



MONASH University
Accident Research Centre

**EVALUATION OF A RANDOM BREATH
TESTING INITIATIVE IN VICTORIA
1990 & 1991**

SUMMARY REPORT

by

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December 1992

Report No. 39

**MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE
REPORT DOCUMENTATION PAGE**

Report No.	Report Date	ISBN	Pages
39	December 1992	0 7326 0039 1	32

Title and sub-title:

EVALUATION OF A RANDOM BREATH TESTING INITIATIVE IN VICTORIA 1990 & 1991.
SUMMARY REPORT.

Author(s)	Type of Report & Period Covered
Cavallo, A. Cameron, M.H.	GENERAL, 1989-1991

Sponsoring Organisation -

Transport Accident Commission
222 Exhibition Street
Melbourne VIC 3000

Abstract:

This report provides a summary of the findings of two evaluations, with differing methodologies, to determine the impact of a random breath testing (RBT) initiative (including publicity) in Victoria on severe crashes in high alcohol times of the week during 1990 and 1991. Bus-based RBT stations using highly visible "Booze Buses" largely replaced car-based stations, and a multi-million dollar, Statewide anti-drink driving publicity campaign through all mass media, was launched in mid December 1989, and reinforced throughout 1990 and 1991.

It was found the initiative reduced fatal crashes (in high alcohol times of the week) in Melbourne during 1990 by around 19-24% relative to what was expected. Serious casualty crashes (in high alcohol times) in the rural areas around Melbourne were reduced by 15% relative to other rural areas of Victoria where the RBT initiative was expected to have had minimal effect. It was also estimated that there was a 13% reduction in serious casualty crashes (during high alcohol times) in the whole of rural Victoria. The effect on Melbourne serious casualty crashes (during high alcohol times) was more difficult to estimate, given that a new decreasing trend in these crashes emerged shortly before the intervention. The choice of the appropriate model to represent the expected post-intervention trend, and hence estimated change, differed between the two studies. The first study, using an estimate which emphasised the new road safety trend prior to the intervention, found no statistically significant evidence that the RBT initiative had an effect over and above that which would have occurred if the pre-intervention trend had continued downward. In contrast the second study, using a model which basically placed equal weight on the trend for the previous twelve month pre-intervention period, suggested that RBT reduced serious casualty crashes during high alcohol times in Melbourne by between 8 and 27%.

The second evaluation also attempted to assess the effect of the initiative on these crashes in 1991. The results suggested that there was a statistically significant reduction in serious casualty crashes (in high alcohol hours) in rural Victoria only, and no change in fatal crashes (in high alcohol hours) in either Melbourne or the rural area. The confidence limits were very wide for fatal crash estimates in this period however, reducing the chance of showing a significant effect. The findings for the 1991 period are also less conclusive because other (new or changing) factors may mask or weaken the effects further away in time from the beginning of the intervention.

Key Words:

(IRRD except where marked*)
evaluation (assessment), collision,
road trauma, publicity, enforcement,
Blood Alcohol Content, alcohol*,
drink driving*, Random Breath Testing*

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EXECUTIVE SUMMARY

BACKGROUND

This report provides a summary of the findings of two evaluations, with differing methodologies, to determine the impact of a random breath testing (RBT) initiative (including publicity) in Victoria. The first evaluation estimated the effect of the initiative on severe crashes in high alcohol times of the week during 1990 whilst the second study also estimated its effect during 1991.

The initiative, introduced late in 1989, involved a substantially different method of RBT enforcement compared with past operations. Bus-based RBT stations using highly visible "Booze Buses" largely replaced car-based stations, and a multi-million dollar, Statewide anti-drink driving publicity campaign through all mass media, was launched in mid December 1989, and reinforced throughout 1990 and 1991. This campaign was the cornerstone of public perceptions of the program, designed to both heighten perceptions of extended enforcement and sensitize the public to the consequences of drink driving. In brief the key aspects of the initiative were:

- A major multi-million dollar, multi-media publicity campaign
- Thirteen new, high profile 'Booze Buses', progressively replacing car-based testing, especially in Melbourne
- A strike force using 'Probationary Constables In Training' (PCIT's) on monthly roster to operate buses
- More than doubling the number of drivers tested, mostly in Melbourne, gradual but smaller increases in session hours and no change in the number of sessions conducted in Melbourne.

EVALUATION STUDIES

Two different evaluation methods and statistical methodologies were used to evaluate the impact of RBT on severe road crashes in high alcohol hours of the week during 1990. The second evaluation also estimated effects during 1991.

The first study (Drummond, Sullivan & Cavallo, 1992) used a quasi-experimental time series analysis. A forecasting model was used to estimate the changes in two treated areas, Melbourne and a part of rural Victoria (Rural 1), taking into account changes in the same crash types in two respective comparison areas, Sydney and Rural 2 (a minimally affected area in country Victoria). Accounting for changes at these comparison areas (quasi-experimental control) increases the likelihood that measured effects are validly ascribed to the initiative, rather than the effect of any other factors. This quasi-experimental design was used in the absence of a full

experimental design (which provides the most rigorous assessment), and in preference to the use of statistical control.

The second study (Cameron, Cavallo & Sullivan, 1992) used a multivariate time series analysis. An Intervention Analysis (assessing a step reduction with the introduction of the initiative) was used to estimate the changes in crashes in treated areas (Melbourne and rural Victoria) relative to comparison areas (Sydney and rural NSW). However, respective unemployment rates were also directly taken into account because it was considered that statistically controlling for this factor was appropriate.

RESULTS

The quasi-experimental time series analysis found:

- a 19% reduction in fatal crashes (in high alcohol times of the week) in Melbourne in 1990 due to the initiative, but no change in serious casualty crashes
- a 15% reduction in serious casualty crashes (in high alcohol hours) in the Rural 1 area (mainly the rural area around Melbourne) in 1990, but no change in fatal crashes; a more tentative attribution of this effect to the initiative was made given the pattern of results.

The multivariate time series analysis found:

- a 24% reduction in fatal crashes and an 18% reduction in serious casualty crashes (in high alcohol hours) in Melbourne in 1990 due to the initiative
- a 13% reduction in serious casualty crashes (in high alcohol hours) in rural Victoria in 1990 ascribed to the initiative, but no change in fatal crashes.

INTERPRETATION

The most significant finding from these studies is that the initiative reduced fatal crashes (in high alcohol hours) in Melbourne by around 19-24% relative to what was expected. This significant drop in high alcohol hour fatal crashes as measured by both studies is the strongest evidence of the program's effectiveness, given that:

- high alcohol hour fatal crashes are more likely to be alcohol related, and
- large statistically significant reductions were found even though the smaller number and greater fluctuation of fatal crashes make it more difficult to estimate changes.

The first study found a 15% reduction in serious casualty crashes in the rural areas around Melbourne relative to the other rural areas in Victoria (where the RBT initiative was expected to have had minimal effect). The second study found a 13% reduction in serious casualty crashes in the whole of rural Victoria relative to rural NSW (where no substantive change in RBT activity occurred during 1990). Both

studies found no change in rural fatal crashes however, which are considered to be more alcohol related (than serious casualty crashes) and thus likely to be affected by the RBT initiative. It is conceivable that reduced statistical sensitivity for measuring changes in rural fatal crashes (given smaller numbers) means that an effect is difficult to detect. The absence of evidence for an effect on fatal crashes but evidence for a significant effect on serious casualty crashes provides tentative evidence of an effect of the RBT initiative in rural Victoria.

The effect on Melbourne serious casualty crashes was more difficult to estimate, given that a new decreasing trend in these crashes emerged shortly before the intervention. The choice of the appropriate model to represent the expected post-intervention trend, and hence estimated change, differed between the studies. The first study, using an estimate which emphasised the new road safety trend prior to the intervention, finds no statistically significant evidence that the RBT initiative had an effect over and above that which would have occurred if the pre-intervention trend had continued downward. It should be noted however, that this finding is also in part due to the wide confidence interval (-18.7% to 25.9%) in which the estimate lies. In contrast, the second study, using a model which basically placed equal weight on the trend throughout the previous twelve month pre-intervention period, suggested that RBT reduced serious casualty crashes in Melbourne by between 8 and 27%.

Findings for 1991

The second evaluation also attempted to assess the effect of the initiative on these crashes in 1991. The results suggested that there was a statistically significant reduction in serious casualty crashes (in high alcohol hours) in rural Victoria only, and no change in fatal crashes (in high alcohol hours) in either Melbourne or the rural area. It must be noted however, that the confidence limits were very wide for fatal crash estimates in this period which reduces the chance of showing a significant effect and providing precise estimates. The findings for the 1991 period are also less conclusive because other (new or changing) factors may mask or weaken the effects further away in time from the beginning of the intervention.

