



An evaluation of a supplementary road safety package

Jagadish Guria and Joanne Leung

Land Transport Safety Authority

Abstract

A Supplementary Road Safety Package was developed in New Zealand in 1995/96 to supplement the compulsory breath test and speed camera programmes introduced in 1993. The major features of the package were the use of emotion and shock advertising campaigns to affect bad driving attitudes and behaviours and making police enforcement more risk-targeted (to drink driving, speeding and seatbelt use). This package continued for five years. This paper estimates the effect of the package on road trauma.

Contact author

Joanne Leung
Economic Adviser
Land Transport Safety Authority of New Zealand
PO Box 2840
Wellington
New Zealand
E-mail: JLL@ltsa.govt.nz

Introduction

The New Zealand Road Safety Programme (NZRSP) is prepared every year since 1990/91. It details the amount of police resources that would be spent on strategic enforcement and other management activities (e.g. attending crashes) by local authority areas. It also sets out the work programmes for safety information, education and promotion (including advertising and community programme).

Strategic enforcement activities aimed at changing road users' behaviour, e.g., drink driving, speeding, seat belt wearing and general compliance with the traffic rule. Resource available for strategic activities was increasing steadily till 1993/94 and then it remained somewhat static for a while.

A Supplementary Road Safety Package (SRSP) was developed in 1995/96 to supplement the compulsory breath test and speed camera programmes introduced in 1993. The major features of the SRSP were the use of emotion and shock advertising campaigns to affect bad driving attitudes and behaviours and making police enforcement more risk-targeted.

Cameron and Vulcan (1998) estimated that 109 fatalities and 1,029 serious injuries were saved by the SRSP during the first 2 years. Analysing the effects on evidential breath tests, Macpherson and Lewis (1998) contested these results. White (2000) raised a concern that the analysis did not include a time trend variable. Analysing the same data more thoroughly, Tay (1999, 2001), on the other hand, concluded that the SRSP was effective in reducing both the numbers of evidential breath tests and serious casualties. This paper analyses the effectiveness of this package over a five-year period to 1999/2000.

Model specifications

Due to data constraints, three sets of models were developed based on annual data for 10 years and 29 years, and quarterly data for 10 years. Both the enforcement and advertising measures were available annually only from 1990/91 and quarterly only from 1994/95. Estimates had to be made for these variables. Given these limitations, consistency between results from these three sets of models should ensure robustness of the results.

The general structure of the model is as follows:

$$Y_t = \exp\left(a + \sum_j \beta_j X_{jt}\right) \quad \text{or} \quad \ln Y_t = a + \sum_j \beta_j X_{jt} \quad (1)$$

where Y is a measure of safety outcome per unit of travel and X s are explanatory variables. This suggests that for every additional unit of X , risk reduces by a constant proportion. The exponential function takes into account the diminishing return property of enforcement and advertising activities.

The dependent variables

With sustained traffic growth, the actual risk per unit of travel could be reducing over time but yet there could be no reduction or even an increase in the total number of crashes or casualties. Hence, all the dependent variables used in this analysis were normalised by Traffic Volume Index (TVI). At the national level, we do not expect an increase in the volume of traffic to have a significant impact on the risk per kilometre of travel without improvements in vehicle quality, road conditions or enforcement level (Guria, 1999).

We used fatal crashes, fatalities and non-motorcycle fatalities normalised by TVI as the dependent variables for the annual models. Since the use of motorcycles had declined in recent years and so the fatalities of motorcycle riders, we used the number of non-motorcycle fatalities as the main dependent series in the annual models. Fatalities and fatal crashes were used mainly for consistency checks.

For the quarterly models, we used serious casualties (i.e. fatalities plus serious injuries) and non-motorcycle serious casualties because the numbers of quarterly fatalities are small. As only about half of the serious injuries were reported to the Police, the total numbers of serious injuries were estimated. Because of the uncertainty in reporting rates, the quarterly models would be subject to measurement errors. We used the quarterly models mainly for checking consistency in the estimates.

The explanatory variables

Dummy variables

All dummy variables had a value of 1 if the change affected the whole year. For part year effects we used a fraction, e.g. 5/12 for a 5-month effect. It would be 0 otherwise.

