BREATH TESTING IN NEW SOUTH WALES: HOW GOOD A DETERRENT?

J. THOMSON
Senior Research Officer
Public Affairs Research Department
National Roads and Motorists' Association (NRMA)

ABSTRACT: *An attempt is described to establish whether the police breath testing program in New South Wales, which commenced in December 1968, has been effective in reducing fatalities on the roads and to estimate the reduction in fatalities associated with the program.*

The basic hypothesis underlying the analysis is that police breath testing has acted as a deterrent on drinking drivers leading to a reduction in road fatalities, and that this effect can be measured by statistical association between fatalities and the number of screening tests conducted by the police.

The hypothesis was tested by constructing an econometric model of seven classes of driver and passenger fatalities in New South Wales using annual data from 1952-3 to 1980-1. It was necessary to construct this model in order to control for the effect on fatalities of other influential variables. The modelling process confirmed the hypothesis that breath testing has had a significant effect on the road toll. A simulation using the model led to an estimated saving of 588 lives on NSW roads due to breath testing from 1970-1 to 1980-1. This is about 6.6 per cent of fatalities during this period.

INTRODUCTION

An enormous amount of effort, both in Australia and overseas, has gone into the development of breath testing procedures to detect motor vehicle drivers whose ability is impaired by the effect of alcohol ingestion. The direct relationship between the amount of alcohol detected in a unit volume of air from the driver's lungs, the amount of alcohol in the blood, and his ability to control his vehicle are now fairly well established. The two main instruments currently used by Police to measure alcohol on a driver's breath are the Drager Alcotest and the Breathalyzer 900. The latter is a highly developed instrument which has stood the test of court challenges as to its validity, and is now accepted as the sole evidence needed to convict a driver of alcohol-impaired driving. The Drager Alcotest is now well established as an efficient screening device and a good indicator of a later positive reading on the Breathalyzer for any particular driver. Since the Drager Alcotest is likely to eventually be phased out in favour of an improved instrument, the Alcolmeter, the term "screening" will be used in this report to refer to the use of one or other of these two devices.

It can be argued that the main thrust of the breath testing programme in New South Wales has been to PREVENT road accidents rather than to obtain court convictions, and that screening has been the most important procedure in this regard. Screening can be applied to a large enough number of drivers so as to increase substantially an individual driver's perception that he or she could be stopped by Police for testing. This is because a driver is more likely to have friends or acquaintances who have been tested and may even have been previously tested himself. The greater the number of tests conducted by police, the greater will be the driving public's awareness of being apprehended for excessive drinking before driving; and the greater this awareness, the less accidents there will be. Therefore we should find that when the annual number of tests rise, annual accidents and fatalities tend to fall (and vice versa) if other factors are held constant.

Thus this paper attempts to establish whether there has been a statistically significant drop in fatalities associated with screening and if so to estimate how many lives have been saved on N.S.W. roads as a result. It appears that little statistical evaluation of this aspect of screening has been done in Australia the main work being done by Cameron (1982) in evaluating Victoria's random breath testing programme (RBT). However RBT is qualitatively different from the type of testing done in NSW after December 1968 which we might call "non-random testing" (NBT) where a driver is tested by a police officer after the officer observes some deviant or irregular driving behaviour or after an accident has occurred. This paper is an evaluation of NBT and not RBT.

The number of tests conducted by police since 1969 is shown in Table 1 along with total road fatalities in NSW. As can be seen the number of tests were fairly constant at about 26000 to 28000 from 1972-3 to 1979-80, while in 1980-1 the numbers increased substantially due to compulsory screen testing of drivers involved in serious accidents.

Table 1 - Number of Screening Tests of NSW Drivers

Versus Total Road Fatalities

	Number of Screening Tests	pcnt change	Number of Road Fatalities	pcnt change
1969-70	3000*	-	1267	5.1
1970-71	5000*	66.7	1264	-0.2
1971-72	18000*	360.0	1137	-10.1
1972-73	26099	11.9	1181	3.9
1973-74	27965	7.2	1257	6.4
1974-75	25958	-7.2	1311	4.3
1975-76	25283	-2.6	1242	-5.3
1976-77	26749	5.8	1279	3.0
1977-78	28120	5.1	1336	4.5
1978-79	28305	0.7	1312	-1.8
1979-80	29256	3.4	1276	-2.7
1980-81	121620	315.7	1308	2.5
1981-82	115581	-5.0	1302	-0.5

* estimate based on incomplete data

It can be seen that total road fatalities have shown no perceptible decline in this 13-year period and that there appears to be no year-to-year negative correlation between the percentage changes in the two series. It thus appears that the effect on fatalities of the testing programme has been insignificant. It also appears from the rising trend of fatalities that the effect of many other life-saving measures introduced in this period have been likewise insubstantial - e.g. compulsory seat belt legislation, improved road building standards (such as freeway standard highways), improved traffic management techniques, the penalty points/disqualification system, better hospital treatment of victims, etc. It appears that all these measures have been no panacea for substantially reducing the road toll.