CONCLUSION

Evidence was found from the two evaluation studies for the effectiveness of the RBT initiative in reducing fatal (high alcohol hour) crashes in Melbourne in 1990.

Some evidence was also found to indicate (more tentatively) that the RBT initiative may have reduced serious casualty (high alcohol hour) crashes in Melbourne in 1990, and in rural Victoria both in 1990 and 1991.

EVALUATION OF A RANDOM BREATH TESTING INITIATIVE IN VICTORIA 1990 & 1991

SUMMARY REPORT

1.0 INTRODUCTION

Since the end of 1989 Victoria has experienced dramatic reductions in road fatalities and across most other road trauma and road user groups, far outside the range of chance variation. The full explanation for this reduction is complex. In order to understand the causes of this dramatic change, systematic evaluations of the major road safety initiatives introduced in this period have been undertaken by the Monash University Accident Research Centre (MUARC).

This report provides a summary of the findings of two evaluations, with differing methodologies, to determine the impact of a random breath testing (RBT) initiative (including publicity) on crashes in Victoria introduced in late 1989.

The first evaluation (Drummond, Sullivan & Cavallo, 1992) used a quasi-experimental univariate time series methodology to estimate the effect of the initiative on severe crashes during 1990. The second study (Cameron, Cavallo & Sullivan, 1992) estimated the effect of the program using a multivariate time series approach on serious crashes in 1990 and also attempted to estimate its effect during 1991.

Since its introduction in Victoria in 1976, Random Breath Testing (RBT) activity has progressively increased from 19,006 tests conducted in 1977 to 520,723 by 1989. The program has generally been supported during the 1980's by periods of mass media publicity covering generally a four week period, often targeting the pre-Christmas period of the year. Short periods of intensified RBT in selected areas of Melbourne were also carried out between 1977 and 1983 according to predetermined experimental designs. Evaluations of these 'blitzes' found that intensified RBT is an effective measure for reducing night-time, serious casualty crashes.

The current RBT initiative involved a qualitatively and quantitatively different method of RBT enforcement, with bus-based RBT stations progressively replacing car-based operations, especially in Melbourne. A multi-million dollar, Statewide multi-media publicity campaign "If you drink then drive, you're a bloody idiot" was launched in mid December 1989, and intensively reinforced intermittently throughout 1990 and 1991.

Sections 2 and 3, undertaken by Drummond *et al* (1992), provide important background information about the nature of the initiative and changes in descriptive data pertaining to drink driving and crashes over time.

Sections 4 to 7 cover evaluation principles, the two evaluation methodologies and their results, a comparison of the two sets of results and conclusions about the estimated effects of the initiative.

2.0 THE INITIATIVE

In September 1989 a new method of conducting RBT was gradually introduced. Unlike past RBT operations which largely relied on car-based stations, bus-based operations became the primary form of RBT enforcement, with 13 new custom-built, high visibility booze buses gradually introduced and replacing 4 existing buses. A greater number of police officers can conduct tests in any one bus operation compared to a car-based operation. A breath-testing task force utilising teams of Probationary Constables In Training (PCITs) on monthly deployment enabled higher levels of RBT activity to be achieved.

The aim of this change was to increase significantly the number of drivers who are random breath tested and enhance the visibility of RBT operations, thus more directly exposing a greater number of drivers to RBT in an attempt to increase general deterrence to drink driving.

In December 1989, an intensive Statewide, multi-million dollar publicity campaign was launched to support the new RBT operations. Most advertisements depicted emotive post-crash scenarios. A media launch and publicity for the introduction of the new booze buses also occurred in April and September 1990, respectively. There was also a considerable number of media articles published about the initiative.

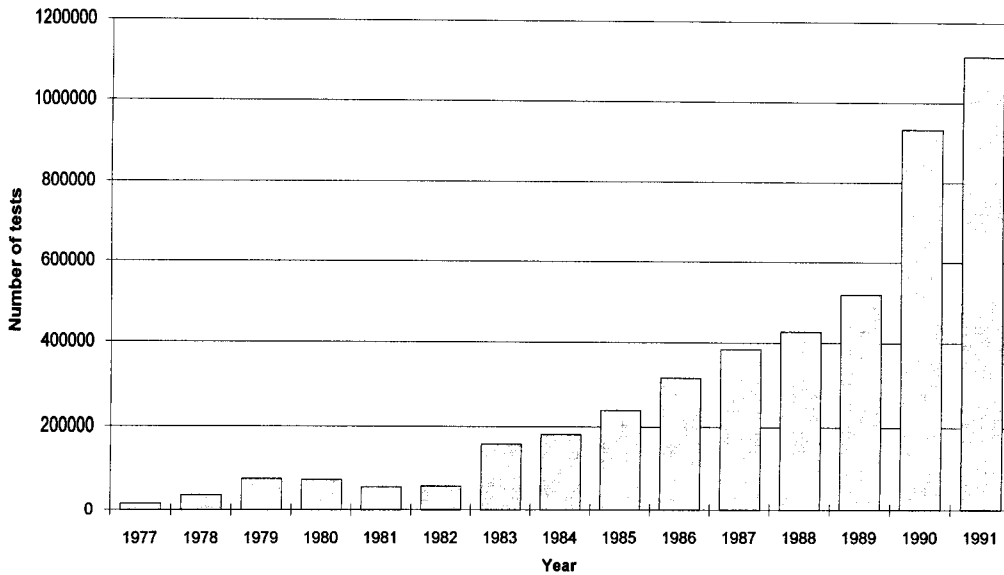
A large-scale shift to bus-based RBT operations from the traditional car-based method (buses had been used at a relatively low level over previous years) occurred in metropolitan Melbourne in late 1989. There was a much smaller and delayed use of bus-based RBT in rural Victoria throughout 1990, although rural areas generally closer to Melbourne (R1) received bus-based testing earlier and more frequently than rural areas farther from Melbourne (R2).

The changes brought about by the new RBT technique during 1990 and 1991 are described below.

2.1 *Statewide Operations*

The initiative almost doubled the total number of RBT tests conducted yearly in Victoria from around ½ million in 1989 to over 900,000 in 1990 and 1.1 million in 1991 (Figure 1). Bus-based RBT operations more than doubled the testing rate (per hour) of car-based operations. Overall this resulted in a substantial increase in the number of RBT tests for relatively small changes in the total time of operation of testing stations. The number of person hours spent testing of course also increased substantially. Changes in RBT operations varied across different parts of the State.

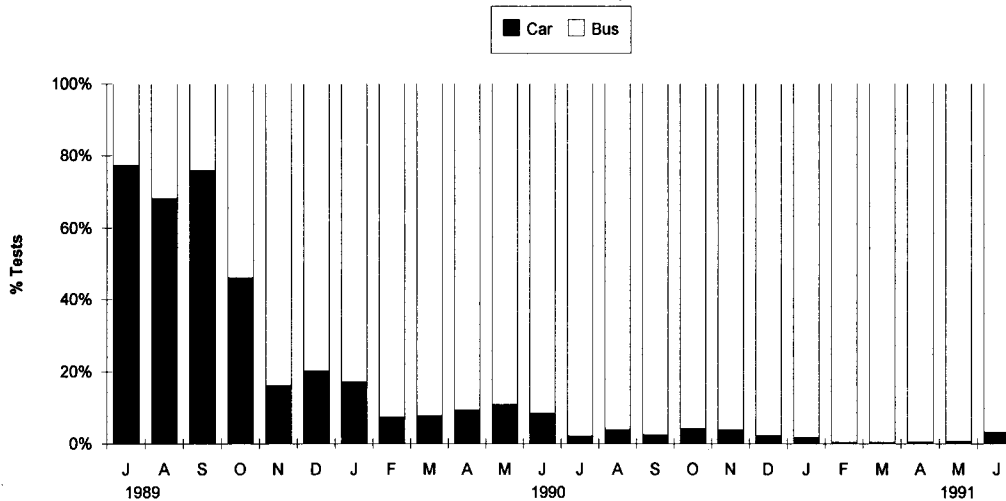
Figure 1
Annual Number of RBT Tests Conducted in Victoria 1977-1991



2.2 Metropolitan and Rural RBT Operations

Buses almost immediately substituted most car-based RBT in all police districts in the metropolitan area, while their introduction in the rural area was much slower and varied across police districts. In the metropolitan area bus-based RBT has been the primary form of RBT operation since November 1989 in terms of both hours of testing and number of tests conducted (Figure 2). In contrast, a minor shift to use of buses was observed between October 1989 and October 1990 in the rural area, with greater use of bus-based RBT after October 1990.