All dummy variables referring to changes or events occurred prior to 1990/91 were used only in the 29-year annual models.

Trend and seasonal effects

Some researchers (e.g. Beenstock and Gafni, 2000) consider that a linear trend term should be included as an explanatory variable to account for a global downward trend in road trauma since the 1970s, due to road and vehicle improvements, and gradual improvements in driver behaviour. While this may be true for vehicle and road improvements, driver behaviour is unlikely to be independent of enforcement and/or advertising campaigns.

In New Zealand, the existence of a downward trend in road trauma is not obvious because there was an upward trend for about 8 years during the 1980s. This of course could be due to some other exogenous factors that suppressed

the downward trend effects. However, road crash and injury risks, as measured by number of crashes or injuries per vehicle kilometre travelled, have generally declined since 1970s. To test whether there was a downward trend, a trend term variable was included in all models.

Since the travel pattern varies over time during a year depending on holidays and weather conditions, it is possible that the risk also changes. To test if there exists any such effect, we included three quarterly dummy variables (S2, S3 and S4) in the quarterly models.

Unemployment Rate

Some studies, e.g. Partyka (1984), Haque (1991) and Newstead, Cameron and Narayan (1998), find a relationship between road trauma and economic activity, particularly with unemployment measures. The main rationale is that when unemployment rate decreases, the level of drink driving as well as the level of traffic exposure (both discretionary and work trips) would increase causing an increase in the level of road trauma. However, this hypothesis ignores the income effect on road and vehicle safety quality. In New Zealand, we did not find any correlation between unemployment rate and total consumption of alcohol, traffic growth trend and social cost of injuries (LTSA 2000, p 18). Since this does not rule out its net effect on safety, we have included it as an explanatory variable.

Oil crisis in 1970s

Following the global oil crisis in 1973, car-less days and petrol-less weekends were initiated during February 1979 to August 1980 as part of an energy conservation campaign. Some of this effect would be captured by a fall in the TVI, but a reduction in interaction between vehicles due to a reduction in the average number of on-road vehicles would not. Also, this campaign would have reduced the level of weekend travel, which tends to be riskier¹. We included a dummy variable (OIL) to account for the net effect.

Changes in speed limits

The open road speed limit was reduced from 55 miles per hour to 50 miles per hour (i.e. from 88 km/h to 80 km/h) in December 1973 as one of the energy conservation measures. In July 1985, open road speed limit was increased from 80 km/h to 100 km/h. We included two dummy variables, D1973 and D1985, to test the effects of these speed limit changes on risk. D1973 was set at 7/12 for 1973/74 and 1 from 1974/75 to 1984/85, whereas D1985 was set at 1 from 1985/86 onwards.

¹ A recent study (Guria & Mara 2000) finds the weekend trauma rate per day (24 hours) is significantly higher than the weekday rate.

Number of new vehicle registrations

Excise duties on imported used motor vehicles were reduced by 50% in March 1988 and were subsequently abolished in July 1990. This increased the volume of used imports since 1988. The overall effect was an increase in the number of vehicles and, hence, in the aggregate exposure levels. This also enhanced the replacement of old vehicles, thereby improving the overall safety quality of the vehicle fleet. We included the number of new vehicle registrations (both used and new imports) to account for the overall effect of the higher level of interaction between vehicles and the overall quality of the vehicle fleet. A negative coefficient for this variable would mean that the removal of tariff on used imports improved safety. As this change occurred prior to 1990/91, the variable was used in the 29-year annual models only.

Strategic police hours and advertising expenditure

Police strategic enforcement hours and safety advertising expenditures were not available in the appropriate format prior to 1990/91. They were estimated using the information available in the annual reports of the Ministry of Transport (see Cameron, Guria and Leung, 2002 for details). For police strategic enforcement, the series was transformed to an index series (SHindex) with 1 for year 1994/95. This transformed series was used for the annual models without further alteration. For the quarterly model, SHindex was obtained by setting the index to remain the same for every 4 quarters.

For safety advertising expenditure, the series was converted to expenditure at June 1995 prices using Consumer Price Index². The constant price series was then converted to a quarterly index (ADindex) series, with 1 for year 1994/95.