However a number of other research studies indicate that the road toll would have been much higher without these measures (see Cox et. al. 1979, Herbert 1980 p.48). It can be argued that the beneficial effect of the measures has been partly swamped by a number of social and economic forces which have been acting to substantially increase fatalities and injuries on NSW roads. For example, since 1969 there has been: a 70% increase in the number of vehicles registered in NSW; a 70% increase in the number of kilometres of road travel; a large increase in the number of young drivers as a delayed result of the post-war 'baby boom'; a strong decline (at least until the late 1970's) in the cost of motoring relative to after-tax wages and salaries; and so on.

Evidently then, any statistical evaluation of the effect of screening on fatalities must take place in a "total systems" framework in which the major determinants of road fatalities are taken into account. The only way to accomplish this is to construct a model of the social and economic processes which generate road fatalities. In a paper by Thomson (1982) a theoretical base and an appropriate statistical technique, econometric analysis, was outlined. At the 11th Australian Road Research Board Conference, a preliminary model of road fatalities in NSW was presented by the author (see forthcoming ARRB Conference Discussion Papers). In what follows, a reformulated version of this model is presented and, using it, an estimate is made of the reduction in fatalities associated with screening.

THE MODEL

Seven equations comprise the current version of an econometric model of driver and passenger fatalities which has been estimated using annual data from 1952-3 to 1980-1. While equations for other classes of road user have not yet been finalised, the current model stands alone since it would not be expected that the other classes (in particular pedestrians, pedal cyclists, and motor cyclists) signigicantly affect the model in any causal sense. Thus conclusions reached in this paper apply only to drivers and passengers.

Table 2 - Definition of Dependent

Variables in NSW Fatalities Model

Acronym	Definition	Used as an indicator of
MDRU21	fatality rate for under 21 year old male drivers, i.e. fatalities per billion kilometres of total road travel	probability of an under 21 year old driver being killed
MDR2129	as above for 21-29 year old male drivers	as above for 21-29 yr olds
MDR029	as above for male drivers over 29	as above for over 29 yr olds
FDR	fatality rate for all female drivers killed per billion kilometres of road travel	probability of a female driver being killed
PSRU17	fatality rate for under 17 year old passengers per billion kilometres of road travel	probability of an under 17 year old passenger being killed
PSR1729	as above for 17 to 29 year old passengers	as above for 17 to 29 yr olds
PSR029	as above for over 29 year old passengers	as above for over 29 yr olds

In order to present the equations in a concise form, acronyms for the variables are used. The acronyms and definitions of the seven dependent fatality rate variables are given in Table 2.

For each of the above dependent variables, annual fatalities are divided by total annual kilometres of road travel in New South Wales. This denominator was estimated from the four Surveys of Motor Vehicle Usage (Australian Bureau of Statistics) conducted in 1962-3, 1970-71, 1975-6, and 1978-9 using total road fuel consumption as an instrumental variable for estimating the remaining years. Ideally the particular travel kilometres which relate to each fatality group should have been used but these are unavailable prior to 1976.

In order to estimate equations for the fatality rates in Table 2, many hypotheses were generated about variables which might affect fatality rates. These variables are listed in the previously mentioned paper by Thomson (1982). Of course only variables which had a long data history could be used. The hypotheses were developed from theories about the causes of road crashes in the road safety literature, and included expectations about what sign (positive or negative) each variable coefficient should take in the model. For example one would expect that the seat belt wearing rate is an important determinant of road fatalities and that the sign of the coefficient of this variable should be negative - i.e. as the wearing rate goes up, fatalities go down. In the estimation process all the hypotheses were tested in a series of multiple regression runs (a "Two-Stage-Least-Squares" approach was used). The testing process used was one called 'variable replacement' (see Miller 1979) and consisted of two steps: (1) a "backward-stepwise" approach to arrive at a small set of preliminary regressor variables, and (2) a re-introduction of all the other hypothesised variables, one at a time, to see if any one could improve the explanatory power of the model.