Figure 2
Proportion of Car v. Bus RBT Tests in the Metropolitan Area



In the metropolitan area, the substitution of cars with buses has led to a substantially higher number of RBT tests and gradual, but smaller, increases in the total number of hours of RBT operations and session durations (Figures 3 & 4). The number of sessions conducted remained relatively constant (Figure 5).

Figure 3
Number of RBT Tests per month

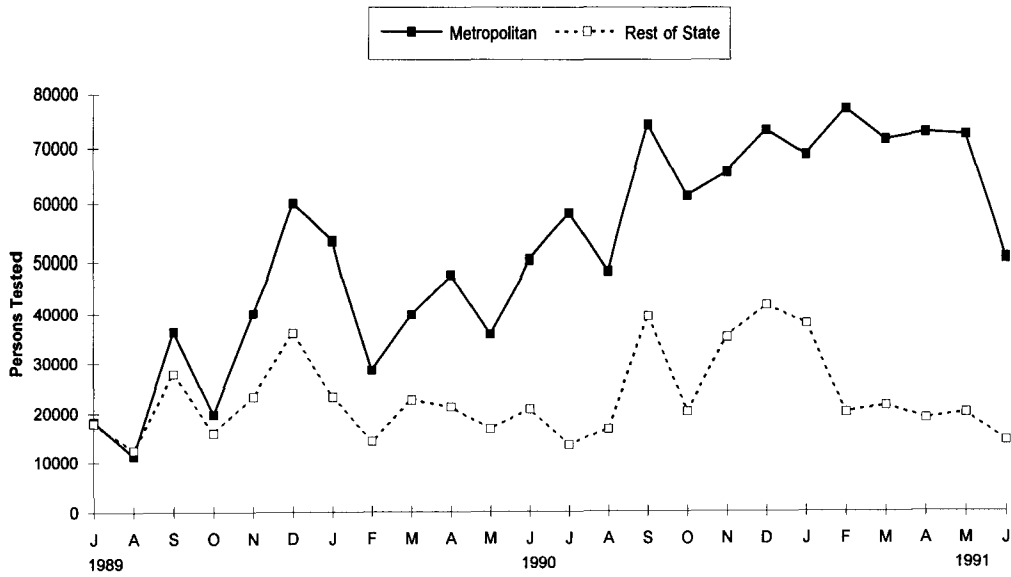


Figure 4
Number of Hours of RBT Testing per month

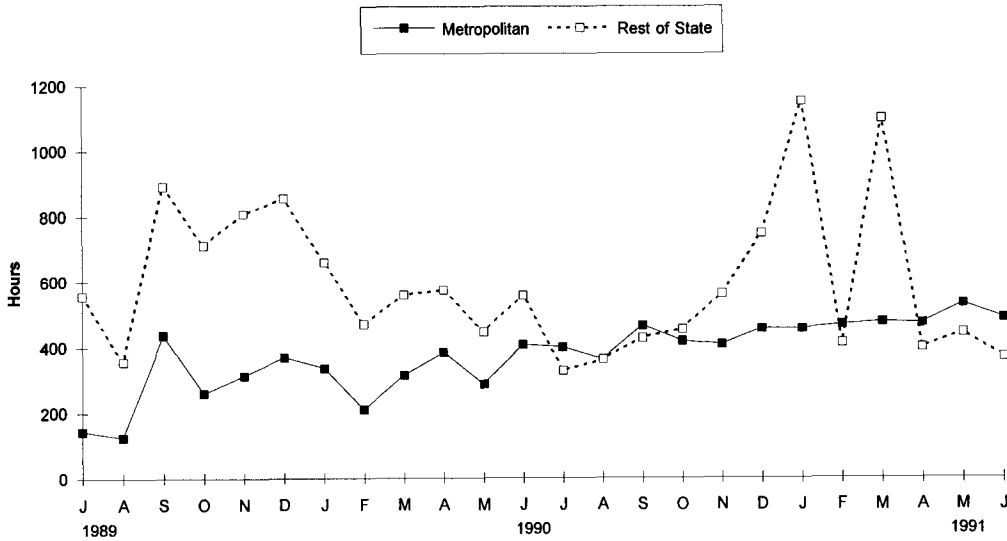
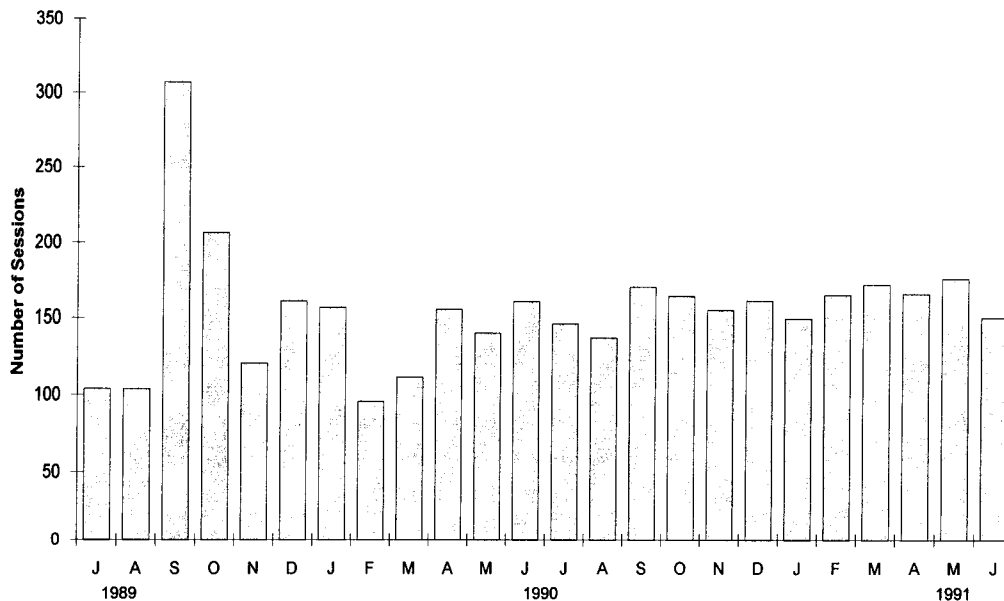


Figure 5
Number of RBT Sessions Conducted in the Metropolitan Area per month



In the rural area, the changes in RBT were much more varied and very different to those in the metropolitan area. Whilst the total number of RBT tests conducted remained relatively constant, the duration of RBT sessions and operating hours decreased throughout 1990 (although increases were observed for the first half of 1991). The number of RBT sessions decreased consistently over time.

2.3 Summary

The change to bus-based operations more than doubled the number of drivers tested per unit time from the passing traffic stream, thus increasing the proportion of drivers tested who approached RBT stations. The initiative also changed the quality of exposure to RBT by the clearly identifiable and highly visible "Booze Bus" designed solely for that purpose. In the metropolitan area there was no change in the number of RBT sessions conducted, and gradual but smaller increases in session hours/duration. In rural Victoria, the number of sessions decreased, whilst session hours dropped mainly throughout 1990.

The 1990 period of the initiative involved the launch of the initiative and publicity, the change-over to the use of buses in enforcement operations, the phased introduction of 13 new buses to replace 4 existing buses, but relatively small increases in hours of RBT operation (in the metropolitan area). The 1991 period represents a more stable period of new bus operations and publicity, and larger increases (relative to 1989) in both hours of RBT operation and tests conducted in the metropolitan area.

3.0 DESCRIPTIVE ANALYSIS OF EVIDENTIAL BREATH TESTS AND CRASH DATA

Evidential breath tests and crash data were analysed to provide an indication of changes and trends in drink driving and serious casualty crashes (defined as crashes in which one or more person(s) is killed or seriously injured).

3.1 Evidential Tests

Despite more than doubling the number of random breath tests there were no significant changes in the number of drivers charged with exceeding 0.0% or 0.05% nor in the characteristics of these offenders over the period from January 1989 to June 1991, apart from a reduction in the proportion of younger drivers charged with exceeding 0.0% through both non-crash and non-fatal crash evidential breath tests. There was some suggestion that there was a decrease in drinking at hotels and increase in drinking at home for crash-involved offenders.

3.2 Fatal BAC Readings

The proportion of drivers and riders killed with BACs between 0.011-0.15% decreased in 1989 and 1990, whilst the proportion of sober drivers and riders killed has correspondingly increased. The proportion of those killed in "high alcohol hours" with BACs between 0.05-0.15% also decreased in 1989 and 1990. The proportion of drivers and riders killed with higher BACs (greater than 0.15%) has remained relatively constant. As a result, this group made up a greater proportion of "drink drivers" killed.