The use of indices would not affect the model outcome. It would simply change the scales of measurement making it easier to estimate the savings in deaths and serious injuries.

The CBT and speed camera programmes

The CBT and the speed camera programmes were introduced in April 1993 and October 1993 respectively. Although we could define two dummy variables for them, it would be difficult to separate out their effects in the annual models. We included a dummy variable (CBT) for the CBT programme only. The coefficient is expected to indicate the joint effects of the CBT and the speed camera programmes. It is expected to have a negative sign. For the quarterly models, however, we used two dummy variables: one for the introduction of the CBT programme and the other for both the CBT and the speed camera programmes, denoted as CBT and CBTSPD respectively.

² Consumer Price Index (CPI) is obtained from Statistics New Zealand. As CPI on advertising and promotion is not available, we used the CPI for all groups here.

Interaction terms

Enforcement and advertising complement each other. The effect of enforcement may be different with different levels of advertising. For this, we included an interaction term of the two variables, defined as the product of enforcement and advertising expenditure variables, i.e. SHindex and ADindex.

Apart from increased spending on advertising campaigns and police enforcement, the SRSP also included a change in the style of advertising, to make it more realistic and emotional, and making enforcement more targeted towards speeding, drink driving and seatbelts wearing compliance problems. To capture the effects of these changes, we introduced two more interaction terms, defined as [SRSP*SHindex] for enforcement and [SRSP*ADindex] for advertising. SRSP was a dummy variable with 1 from 1995/96 onwards and 0 otherwise. We would expect these terms to have negative coefficients for both changes to be effective. We did not include SRSP as a separate dummy variable because we considered the changes to result in a discontinuity in the fitted line, rather than a “kinked” continuous line (i.e. a change in the intercept).

Principal component analysis

The strong correlation between some of the variables caused problems in model estimations when using Ordinary Least Square (OLS). This is because OLS coefficient estimates for highly correlated data have high standard errors, making hypothesis testing unreliable. To overcome this multicollinearity problem, we employed Principal Component Analysis (PCA), a technique known to have a minimum variance property (Fomby, Hill and Johnson, 1978).

Principal components (PCs) are orthogonal linear combinations of variables. In some cases the PCs can be interpreted as easily identifiable factors. However, it is not a requirement for their use and the PCs may not have an exact physical interpretation as noted by Greene (1993). However, they can still be used to deal with multicollinearity and small degree of freedom problems as explained in details by Jackson (1991).

The idea of PCA is to select a minimal number of PCs that account for as much variation of the explanatory variables as possible for the regression. Using a subset of the PCs is equivalent to assuming certain linear combinations of the explanatory variables have zero values (Judge, Hill, Griffiths and Lee, 1985 and Greene, 1993). Thus, PCA provides more degrees of freedom, but the estimates can be biased. Considering this, we used PC regressions mainly to determine the variables to be retained and then used both PCA and OLS regressions to estimate savings in road trauma. Even though strong multicollinearity causes problems in testing the significance of coefficient estimates, OLS still provides the best linear unbiased estimates. Therefore, once the variables are selected, OLS estimates have merit.

There is no standard procedure for selecting the PCs for regression analysis. Many studies use all PCs as a starting point and then retain only those that are statistically significant at 5% level (see Jackson 1991 for examples). We followed this backward elimination approach. All variables are included in the PCs apart from seasonal dummies because they are not correlated with other variables (r was between 0 and -0.13).

We used SHAZAM, an econometrics computer programme, to conduct all the regression analysis.

Data

The dataset covered the period from July 1990 to June 2000 for the quarterly and the 10-year annual models and from 1971/72 to 1999/2000 for the 29-year annual model. Crash/casualty data were extracted from the Traffic Crash Report database of police-reported injury crashes maintained by the LTSA.

Data on strategic hours and safety information and promotion expenditure for the period from 1990/91 to 1999/2000 were obtained from various issues of the NZRSP. Similar data for the period prior to 1990/91 were obtained from the annual reports of the Ministry of Transport. The TVI was obtained from Transit NZ for the annual models. The quarterly TVI series was estimated using the data collected from Transit's Traffic telemetry sites (see Cameron, Guria and Leung, 2002 for details).