The final set arrived at by this process is listed in Table 3.

Table 3 - Definition of the Set of Explanatory Variables in the NSW Fatalities Model

Independent Variables

Acronym	Definition	Used as an Indicator of:
SBWR	seat belt wearing rate	percent of all drivers who wear seat belts while driving
ATEST	number of screen tests conducted by police	awareness of police activity regarding drink drivers
PCGMP	percent change on a year ago in NSW gross manufacturing product	"cycles" in economic activity
FW	total kilometres of freeway available	freeway construction and general roads investment
PMPOP-1720	percentage of male population aged 17 to 20 years old	percentage of male drivers aged 17 to 20 years old

PMPOP-2129	as above for 21 to 29 year olds	as above for 21 to 29 year olds
VD	log of vehicle density - i.e. vehicles registered per kilometre of total roads available	crowding on roads
PFD	proportion of female drivers in total drivers	increased road usage by female drivers
PFD2	square of PFD	
POPVR	population of NSW divided by total vehicles registered	extent to which vehicles carry passengers
TMDR2129	calculated values from equation 2 for male drivers 21 to 29 fatality rate	extent to which passenger fatalities are associated with 21 to 29 year male drivers
TMDRU21	calculated values from equation 1 for male drivers under 21 years fatality rate	as above except under 21 year old drivers
TMDO29	calculated values from equation 3 for male drivers over 29 years fatality rate	as above except for over 29 year old drivers

Many other variables were found in the estimation process to have a poor "fit" such as rainfall pattern, number of traffic lights installed, change of the urban speed limit in 1964, change of country speed limit in 1979, real roads investment, real disposable income, proportion of migrant drivers, proportion of kilometres travelled in country areas, etc. The reasons for non-fit of these series vary and cannot be canvassed here, except to say that availability of a properly representative data series for some variables was a significant problem. The rainfall series used, for example, was for the area around Sydney Observatory - hardly representative of the whole of NSW.

The seven-equation model which links the dependent variables of Table 2 with the final set of regressor variables of Table 3 can now be presented in Table 4. It will be noted that the prefix "LG" is used with all dependent variables and some regressor variables; this denotes that logarithmic transformation was used on these particular variables. The reason logs were used a priori on the dependent variables was that fatalities and fatality rates are very skewed in the shape of a Poisson distribution. Taking logs makes this distribution reasonably symmetric and avoids such potential problems as extreme high residuals. Other variables have "L1", "L2", "L3", as a suffix; this denotes a lag of 1, 2, or 3 etc years which was used in fitting these variables. Annual, financial-year data for the period 1952-3 to 1980-1 were used to estimate the equations. The number in brackets under each coefficient is the value of the t-test statistic for that coefficient. Also shown is the coefficient of determination 'R-squared' both in unadjusted and adjusted form (shown in brackets), as well as the Durbin-Watson test statistic for autocorrelation.

Table 4 - Equations for NSW Fatalities Model

1. Male Drivers Under 21 years old

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LGMDRU21 = -2.735 + 0.676 (PMPOP1720) + 0.026(PCGMPL1) + 0.418(LGVD)
                    (2.6)               (3.4)            (1.5)
- 0.034(LGFW) - 0.068(LGFWL1) - 0.001715(ATEST) - 0.001286 (ATESTL1)
  (-3.5)        (-3.5)          (-1.9)            (-1.9)
        - 0.000857(ATESTL2) - 0.000429(ATESTL3)
          (-1.9)              (-1.9)
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R-sqd: 0.831 (0.794)   DW: 1.8

2. Male Drivers 21 to 29 years old

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LGMDR2129 = -2.433 + 0.227 (PMPOP2129) + 0.01385(PCGMPL1) - 0.177(LGSBWR)
                     (2.3)               (2.4)              (-3.5)
+ 0.772(LGVD) - 0.0242(LGFW) - 0.0485(LGFWL1) - 0.001458(ATEST)
  (4.4)         (-2.0)         (-2.0)           (-2.0)
- 0.001094(ATESTL1) - 0.000729(ATESTL2) - 0.0003654(ATESTL3)
  (-2.0)              (-2.0)              (-2.0)
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R-sqd: 0.770 (0.704)   DW: 2.2