Figure 6
Percentage of Drivers/Riders Killed by BAC Range - Victoria

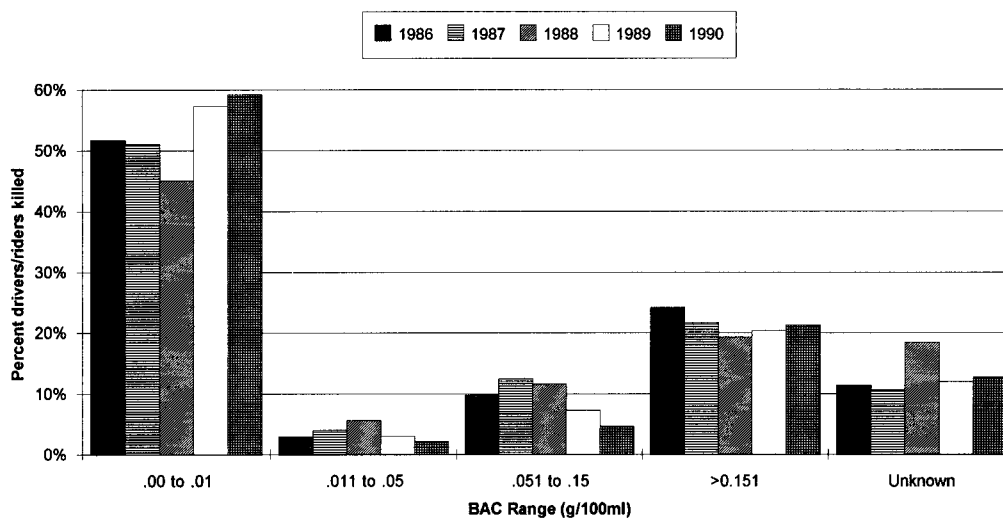
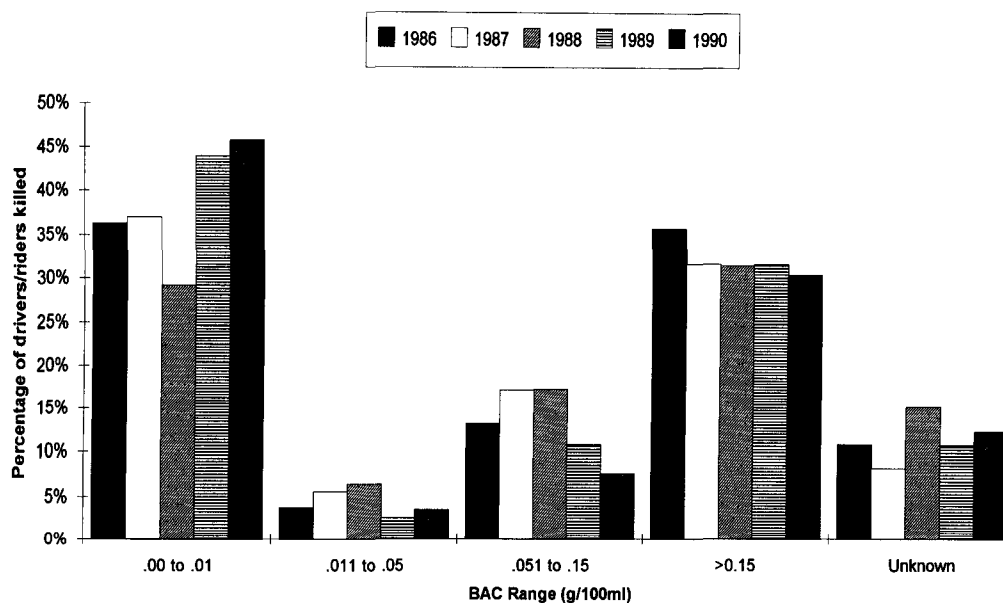


Figure 7
Percentage of Drivers/Riders Killed in High Alcohol Hours by BAC Range - Victoria



3.3 Trends in Crashes

Twelve monthly moving totals of serious casualty crashes in Victoria since 1983 show that crashes began increasing some time in 1986 and continued increasing throughout 1987. Through most of 1988 and early 1989 the total had stabilized and began to decrease steadily from mid 1989. The 12 month moving totals of fatal crashes had increased slightly up to the end of 1989 and since December 1989 there have been dramatic reductions in the number of fatal crashes. This reduction was more pronounced in high alcohol hours. Crashes which occur in "high alcohol hours" of the week refer to those crashes between Monday-Thursday 6pm to 6am Tuesday-Friday, Friday 4pm to 8am Saturday, Saturday 2pm to 10am Sunday, Sunday 4pm to 6am Monday. Low alcohol hours relate to the complementary times of the week.

Serious casualty crashes in high alcohol hours (mainly night-time) provide a powerful criterion because 38% of these crashes have been shown to involve drivers with Blood Alcohol Concentrations (BACs) over 0.05%, while during low alcohol hours the corresponding percentage is 4% (Harrison, 1990). In addition, past experience suggests that RBT can affect other types of high alcohol hour crashes other than those which are alcohol related (Homel, 1981; Cameron & Strang, 1982). Both serious casualty crashes and fatal crashes (which are more likely to involve alcohol) were used as the evaluation criteria for the two studies.

Figure 8
 Serious Casualty Crashes in High and Low Alcohol Times of Week
 (12 Month Moving Totals), December 1983 to December 1990 Victoria

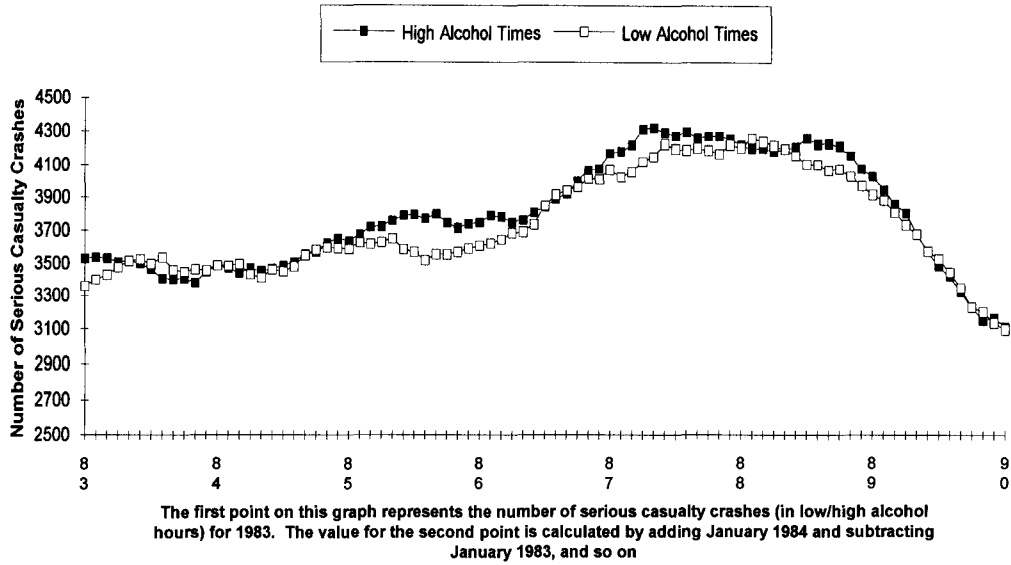
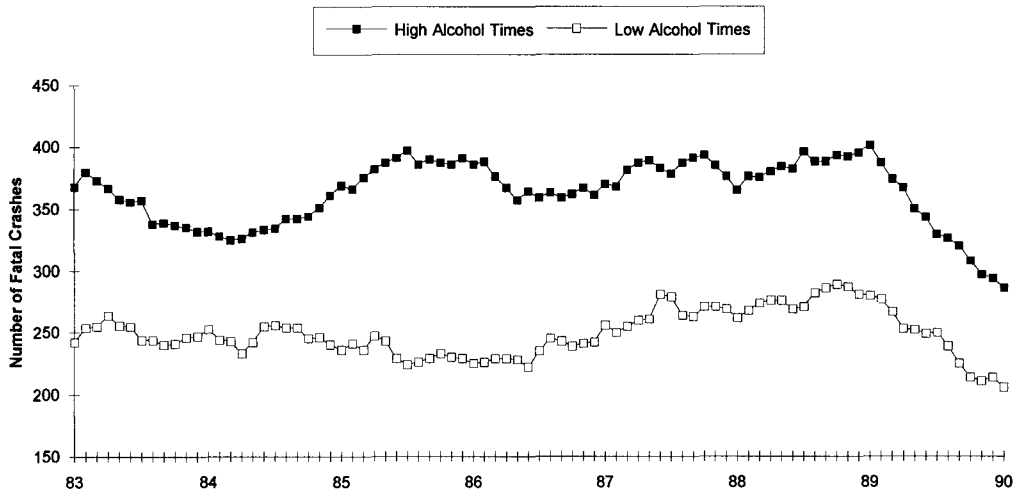


Figure 9
 Fatal Crashes in High Alcohol and Low Alcohol Times of Week
 (12 Month Moving Totals), December 1983 to December 1990 Victoria



4.0 EVALUATION PRINCIPLES

Experimental evaluations provide the most rigorous test of the effectiveness of programs. Through the use of appropriate control (untreated) and treatment groups experimental evaluations ensure that observed effects are attributable to the treatment rather than other extraneous influences. Treatment and control groups are obtained through either random allocation or by matching groupings according to important criteria. Parallel changes in a control group provide an estimate of the changes that would have occurred in the treatment group had the program not been implemented, and hence any additional changes in the treatment group can be ascribed to the treatment.