Estimation of Safety gains

What would happen in the absence of the SRSP were estimated by setting the SHindex and the ADindex to equal their 1994/95 level (i.e. 1). The savings were

estimated as $\text{Savings} = \sum_t \left(Y_t^{\text{fitted, noSRSP}} - Y_t^{\text{fitted}} \right)$, for t from 1995/96

onwards for the annual models and from 1995 September quarter onwards for the quarterly model. As the quarterly models included fatalities and serious injuries, further steps were taken to split the savings into two components: fatalities and reported serious injuries. For this, we assumed the proportions of fatalities and serious injuries were the same in the observed and the fitted series. We also assumed the reporting rates would remain the same if there were no SRSP.

We also estimated the savings in fatalities using models with non-motorcycle deaths. It is assumed that savings in non-motorcycle deaths as a proportion of the total estimated non-motorcycle deaths without the SRSP is the same as that for all fatalities. That is

$$\frac{\text{Estimated Savings in Non - motorcycle Fatalities}}{\text{Total Estimated Non - motorcycle Fatalities Without SRSP}} = \frac{\text{Estimated Savings in All Road Fatalities}}{\text{Total Estimated All Road Fatalities Without SRSP}}$$

The savings in all road fatalities is estimated as

$$\frac{\text{Total Estimated All Road Fatalities Without SRSP}}{\text{Total Estimated Non - motorcycle Fatalities Without SRSP}} * \text{Estimated Savings in Non - motorcycle Fatalities}$$

Results

The adjusted R² is reasonably high in all cases. This is encouraging. Some of the explanatory variables were estimated. However, since the estimates were based on external data, not related to the dependent variables, this should not have an influence on R². At the same time, it does not necessarily mean the relationship is robust. For that we need to look at other relevant characteristics, for example, the relativity between estimates of savings obtained using different dependent variables and also from the three sets of models.

The PC regression coefficients are negative for SHindex and ADindex as well as product terms in almost all cases. The negative coefficients support the diminishing return characteristics assumed in the selection of model structure. In OLS estimates they are not obvious because of the multicollinearity effects.

10-year annual models

Table 1 shows that unemployment rate was not significant except for fatal crashes. The time trend variable (Time) has a significant negative coefficient in all PC regressions. This suggests that variables not included in the regressions have downward effects on fatalities and fatal crashes. The coefficients of all intervention variables have the expected negative signs. The interaction term between advertising and enforcement is significant with a negative sign, suggesting that there were some joint effects on top of the individual effects.

ADindex has significant negative coefficient in most models (except for fatal crashes with unemployment rate) suggesting that there is a significant negative relationship between the level of advertising expenditure and road trauma. Also the negative coefficients of the interaction term [SRSP*ADindex] suggest that the new style of advertising has been additionally effective over and above that represented by ADindex.

Similarly, the significant negative coefficients of the SHindex also suggested a negative relationship between strategic enforcement and road trauma. The

[SRSP*SHindex] interaction is negative and significant in all cases without unemployment rate as an explanatory variable. With unemployment, however, it is significant for the fatal crash models only.

In the fatal crash models, half of the intervention variables (including the CBT dummy) do not have the expected negative signs when unemployment rate is included. When it is excluded, the coefficients for other variables become more logical in terms of sign and magnitude. Furthermore, when we excluded the insignificant variables instead, the coefficient for unemployment rate continues to be significant and negative but most of the intervention variables become positive. There is a possibility that unemployment rate captured the effects of time and other variables with which it is strongly correlated. Hence, we believe that models without unemployment rate are more appropriate, although its inclusion yields higher adjusted R^2 .

29-year annual models

Table 2 gives two versions of the models with and without OIL dummy. OIL dummy is not significant, suggesting the residual effect of car-less days and petrol-less weekends on the risk of travel was not large enough to be identified by the models. The coefficient estimates for all other variables are broadly similar when OIL dummy is excluded, except in the case for non-motorcycle fatalities, where the coefficient of [SRSP*SHindex] became non-significant. Furthermore, the adjusted R^2 for the fatality and fatal crash models became slightly lower indicating an inferior goodness of fit.