<u>3. Male Drivers Over 29 years old</u>

$$\begin{aligned} \mathrm{LGMDR029} = {} & 0.371 + \underset{(2.1)}{0.007122}(\mathrm{PCGMPL1}) - \underset{(-5.1)}{0.1415}(\mathrm{LGSBWR}) + \underset{(6.4)}{0.533}(\mathrm{LGVD}) \\ & - \underset{(-2.6)}{0.01217}(\mathrm{LGFW}) - \underset{(-2.6)}{0.02433}(\mathrm{LGFWL1}) - \underset{(-2.7)}{0.00106}(\mathrm{ATEST}) - \underset{(-2.7)}{0.000797}(\mathrm{ATESTL1}) \\ & - \underset{(-2.7)}{0.000531}(\mathrm{ATESTL2}) - \underset{(-2.7)}{0.0002656}(\mathrm{ATESTL3}) \end{aligned}$$

R-sqd: 0.913 (0.894) DW: 1.8

<u>4. Female Drivers</u>

$$\mathrm{LGFDR} = -1.563 + \underset{(3.3)}{0.030}(\mathrm{PCGMP}) + \underset{(7.3)}{0.125}(\mathrm{PFD}) - \underset{(-4.9)}{0.001695}(\mathrm{PFD2})$$

R-sqd: 0.881 (0.867) DW: 2.1

<u>5. Passengers Under 17 years old</u>

$$\mathrm{LGPSRU17} = -0.123 + \underset{(2.2)}{0.3574}(\mathrm{TMDR2129}) + \underset{(6.9)}{0.1784}(\mathrm{POPVR})$$

R-sqd: 0.753 (0.734) DW: 1.9

<u>6. Passengers 17 to 29 years old</u>

$$\mathrm{LGPSR1729} = 0.540 + \underset{(5.4)}{0.510}(\mathrm{TMDRU21}) + \underset{(9.0)}{0.221}(\mathrm{POPVR})$$

R-sqd: 0.721 (0.699) DW: 2.0

<u>7. Passengers Over 29 years old</u>

$$\mathrm{LGPSO29} = -0.311 + \underset{(5.4)}{0.649}(\mathrm{TMDRO29}) + \underset{(12.0)}{0.253}(\mathrm{POPVR})$$

R-sqd: 0.934 (0.929) DW: 1.8

A logarithmic transformation was used for each of the dependent variables in an attempt to 'normalise' their distribution. Fatalities data exhibit a very skewed distribution (probably a Poisson), and if used untransformed, give rise to a problem of extreme high residuals (particularly with the passenger equations). A "T" was used as a prefix for the male driver fatality rates in the passenger equations to denote that the model values were used in a two-stage-least-squares estimation approach.

COMMENTS ABOUT THE MODEL

For the three male driver equations, five variables accounted for most of the explainable variation: the seat belt wearing rate, vehicle density, the number of screen tests conducted by police, the number of kilometres of freeway available each year; and the growth rate of NSW gross manufacturing product. The life-saving effect of seat belt usage is, of course, well documented, while the importance of freeways has been well demonstrated by Cox, Searles, and Fleming (1979). Vehicle density turned out to be important for the male driver equations but not the female driver equation. This probably reflects the relative impatience of male drivers as more and more vehicles crowd on to a relatively fixed amount of available roadway. The life-saving deterrent effect of the screening programme by police has been less well demonstrated, the main studies being of the effect of the Victorian random breath testing programme (see Cameron, 1982).

The three passenger equations are dominated by two variables - population per vehicle, and one of the least squares estimates of male driver fatalities. The former represents the extent to which road vehicles carry passengers, while the latter simply represents the fact that every male driver killed tends to take a few passengers with him.

Another variable important in the equations is economic activity, which enters the model both explicitly and implicitly. Three of the four driver equations contain the annual percent change in NSW gross manufacturing product (estimates come from W. D. Scott and Co.). This variable explicitly states that as economic activity rises, the fatality rate rises. Implicitly economic growth is in the model through its effect on vehicle kilometres travelled (the denominator of the fatality rate) and vehicle density. It was mentioned earlier that fuel consumption was used as an instrumental variable in estimating kilometres travelled; since the growth of consumption varies with economic activity, the fatality rate incorporates a partial adjustment for this. Vehicle density represents the fact that as real economic growth proceeds, more people are able to afford motor vehicles which then are added to a road network that is growing much more slowly (increased crowding).