However, given that in this instance the countermeasure was not implemented according to pre-determined experimental designs (eg. apply RBT and publicity to only a portion of the State), a post hoc or quasi-experimental evaluation had to be used. Suitable comparison groups need to be identified to play the role of the traditional control group for a quasi-experimental evaluation to be undertaken. A good comparison group automatically allows for the effects of extraneous factors, but cannot be a perfect control group, and its adequacy as a control group (ie. reflecting the change that would have occurred in the treatment group if no treatment had been applied) can often be difficult to assess, in turn reducing the certainty of results.

The advantage of the quasi-experimental approach is that the comparison group allows for the effect of 'other factors' without assuming what these factors might be and trying to measure them and account for their effect. Identifying, measuring and accounting for the effect of other important factors directly (defined as statistical control) is difficult to do for complex events such as crashes, which are influenced by many factors and for which all the factors are not yet fully understood.

In evaluating the RBT initiative, two different conceptual approaches were taken. These are described below.

4.1 *Quasi-experimental time series analysis*

The essence of designing an evaluation is to increase the likelihood that measured effects are validly derived and can be attributed to the "treatment", rather than the effect of any other factors. The issue of control (experimental, quasi-experimental and statistical) is central to the achievement of this objective. The first evaluation relied solely on quasi-experimental control for the following reasons:

- full experimental control was not available
- it was considered more appropriate to rely on quasi-experimental control (a "passive" approach) than to actively influence analysis outcomes through the incorporation of statistical controls.

The comparisons undertaken were basically between Melbourne and Sydney, and between two areas of rural Victoria (R1 and R2). The pattern of results across

Melbourne, R1 and R2 was also used to aid interpretation of measured effects and attribution of these to the treatment.

4.2 *Multivariate time series analysis*

In this study, Sydney was used as a comparison group for Melbourne and the "rest of NSW" as a comparison group for the "rest of Victoria" (R1 and R2 combined).

However, unemployment rate was directly taken into account as a covariate because correlational evidence for the relationship between unemployment and fatalities (across all times of the week) had been established. It was also considered that this provided a good proxy measure for changes in high alcohol hour vehicle exposure (which affects crash frequency). There was an indication that total estimated vehicle travel (derived from fuel sales) and unemployment rates in the treatment and comparison groups changed differentially over the intervention period, potentially affecting the estimated effect of the initiative.

The results of the two evaluations are described in the following sections, followed by a comparison of their results.

5.0 QUASI-EXPERIMENTAL TIME SERIES EVALUATION

5.1 *Research design*

A quasi-experimental research design was developed to structure the crash data given that the initiative was not implemented according to a predetermined experimental design. Given the manner in which the RBT initiative was implemented, control (ie. matching 'untreated') areas for comparison with 'treated' areas were not available, as all police districts in the metropolitan area, over all days of the week, were exposed to the new bus-based method. Additionally the introduction of a State-wide Speed Camera Program almost simultaneously, further eliminated the use of low alcohol times as a comparison. Statewide intensive publicity also diminished the differences between 'treated' and 'untreated' areas. The different use of RBT across the State during 1990, was used to most appropriately structure the crash data into treatment and comparison groups.

5.2 *Methods of RBT Operation across the State*

Three different types or methods of RBT operated in different parts of Victoria from late 1989 to the end of 1990:

Metropolitan Melbourne RBT Method (MM)- RBT operations were conducted primarily through bus stations resulting in large increases in the number of drivers tested and gradual increases in hours spent testing;

Rural RBT Method 1 (R1)- In this area (mainly the rural police districts around Melbourne), bus-based RBT was used at low levels whilst car-based RBT continued during this period, decreasing gradually. The number of RBT tests conducted overall

did not change over this time (apart from increased activity in the last quarter of 1990) but there was some decrease in the number of operating hours compared with 1989; ***Rural RBT Method 2 (R2)***- In this area (mainly the rural police districts furthest from Melbourne), bus-based RBT was not obvious until late 1990 and early 1991. There was little change in the number of RBT tests conducted and the number of operating hours, apart for some decrease in both hours and tests in the latter half of 1990. This area was least changed by the new RBT method for the period to late 1990.

5.3 *Statistical Analysis*

After homogenous treatment groups (MM & R1) and comparison groups (Sydney metropolitan (SM) & R2, respectively) were identified, changes in each comparison group are used to account for the changes in crash frequency due to the influence of 'other factors' (for example, abrupt changes in road use) which coincided with the timing of the initiative, for the respective treatment groups. Sydney was used as a comparison group for Melbourne, to avoid locational confounding between urban and rural areas for which there may be different effects of the program.

Statistical analysis was undertaken comparing the relative changes in serious casualty and fatal crashes, during high alcohol hours, for each of the treatment and comparison areas. This involved predicting expected crash numbers for each area, using time series modelling of data between December 1982 and December 1989 (8 full seasonal cycles), and comparing predicted and actual crash frequencies to determine whether there had been changes. The changes at each area were then compared to provide an ***estimated net percent change*** at the treatment areas.

Both exponential and Auto Regressive Integrated Moving Average (ARIMA) forecasting models were developed for each area to provide the best prediction, on the basis of pre-intervention trends and also taking into account seasonal fluctuations and longer term trends in the series, of the incidence of crashes that would have occurred post-intervention. This was compared to the actual number of crashes in the post-intervention period to determine whether there have been changes in each group. Forecasting methods allow predictions up to 12 months ahead, and do not apply a pre-determined framework to the distribution of effects post-intervention.

The forecasts obtained using the two family of time series models were virtually identical, however the ARIMA models provided forecasts with smaller mean square errors and hence narrower prediction limits and therefore were adopted. The ARIMA models were based on 52 week moving totals for each series more appropriately giving forecasts and forecast variances for the 52 weeks of 1990, and eliminating seasonal effects. Thus, using ARIMA models also made it easier to calculate prediction intervals of total target crashes during 1990. A Sensitivity Analysis was also undertaken to ascertain the stability of the predictions by using alternative intervention dates from which to predict. Predictions were found to be stable regardless of the date used around the one selected as best representing the beginning of the initiative (16 December 1989 coinciding with the launch of the initiative and the changeover to buses in the Melbourne metropolitan area), thus providing further confidence regarding the results from the models adopted.

5.4 Results

Each series and the predicted number of crashes and prediction intervals are illustrated in Figures 10 and 11. Results of the statistical analyses are shown in Tables 1 and 2.

Table 1

Estimated percentage changes (and 95% confidence intervals) in high alcohol hour serious casualty crashes and fatal crashes in Melbourne, Sydney, R1 and R2 areas

Crash Series	1990 Actual (O)	1990 Predicted (E)	Percent Change (P)	95% Confidence Interval	Standard Error
MM serious	2128	2275	-6.5%	(-30%, 17%)	0.122
MM fatal	152	227	-33.0%*	(-49%, -17%)	0.081
SM serious	1555	1730	-10.1%	(-22%, 2%)	0.060
SM fatal	178	207	-14.0%	(-37%, 9%)	0.116
R1 serious	580	785	-26.1%*	(-38%, -15%)	0.059
R1 fatal	83	102	-18.6%	(-43%, 6%)	0.125
R2 serious	415	466	-10.9%	(-23%, 2%)	0.064
R2 fatal	51	65	-21.5%	(-55%, 12%)	0.173

*statistically significant at $p < 0.05$ level, two-tailed

MM = Metropolitan Melbourne
SM = Metropolitan Sydney

R1 = Rural RBT Method 1
R2 = Rural RBT Method 2

As can be seen from the standard error terms and 95% confidence interval for the post-intervention percentage changes for each series (Table 1 and Figure 10), the percentage change in Melbourne serious casualty crashes had much wider confidence intervals than that for Sydney (double) reflecting that the expected post-intervention trend for this series was much more difficult to predict. Inspection of the pre-intervention trend shows that this is because of the large variation in trend in the series, changing from a general upward trend in 1988, to a stable trend until mid 1989 when a decreasing trend begins. These changes, particularly in the immediate pre-intervention trend, meant that the model was unable to provide a narrower forecast interval.

