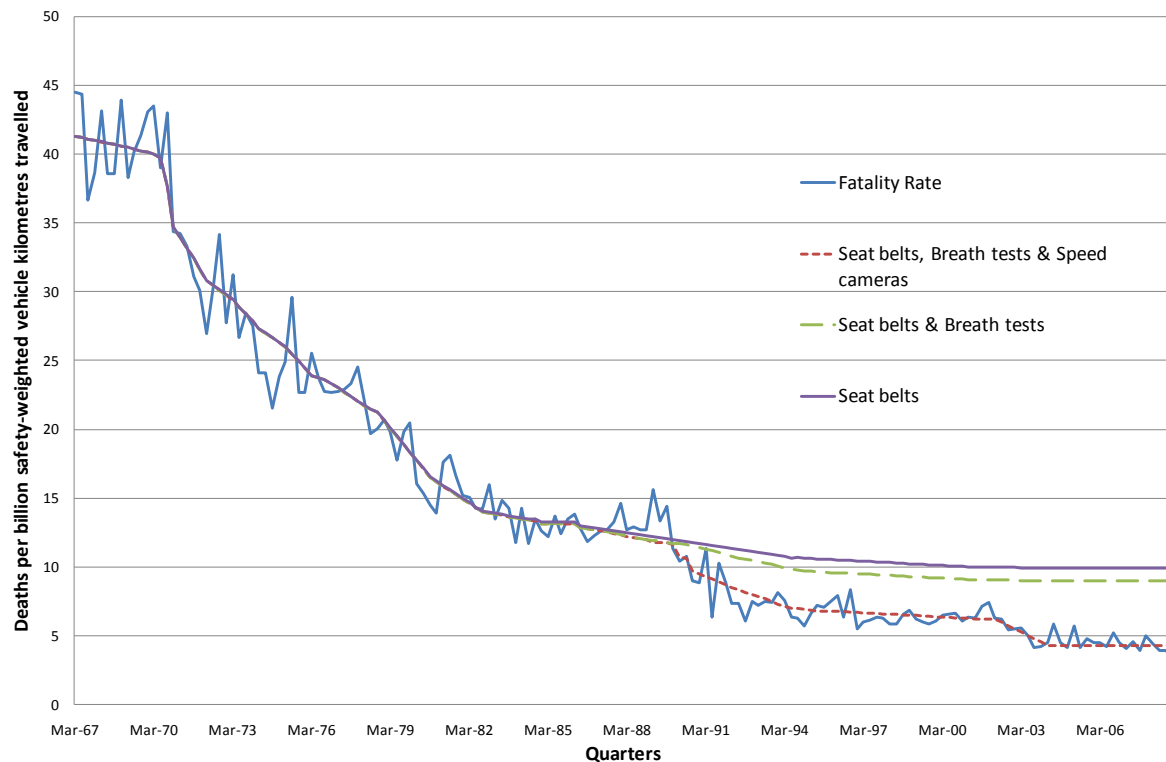
Figure 10   Relative contributions of the three main safety measures over time

Of course, there are countless smaller road safety measures implemented during the 40 years. Not being included in the model, their effects will have been soaked up by the three included measures.

5. USES OF THE MODELLING

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

So, by early June 2009, the March quarter data was able to be added to the database. Victorian fatalities were 76, unchanged from the December quarter raw number. But as December is the worst quarter seasonally, the same number for March meant that the seasonally adjusted fatalities had increased from 68 in December to 75 in March. Furthermore, in the face of budget squeezes and uncertainty from the coming global and Australian recessions, something has been happening to vehicle kilometres travelled that is very rare. Figure 11 shows again the seasonally adjusted safety-weighted vkt for Victoria since 1967, adding in the March quarter 2009. It can be seen that absolute seasonally adjusted falls are continuing – something quite rare (only in 1990, 2005 and from 2008 on have significant falls occurred).
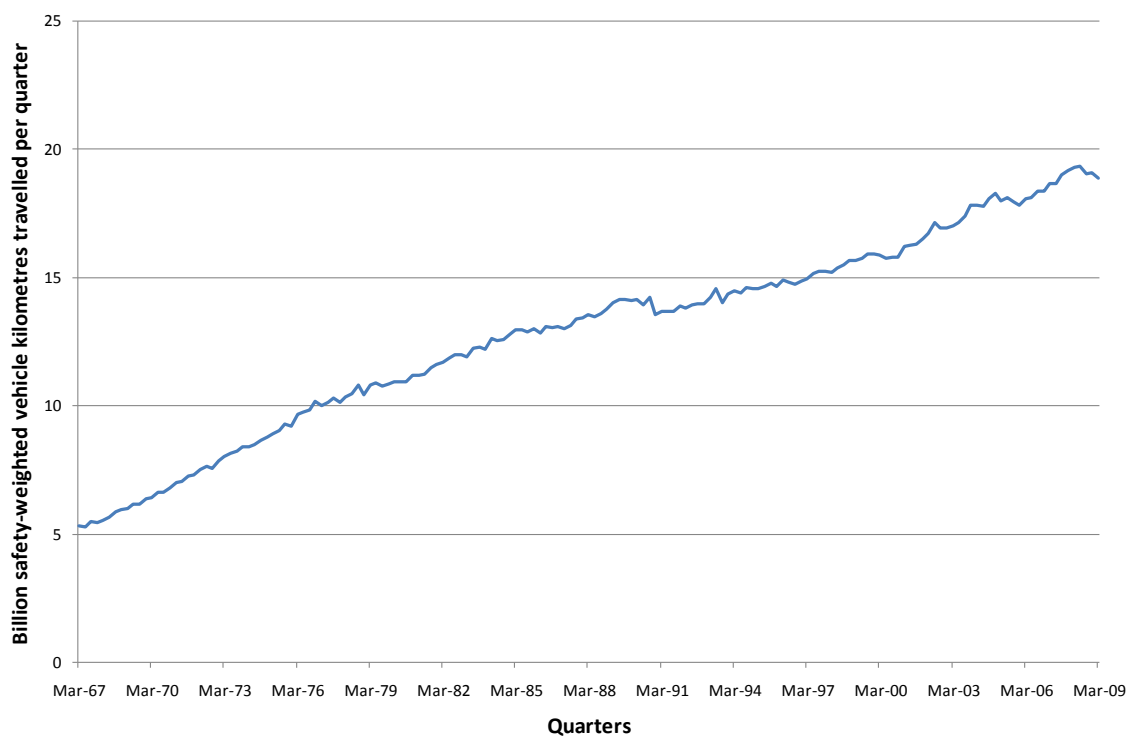
Figure 11 Falls in vkt continue into 2009