It will be noted that a polynomial distributed lag is used on both FW (freeway length) and ATEST. The lag on FW represents merely that new extensions of the freeway network are opened part way through a financial year and are not fully operational until the next financial year. The type of lag model used was a 1st degree polynomial, constrained to zero at the head of the polynomial.

The lag on ATEST of up to 3 years is quite a significant feature of the model and denotes the long residual impact of screening on the consciousness of drivers. The type of lag model used here was as for FW, but constrained at the tail.

It must be emphasised at this point that the above model, and any conclusions drawn from it, must be viewed as preliminary. This is mainly for two reasons. Firstly the modelling process has not been replicated or the calculations checked by an independent agency*. Secondly the variable definitions, transformations, and model specification generally are capable of further refinement - no model can be viewed as being incapable of being improved.

A MODEL SIMULATION ON SCREEN TESTS

Having described the structure of the fatalities model, we can now return to the main subject of this paper. The model estimation process showed a statistically significant negative relationship between annual screen tests conducted and annual fatalities for male drivers and indirectly for passengers.

* For a copy of all data used please contact the author at the NRMA in Sydney.

A simulation was performed which consisted simply of zeroing the screening variable and then running the model to calculate the number of road fatalities that would have occurred if no screening had been conducted since 1969. These fatality estimates were then subtracted from the model estimates with screening (i.e. the model which was fitted to the fatalities data) to get the resulting saving in fatalities. The results are summarised in Table 5 which shows the estimated number of fatalities avoided since 1970-1 by the classes of road user used in the model.

Table 5 - Reduction in Road Fatalities in New South Wales as a Result of Screening by Selected Road User Class

Year	Male Drivers Under 21	Male Drivers 21-29	Male Drivers Over 29	Passengers Under 17	Passengers 17-29	Passengers Over 29	Total
1970-1	1	2	2	0	1	1	7
1971-2	3	4	5	1	3	2	18
1972-3	5	7	8	2	5	4	31
1973-4	7	10	11	2	7	5	42
1974-5	8	12	13	2	8	6	49
1975-6	8	11	14	3	8	6	50
1976-7	9	12	14	3	9	7	54
1977-8	10	13	16	3	10	7	59
1978-9	11	14	17	3	10	7	62
1979-80	12	15	18	3	11	8	67
1980-81	26	33	41	7	24	18	149
Total	100	133	159	29	96	71	588

Thus in the eleven years since screening has been in full stride in NSW, it is estimated that a saving of 588 male drivers and passengers lives has been associated with the breath testing programme. Of course many more pedestrian, motor cycle, and pedal cyclist lives would also have been saved, as well as some female driver lives.

To put the figures of Table 5 more into perspective we can calculate the percentage savings in fatalities due to screening over the 11 years since 1970-1. This is done in Table 6.

Table 6 - Percentage Reduction in Passenger and Male Driver Fatalities, 1970-1 to 1980-1 Due To Screening Tests

	Actual Fatalities	Estimated Fatalities Saved	Estimated Fatalities without screening	% reduction
Male Drivers:				
under 21	833	100	933	10.7
21-29	1343	133	1476	9.0
over 29	2169	159	2328	6.8
Passengers:				
under 17	818	29	847	3.4
17-29	1655	96	1751	5.5
over 29	1531	71	1602	4.4
Total	8349	588	8937	6.6

Thus the reduction in fatalities over the 11 year period for passengers and male drivers is about 6.6%, with the greatest reduction being 10.7% among young male drivers.

CONCLUSION

The estimation process involved in deriving a model of driver and passenger road fatalities presented in this paper established a stable and significant relationship between fatalities and the number of screening tests conducted by police.

This relationship was found to hold after controlling for the effect of the introduction of compulsory seat belt usage, the extension of the freeway network and other variables. It also holds over an extended time period as the modelling time frame included the period from 1952-3 to the late 1960's when there were little or no freeways, screening, or seat belt usage.

The size of the relationship was quantified in a simulation run on the model, which indicated that an estimated 588 fatalities were avoided due to the deterrent effects of screening. This represents about a 6.6% reduction in the fatalities which apparently would have occurred without the screening programme.

These estimates can be expected to grow in magnitude due to the fact that in 1980-1 the NSW Police Department greatly expanded its screening programme, thus forcing a greater awareness on drivers of police presence on the roads. This effect may be further magnified by the introduction of random breath testing in NSW, as this programme may enable a given number of police officers to conduct a considerably greater number of screen tests.

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