Similarly, all models for fatal crashes had wider ranges for predictions, relative to serious casualty crashes, particularly for the Victorian rural areas and R2 (around 2 to 3 times that for serious casualty crashes). This is in part due to the greater variance in fatal crashes than serious casualty crashes.

The results in Table 1 indicate that in all areas and for both crash types there was a reduction in target crashes, but only for Melbourne fatal crashes and Rural 1 serious casualty crashes were the reductions statistically significant (at the 5% level).

Table 2

Estimated net percentage changes, reflecting RBT effect, for Melbourne and R1 high alcohol hour serious casualty and fatal crashes during 1990 & associated 90% confidence intervals and one-tailed level of statistical significance

Crash Series	Percent Change	RBT Effect	Standard Error	90% Confidence Interval	P Value
MM serious	-6.5%	3.6%	13.6%	(-18.7, 25.9)	0.60
MM fatal	-33.0%	-19.0%*	14.1%	(-42.1, 4.1)	0.09
R1 serious	-26.1%	-15.2%**	8.7%	(-29.5, -0.9)	0.04
R1 fatal	-18.6%	-2.9%	21.3%	(-37.8, 32.0)	0.45

***statistically significant at $p < 0.05$ level, one-tailed; *statistically significant at $p < 0.1$ level, one-tailed*

Table 2 shows that there was a statistically significant 19% net reduction in fatal crashes (in high alcohol hours) in Melbourne in 1990 (there is a 9% chance that this reduction is due to chance). There was a statistically significant 15% net reduction in serious casualty crashes (in high alcohol hours) in R1 in 1990 (there is a 4% chance that this reduction is due to chance).

The results from Table 1 demonstrate:

- a large statistically significant reduction in **fatal crashes** (in high alcohol hours) in the Melbourne metropolitan area but not in the rural Victorian areas and the Sydney metropolitan area;
- a large statistically significant reduction in **serious casualty crashes** (in high alcohol hours) in Rural 1 but not in Rural 2, and no statistically significant change in both the Melbourne and Sydney metropolitan areas.

Controlling for location (Table 2), there was evidence of an incremental benefit for:

- the **Melbourne** metropolitan area (relative to Sydney) for **fatal crashes** only
- **Rural 1** (relative to Rural 2) for **serious casualty crashes** only

Again, the large standard errors associated with the estimated percent changes for fatal crashes at both R1 and R2, and particularly the net change (RBT effect) for fatal crashes at R1 (21.3%) should be noted when interpreting these results. Only extremely large changes would be detectable (statistically), making it difficult to determine what the effects were of RBT on fatal crashes at R1.

Figure 10
Actual and predicted weekly frequencies and prediction intervals for Melbourne and Sydney high alcohol hour (HAH) serious casualty crashes and fatal crashes

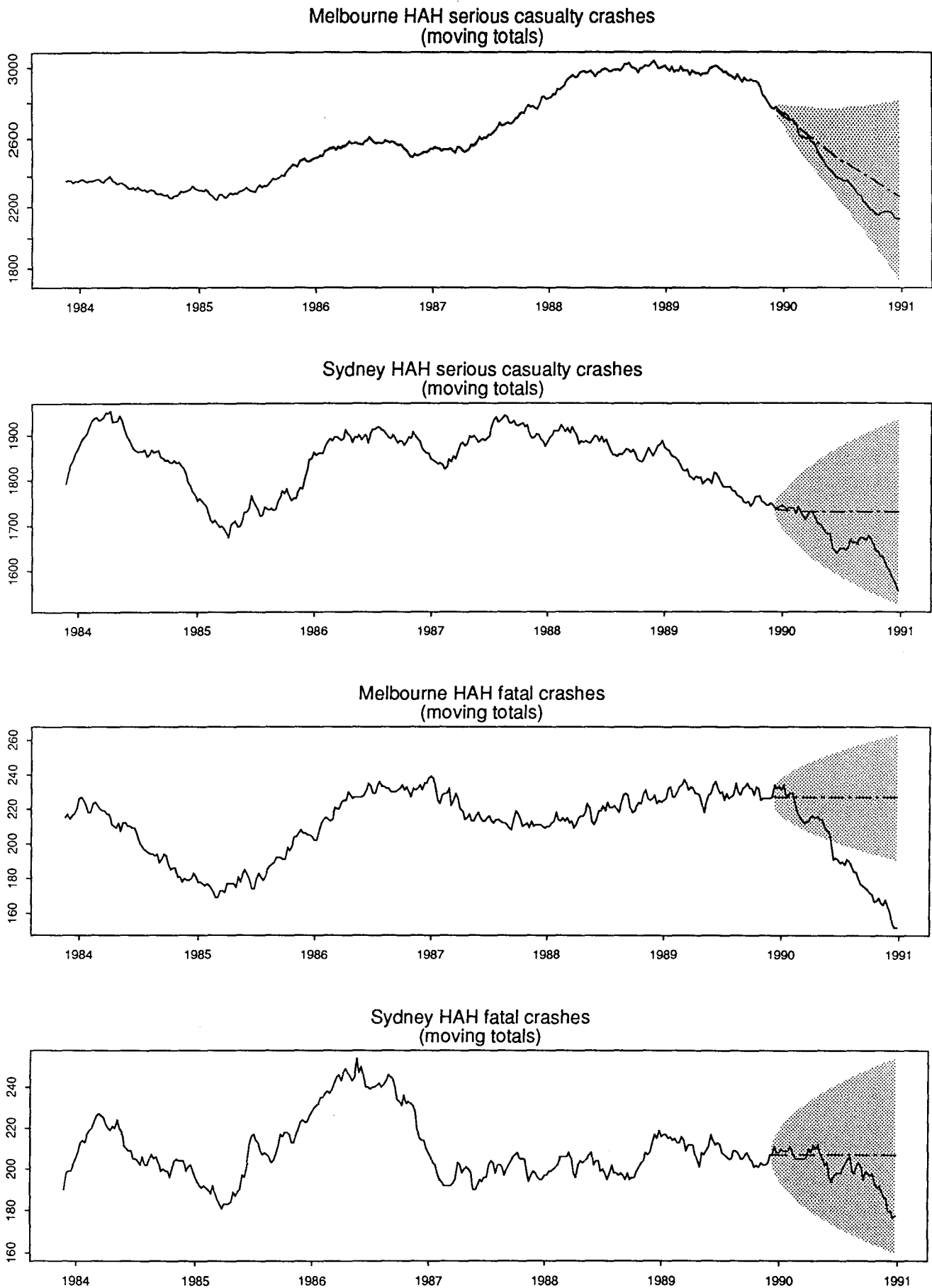
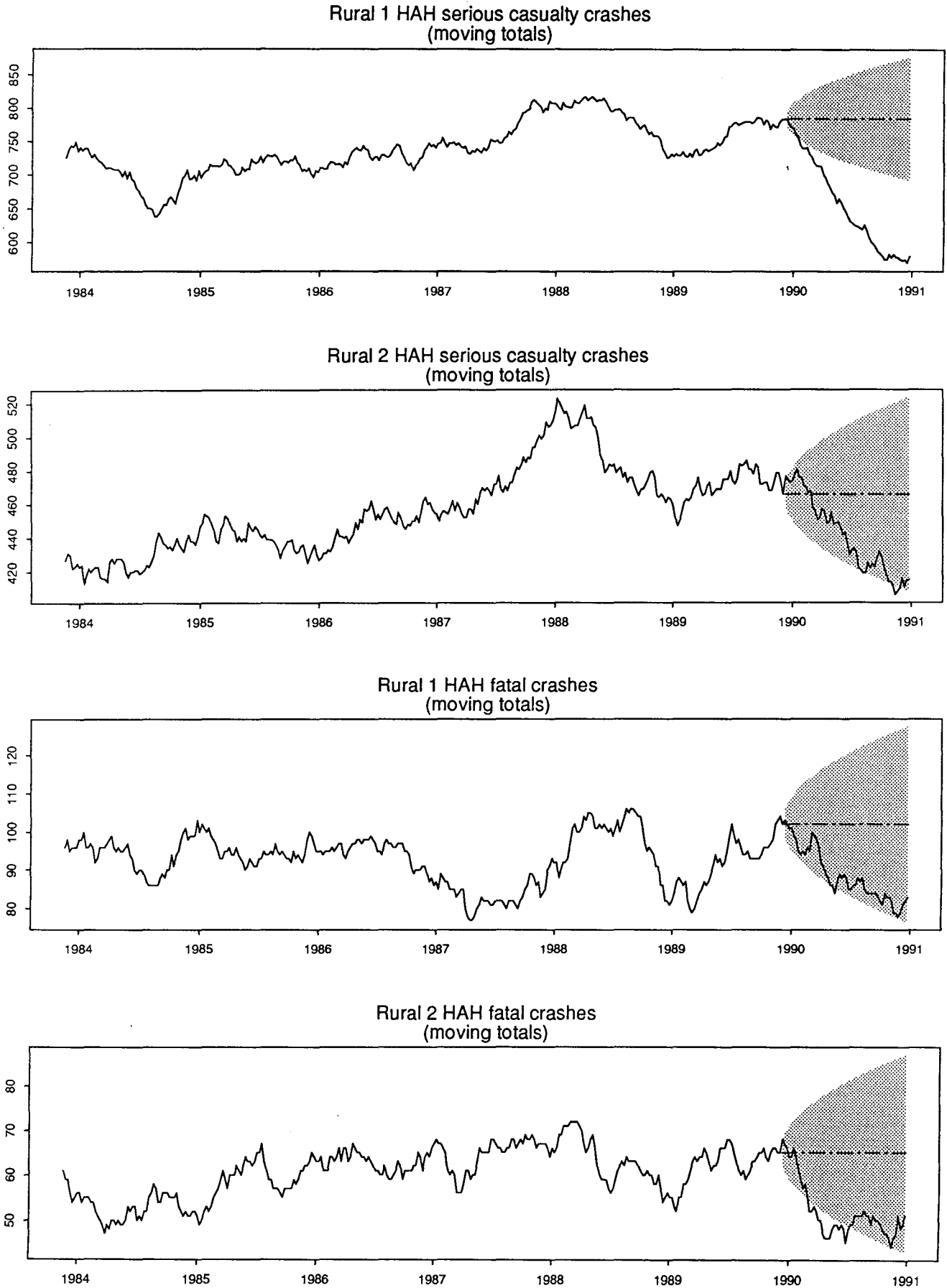