The time trend variable has a significant negative coefficient in all cases. However, the magnitude is slightly lower than what we find in the 10-year annual models. This suggests that the long term downward trend, very likely to be accounting for improvements in roading and vehicle safety quality and perhaps some other factors, is not as steep as the short term trend.

The 1973 speed limit reduction had a significant effect on risks of death and fatal crash per kilometre of travel, but the effect on fatal crash risk is smaller. This indicates that the speed limit change in 1973 had resulted in a slightly higher reduction in fatalities than in fatal crashes. This is logical as a crash with a lower impact speed would have less severe injuries. Another point worth mentioning is that the speed limit reduction was for open roads only, there would be no significant effect on urban areas. The combined results (from the three sets of dependent variables) indicate that the likelihood of very severe injury was significantly lower when a crash occurred. On the other hand, dummy variable D1985 is significant but does not have the expected positive sign. A possible explanation is that the effect of more stringent police enforcement of speed limit outweighed the likely positive effect of the speed limit increase.

As expected, the number of new cars registered has a negative sign in all models. The increase in imports of used cars appears to have reduced the risk through increased replacement of older cars and reduced use of motorcycles.

All enforcement variables (including the interaction terms) have significant negative coefficients confirming our findings from the 10-year annual models.

Quarterly Models

Only the fourth quarter seasonal dummy, S4, has significant (positive) coefficient suggesting that the October–December quarter has higher risk than other quarters. The time trend is significant in all cases (Table 3). Though the estimated coefficients are similar to that in the 10-year annual models, the effect is actually much higher because of the cumulative effects over quarters.

The levels of enforcement and advertising have significant effects on risks of fatality and serious injury. However, the variable [SRSP*SHindex] is positive and significant. Because we assumed SHindex and ADindex were the same over every 4 quarters while in reality they were not, the collinearity problem would be more severe. Hence, the effect of targeted enforcement could have been captured by some other variable(s), most likely the interaction term [SHindex*ADindex].

The CBT dummy is not significant in the models with unemployment rate. When CBT dummy is excluded (*version b*), unemployment rate continues to be non-significant. When that is excluded, CBTSPD becomes non-significant. Hence, in the final models (*version c*), we have excluded all the 3 variables. *Versions b* and *c* have relatively high adjusted R^2 and provide similar goodness of fit for the PC regression. But the OLS estimates for *version b* is somewhat better.

Estimated savings

Savings have been estimated in two ways: (1) directly from the model and (2) first estimating the savings in non-motorcycle fatalities and then total fatalities based on the expected ratio of total to non-motorcycle fatalities (Table 4). The second method is more appropriate as it takes into account the reduction in motorcycle fatalities due to a reduction in the exposure of motorcycles.

Models including unemployment rate tend to yield higher savings. To check consistency, we estimated the ratios of the five-year savings in fatalities to fatal crashes for annual models and non-motorcycle fatalities to all fatalities for all models. The corresponding ratios in the observed total are 1.16 and 0.9 respectively. Though it is not necessary for the ratios on savings to be the same, a large departure would be unusual.

Some of the ratios in the 10-year annual models with unemployment are unrealistic. Considering this, we prefer to base our estimates on models without unemployment rate. The ratios of fatalities to fatal crashes are considerably high for OLS estimates except for the 10-year annual models without unemployment

rate. The PC regression estimates, except for the 10-year annual models with unemployment rate, show more realistic ratios.

The ratio of non-motorcycle fatalities to total fatalities is smaller than 0.9 in all cases, except for the OLS estimates of the 10-year annual models with unemployment rate. As this ratio can never be greater than 1, those estimates should not be considered. In all other cases, it is considerably smaller than 0.9 suggesting motorcycle fatalities could have reduced at a higher rate during the period. Thus, the final estimates of savings due to the SRSP should be based on the estimates for non-motorcycle fatalities.

The analysis suggests that the number of fatalities saved varied between 285 and 516, over the 5-year period. Considering the limitation of PC regressions, a conservative range would be between 285 and 360 (or an average of 333), based on the OLS results. Similarly, the estimate of reported serious injury saved would be about 1,700 during over that period.