So when a rising seasonally adjusted fatality total is deflated by a falling seasonally adjusted vkt, the result is a substantial rise in the March quarter 2009 seasonally adjusted fatality rate. The March quarter figure brings the Victorian fatality rate back quite close to trend (see Figure 12). Such up-to-date information on fatality rates is useful for policy makers in understanding recent trends.

Beyond the short term, the equation 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. Thus, 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 12.
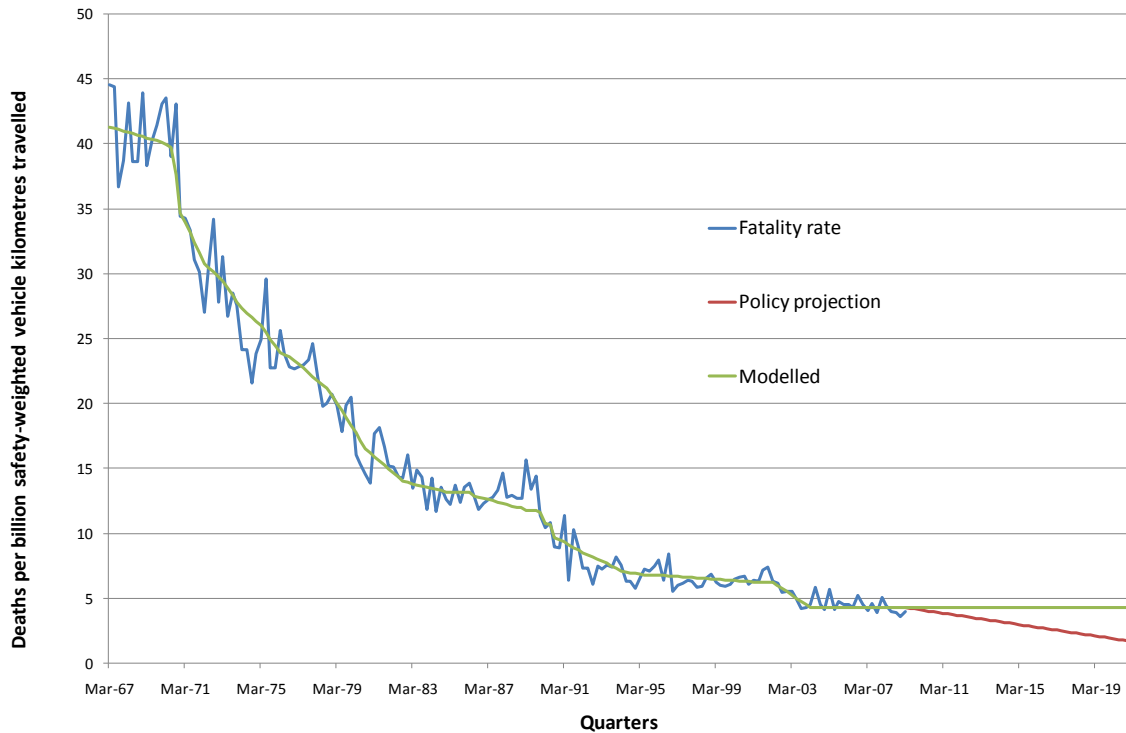
Figure 12 Implications of a policy of halving the number of fatalities by 2020

SUMMARY

The methodology presented here allows fatality *rates* to become the proper measure of state safety campaigns, by allowing vkt calculations based on a regular quarterly data source (fuel sales).

The three major road safety programs of the past 40 years were roughly measured and their impact modelled.

The modelling, although preliminary at this stage, concluded that seat belts and speed cameras were the two most effective countermeasures over the 40 year period. Random breath testing also may have had an effect. The overall effect of the 3 countermeasures was truly tremendous. The absolute number of fatalities per quarter fell in 2008 to one-third of the number per quarter in the late 1960s. This was in the face of traffic growing by a factor of about three and a half times. Thus the fatality *rate* has fallen to 1/10 of its value in the 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 presented here, although preliminary and for one state only, shows promise of allowing an understanding of the short-term dynamics of state fatality rates, as well as of the implications for long-term policy targets.

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