Figure 11
Actual and predicted weekly frequencies and prediction intervals for Rural 1 and Rural 2 high alcohol hour (HAH) serious casualty crashes and fatal crashes



5.5 Conclusions drawn from quasi-experimental evaluation

Melbourne Metropolitan region- On balance it seemed reasonable to conclude that the effects of the RBT initiative in the Melbourne Metropolitan area were restricted primarily to fatal crashes in high alcohol hours. This reduction, 33%, was more than twice that found for the Sydney metropolitan area (14%) for the same period. On the assumption that the reduction in high alcohol hour fatal crashes in Sydney was not due to road safety interventions in that period, and that any "other" factors applied to the same extent in Melbourne as in Sydney, a reduction of the order of 19% in fatal crashes in high alcohol hours in Melbourne could be reasonably attributed to the RBT initiative. No statistically significant change was found in relation to serious casualty crashes, however, the estimated change was associated with a wide prediction interval for this series reflecting the greater difficulty in providing forecasts with greater precision.

Rural 1 region - The greater (statistically significant) reduction in high alcohol hour serious casualty crashes at Rural 1 (26%) compared with Rural 2 (11%) suggests a 15% reduction due to the initiative on these crashes. However, given the imbalance of this pattern compared with that for fatal crashes, and that fatal crashes at Rural 1 have not changed over time, the attribution of the effect on serious casualty crashes to the initiative is more tentative. This is because fatal crashes are more likely to be alcohol related and although it is probable that the presence of police undertaking RBT also affects non-alcohol related crashes, it seems unlikely that it would affect the latter only and not the former. It must be acknowledged however, that the estimated effects for fatal crashes in rural areas are associated with much wider confidence intervals as highlighted previously, and thus the likelihood of being able to detect a statistically significant difference is low for fatal crashes, particularly in R1.

Rural 2 region- The results for Rural comparisons were more difficult to interpret, mainly because there are no truly "untreated" areas. Although the Rural 2 region was the least changed in terms of quantifiable RBT operations, it was exposed to the related publicity and potentially received qualitative changes in treatment. The absence of a comparison area for the Rural 2 region means that the proportion of the non-statistically significant 11% reduction in high alcohol hour serious casualty crashes which is due to the RBT initiative cannot be determined. However, the similarity of serious casualty crash reductions between Rural 2 and both the Sydney and Melbourne metropolitan areas (notwithstanding the confounding of locations with treatments in making this comparison) makes it difficult to ascribe much, if any, of this reduction in Rural 2 to the treatment.

Extraneous factors- Ambient factors in Victoria (eg. speed camera enforcement) have been, as far as possible, controlled for by structuring crash data by time of day periods (crashes in high alcohol hours) which best correspond to the intervention's target and exclude other interventions. For instance, speed camera enforcement has been used mainly in low alcohol hours. To the extent that the effect, if any, of speed camera enforcement generalised to high alcohol hours, the proportional reduction attributed to RBT may be overstated. On balance, the net reduction observed in high alcohol hour crashes noted above has been ascribed to the RBT initiative.

6.0 MULTIVARIATE TIME SERIES EVALUATION

The different patterns in RBT enforcement over time were assessed by testing effects in the 1990 and the 1991 periods separately. The introduction of the initiative differed between metropolitan Melbourne and rural Victoria, with (relatively) smaller, more gradual changes in rural areas. This also indicated that effects for these two parts of the State should be separately evaluated.

Time series modelling of high alcohol hour serious casualty and fatal crashes was undertaken to estimate the change in these crashes relating to the RBT initiative during 1990 and 1991 for the different parts of the State, taking into account changes in unemployment rate and changes in the same crash types in NSW.

6.1 Method

Multivariate time series models of high alcohol hour serious casualty and fatal crashes were developed for Melbourne (treatment area) and Sydney (comparison area), so that the changes beginning from the first month of the initiative could be estimated for each series. Percentage changes in each area could then be contrasted allowing the *net percentage change* in Melbourne to be estimated, ie. estimated percentage changes in target crashes in Melbourne during each of the post-intervention years (1990 and 1991) were adjusted by the parallel estimated percentage changes in Sydney during the same year. The net change provided an estimate of the percentage change in high alcohol hour crashes that is attributable to the RBT initiative. The same process was undertaken for the respective rural areas of Victoria and NSW.

Unemployment rate was used in the models in order to account for different trends in the two States in estimated total vehicle travel and economic activity (especially its influence on night-time travel) over the intervention period. In order to check that unemployment rate was a valid indicator, models were fitted for each State with one using estimated vehicle travel (based on fuel sales) and the other using the unemployment rate. The results obtained were virtually identical regardless of whether estimated travel or unemployment rate was used.

A form of time series modelling known as ARIMA Intervention Analysis was used to estimate effects during 1990, whilst a multiple regression approach was used to estimate effects during 1991. Figures 12-15 show the models fitted for serious casualty crashes in Melbourne, Sydney, rural Victoria and rural NSW over time. For the post-intervention period, two additional trends are shown: the model for crashes if unemployment rate had remained at 1987-1989 levels, and the model for crashes also including the step functions for the intervention. These charts illustrate the models fitted and the differential role of unemployment in the post-intervention period in Melbourne compared with Sydney.