Diagnostic tests

Serial correlation tests (i.e. Durbin-Watson and Lagrange Multiplier tests) for first-order serial correlation found that serial correlation was not a problem in most of the PC regressions (except for 2 cases). For the OLS regressions, serial correlation is a problem for all the 29-year annual models but not for the quarterly models. Because of lack of degrees of freedom in the OLS regressions, we did not carry out the same tests for the 10-year annual models. However, it was carried out for the PC regressions.

The Wald's normality tests did not find any evidence that the residuals were not normally distributed (as the null hypothesis was not rejected) for any of the models.

Conclusions

The results from the three sets of models are mostly consistent, suggesting strong validity of the final estimates. Though serial correlation could not be tested for OLS estimates of 10 year annual models, it was tested for PC regressions.

PC regressions have been used as a tool for selecting the variables, as due to multicollinearity significance tests could not carried out for OLS. However, since OLS provides the best linear unbiased estimates, we consider it appropriate to estimate the savings based on OLS estimates, once the variables have been selected through PC regressions.

The estimates of savings in road trauma obtained from the Principal Component regressions are higher than that from the OLS regressions in most cases. The number of fatalities saved is estimated to be between 285 and 516, over the 5-

year period. A conservative range using only the OLS results would be between 285 and 360 (or an average of 333). Similarly, the estimate of reported serious injury saved would be about 1,700 over this period.

Because of the multicollinearity and complementary effects of advertising and enforcement on each other, it is not feasible to determine the individual effects of these two variables.

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Acknowledgement

We are thankful to Richard Tay, Kelly Mara and two anonymous referees for their comments on an early draft. Only we are responsible for any remaining errors. The views expressed in the paper are our personal views and are not necessarily shared by the Land Transport Safety Authority.

Table 1: Model outputs for the 10-year annual models

Dependent Variable	All Fatalities				Non-motorcycle fatalities				All fatal crashes			
	With unemployment		Without unemployment		With unemployment		Without unemployment		With unemployment		Without unemployment	
	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS
Time	-0.017*	0.019	-0.012*	-0.032	-0.015*	0.075	-0.011*	-0.029	-0.046*	-0.030	-0.012*	-0.023
Unemployment rate	-0.018	0.054			-0.018	0.110			-0.025*	-0.008		
CBT	-0.093*	0.594	-0.112*	0.105	-0.085*	1.179	-0.107*	0.187	0.021	0.161	-0.118*	0.232
SHindex	-0.275*	-2.302*	-0.242*	-0.842	-0.253*	-4.084	-0.227*	-1.124	-0.405*	-0.953	-0.250*	-1.162*
ADindex	-0.013*	0.168	-0.008*	-0.024	-0.012*	0.324	-0.007*	-0.064	0.002	0.182	-0.008*	0.209
SHindex*ADindex	-0.012*	-0.069	-0.008*	0.074	-0.011*	-0.168	-0.006*	0.121	-0.003	-0.055	-0.007*	-0.076
SRSP*SHindex	-0.008	0.444*	-0.042*	0.161	-0.006	0.752	-0.036*	0.177	-0.065*	0.157	-0.040*	0.197
SRSP*ADindex	-0.009*	-0.150	-0.007*	-0.084	-0.008*	-0.224	-0.006*	-0.091	0.0001	-0.129	-0.007*	-0.138
CONSTANT	6.848*	7.317*	6.641*	7.041*	6.676*	7.648*	6.478*	7.089*	6.876*	6.913*	6.498*	6.953*
PCs retained	1,3		1,2		1,3		1,2		1,3,5		1,2	
% of variations explained by the PCs	88.2%		97.9%		88.2%		97.9%		88.7%		97.9%	
Serial correlation test												
DW statistics	2.28		2.07		2.46		2.54		2.03		1.63	
LM statistics	3.32		1.46		3.46		2.64		2.22		4.61	
Normality test												
Wald statistics	1.81	0.41	1.40	0.77	0.92	0.41	1.34	0.94	0.42	0.41	0.68	0.39
Adjusted R²												
Model	0.980	0.999	0.973	0.989	0.957	0.995	0.953	0.941	0.984	0.993	0.959	0.996
Estimated fatality	0.918	0.999	0.894	0.963	0.790	0.980	0.774	0.756	0.938	0.979	0.846	0.988

* significant at the 5% level.

Table 2: Model outputs for the 29-year annual models

Dependent Variable	All Fatalities				Non-motorcycle fatalities				All fatal crashes			
	With OIL dummy		Without OIL dummy		With OIL dummy		Without OIL dummy		With OIL dummy		Without OIL dummy	
	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS
Time	-0.010*	-0.006	-0.011*	-0.009	-0.010*	-0.014	-0.011*	-0.017	-0.011*	-0.007	-0.011*	-0.009
Unemployment rate	-0.029*	-0.039	-0.031*	-0.033	-0.029*	-0.029	-0.032*	-0.024	-0.031*	-0.046*	-0.032*	-0.040*
OIL	-0.108	-0.073			-0.117	-0.060			-0.090	-0.077		
D1973	-0.124*	-0.192	-0.128*	-0.176	-0.136*	-0.194	-0.134*	-0.181	-0.099*	-0.177	-0.109*	-0.160
D1985	-0.029*	-0.154	-0.032*	-0.129	-0.023*	-0.133	-0.032*	-0.113	-0.048*	-0.161	-0.045*	-0.134
New car registered	-0.050*	-0.007	-0.044*	0.002	-0.039*	0.007	-0.033*	0.015	-0.057*	0.034	-0.051*	0.044
CBT	-0.165*	-0.346*	-0.161*	-0.327*	-0.162*	-0.298	-0.157*	-0.283	-0.161*	-0.390*	-0.160*	-0.370*
SHindex	-0.361*	0.223	-0.362*	0.213	-0.357*	0.271	-0.357*	0.263	-0.358*	0.424	-0.359*	0.414
ADindex	-0.013*	-0.032	-0.012*	-0.098	-0.011*	0.001	-0.010*	-0.054	-0.011*	0.116	-0.012*	0.046
SHindex*ADindex	-0.010*	-0.107	-0.010*	-0.076	-0.009*	-0.103	-0.008*	-0.077	-0.009*	-0.241	-0.010*	-0.209
SRSP*SHindex	-0.037*	-0.188	-0.032*	-0.207	-0.029*	-0.163	-0.019*	-0.180	-0.031*	-0.290	-0.031*	-0.311
SRSP*ADindex	-0.006*	0.117	-0.005*	0.148	-0.004*	0.091	-0.003	0.117	-0.005*	0.135	-0.005*	0.168
CONSTANT	7.353*	7.083*	7.350*	7.092*	7.173*	6.900*	7.173*	6.908*	7.232*	6.795*	7.227*	6.805*
PCs retained	1,3,4		1,2,3		1,3,4		1,2,3		1,2,3,4		1,2,3	
% of variations explained	78.4%		93.9%		78.4%		93.9%		94.5%		93.9%	
Serial correlation test												
DW statistics	2.50	2.88	2.49	2.77	2.64	3.10	2.81	3.01	2.49	2.82	2.38	2.72
LM statistics	2.44	8.85	2.23	7.30	2.86	10.82	4.61	8.89	2.68	8.18	1.75	6.75
Normality test												
Wald statistics	1.07	1.01	2.43	1.03	1.65	1.08	3.54	1.76	0.68	0.69	2.12	0.85
Adjusted R²												
Model	0.972	0.967	0.971	0.967	0.957	0.952	0.959	0.954	0.973	0.969	0.972	0.969
Estimated fatality	0.804	0.790	0.793	0.787	0.652	0.652	0.670	0.670	0.793	0.792	0.786	0.788

* significant at the 5% level

Table 3: Model outputs for the quarterly models

Dependent Variable	All Fatalities + serious injuries						Non-motorcycle Fatalities + serious injuries					
	Version a		Version b		Version c		Version a		Version b		Version c	
	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS
S4	0.078*	0.076*	0.082*	0.077*	0.077*	0.078*	0.063*	0.061*	0.067*	0.062*	0.062*	0.063*
Time	-0.010*	-0.012*	-0.011*	-0.012*	-0.012*	-0.010*	-0.010*	-0.013*	-0.011*	-0.013*	-0.011*	-0.011*
Unemployment rate	-0.020	-0.015	-0.018	-0.013			-0.020	-0.019	-0.018	-0.018		
CBT	-0.072	-0.039					-0.061	-0.028				
CBTSPD	-0.096*	-0.029	-0.097*	0.007			-0.091*	-0.019	-0.088*	0.006		
SHindex	-0.292*	-0.696*	-0.358*	-0.807*	-0.497*	-0.709*	-0.264*	-0.655*	-0.329*	-0.734*	-0.427*	-0.611*
ADindex	-0.024*	-0.158	-0.021*	-0.157	-0.021*	-0.133	-0.023*	-0.148	-0.020*	-0.148	-0.021*	-0.113
SHindex*ADindex	-0.022*	0.166	-0.020*	0.173	-0.020*	0.104	-0.021*	0.187	-0.020*	0.191	-0.020*	0.099
SRSP*SHindex	0.113*	0.236	0.124*	0.257*	0.144*	0.233*	0.125*	0.269	0.134*	0.284*	0.159*	0.255*
SRSP*ADindex	-0.012*	-0.087	-0.009*	-0.096	-0.008*	-0.049	-0.010*	-0.115	-0.008*	-0.121	-0.007*	-0.061
CONSTANT	7.953*	8.216*	7.984*	8.262*	7.913*	8.084*	7.745*	8.009*	7.769*	8.042*	7.666*	7.802*
PCs retained	1,2,4,5		1,3,5		1,2,3		1,2,4,5		1,3,5		1,2,3	
% of variations explained	90.8%		89.0%		99.5%		90.8%		89.0%		99.5%	
Serial correlation test												
DW statistics	1.64	2.23	1.69	2.33	1.86	2.14	1.66	2.16	1.72	2.23	1.80	2.02
LM statistics	1.94	1.55	1.73	2.21	0.51	1.06	1.78	1.44	1.52	1.75	0.73	0.90
Normality test												
Wald statistics	0.72	0.93	0.94	1.06	0.97	1.07	1.32	1.38	1.89	1.44	1.69	1.69
Adjusted R²												
Model	0.964	0.964	0.964	0.964	0.966	0.965	0.951	0.948	0.951	0.949	0.951	0.949
Estimated fatality	0.911	0.914	0.915	0.921	0.921	0.918	0.861	0.859	0.869	0.872	0.869	0.863

* significant at the 5% level

Seasonal dummy (S4) was included as a separate variable.

Table 4: Estimated savings in road trauma from 1995/96 to 1999/2000

Model	10 Year Annual Model				29 year Annual Model				Quarterly Model					
	With unemployment		Without unemployment		With OIL dummy		Without OIL dummy		Version a		Version b		Version c	
	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS	PCA	OLS
Fatalities														
Based on model results	650	705	574	315	579	543	547	550	591	435	477	438	438	464
Based on estimated savings in Non-motorcycle fatalities	589	1,013 (high)	499	285	516	354	447	360	500	333	394	335	352	369
Non-motorcycle fatalities	518	1,035	437	254	452	297	389	302	436	288	345	290	307	321
Fatal Crashes	319	299	476	344	450	303	459	309						
Reported serious injuries														
Based on model results									2,970	2,180	2,390	2,200	2,200	2,330
Based on estimated savings in Non-motorcycle serious injuries									2,510	1,670	1,980	1,680	1,770	1,850
Non-motorcycle Serious Injuries									2,080	1,380	1,650	1,390	1,470	1,530
Non-motorcycle / all ratio														
<i>Fatalities</i>														
With estimated savings in fatalities based on model results	0.80	1.47 (high)	0.76	0.80	0.78	0.55	0.71	0.55	0.74	0.66	0.72	0.66	0.70	0.69
With estimated savings based on estimated savings in Non-motorcycle fatalities	0.88	1.02 (high)	0.88	0.89	0.87	0.84	0.87	0.84	0.87	0.86	0.88	0.87	0.87	0.87
<i>Serious Injuries</i>														
based on model results									0.70	0.63	0.69	0.63	0.67	0.66
based on estimated savings in Non-motorcycle serious injuries									0.83	0.83	0.83	0.83	0.83	0.83
Fatalities / Fatal crashes ratio														
With estimated savings in fatalities based on model results	2.04 (high)	2.36 (high)	1.20	0.92 (low)	1.29	1.79	1.19	1.78						