Figure 12
Model of High Alcohol Hour Serious Casualty Crashes in Melbourne

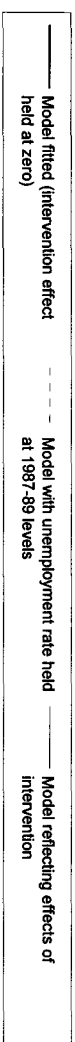
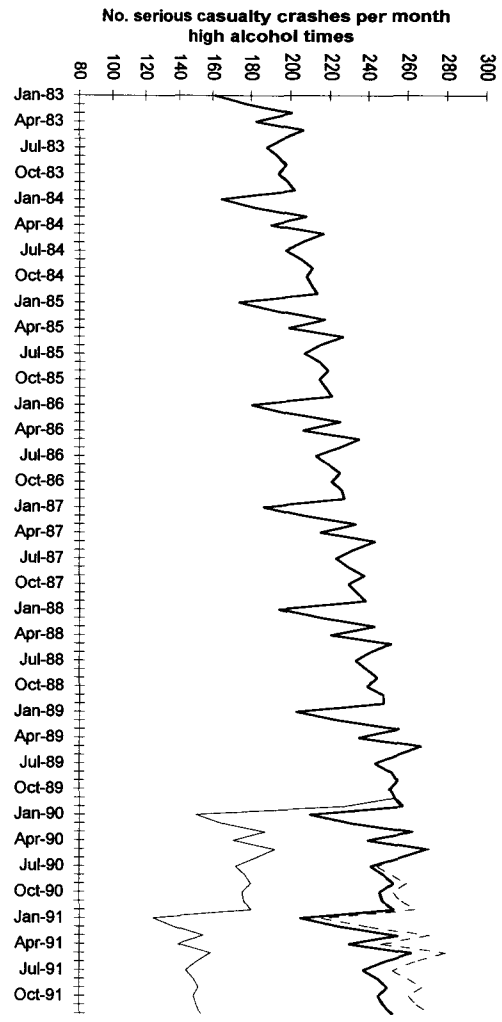


Figure 13
Model of High Alcohol Hour Serious Casualty Crashes in Sydney

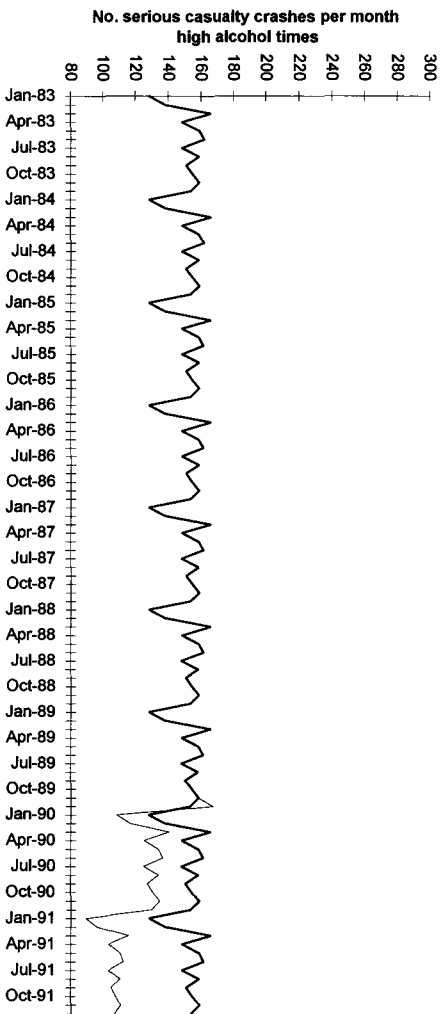


Figure 14
Model of high alcohol hour Serious Casualty Crashes in rural Victoria

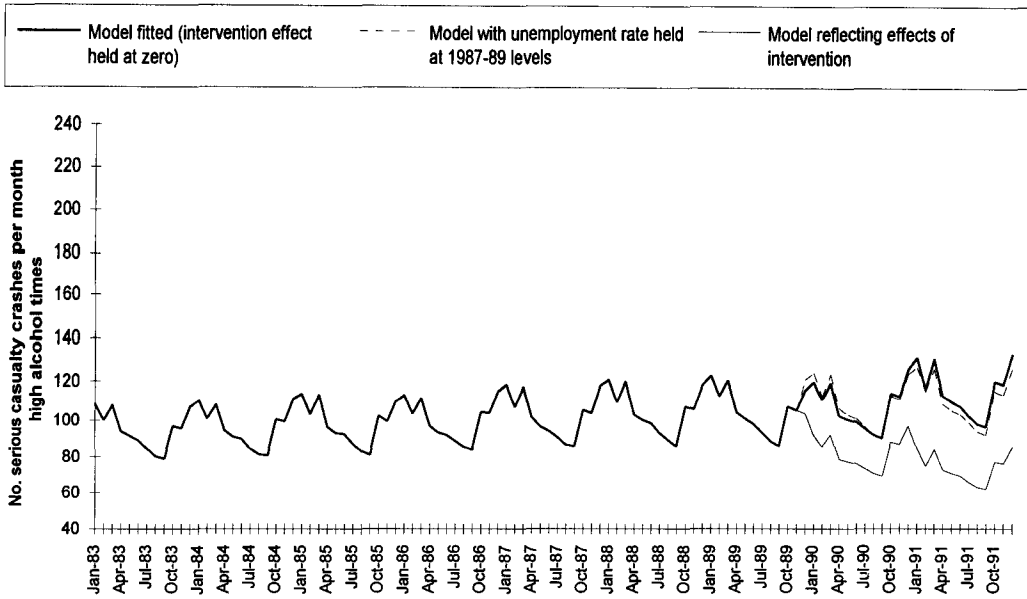
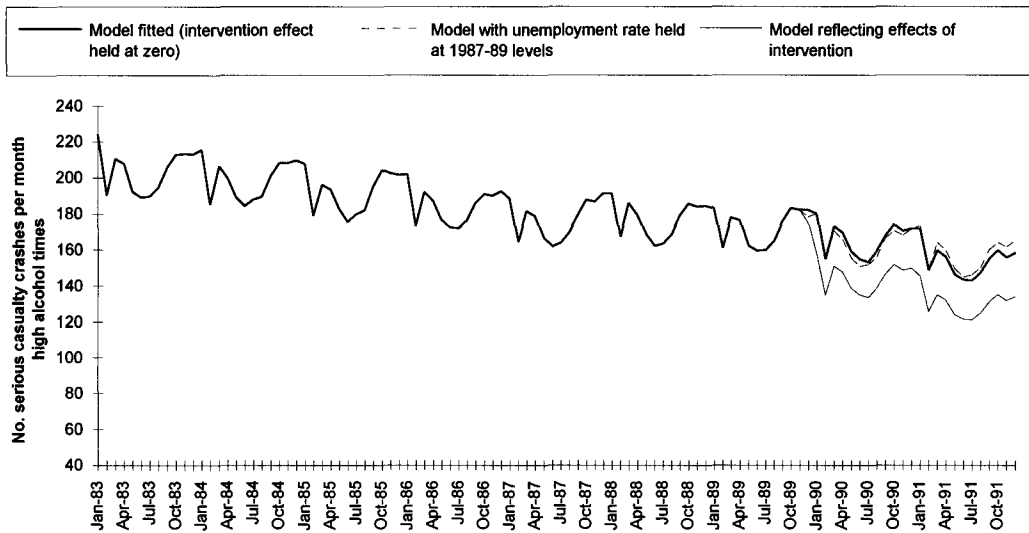


Figure 15
Model of high alcohol hour Serious Casualty Crashes in rural NSW



6.2 Results

Table 3 below shows the estimated changes in high alcohol hour serious casualty crashes for Melbourne and rural Victoria separately during 1990 and 1991.

Table 3

Estimated net percentage changes in high alcohol hour serious casualty crashes in Melbourne and in rural Victoria during 1990 & 1991

Intervention Period	Net change in Melbourne# & 90% confidence interval	Net change in rural Victoria# & 90% confidence interval
1990 (ARIMA model)	-17.9%* (-7.9% to -26.8%)	-12.8%* (-3.7% to -21.1%)
1991 (Regression model)	- 13.4% ns (9.0% to -31.2%)	- 24.3%* (-13.2% to -34.0%)

ONE-TAILED SIGNIFICANCE TESTING FOR NET REDUCTIONS IN MELBOURNE AT 0.05 LEVEL, CORRESPONDING TO 90% CONFIDENCE INTERVALS

* Statistically significant at $p < 0.05$ level ns not significant at the 0.05 level

Using Sydney as a comparison area for Melbourne (after taking into account the different changes in unemployment rate in the two cities), the changes in Sydney were used to estimate the changes that would have occurred in Melbourne had the intervention not taken place. The netted percentage changes show that the initiative was associated with a significant 17.9% reduction in high alcohol hour serious casualty crashes in Melbourne in 1990, but no statistically significant effect in 1991 (non significant 13.4% reduction).

Using rural NSW as a comparison area for rural Victoria (after taking into account the different changes in unemployment in the two rural areas), the changes there were used to estimate the changes that would have occurred in rural Victoria had the intervention not taken place. The netted percentage changes show that the initiative was associated with a significant 12.8% reduction in high alcohol hour serious casualty crashes in 1990 and a significant 24.3% reduction in 1991.

Fatal crashes during high alcohol hours were used as a secondary criterion in this evaluation because of their lower numbers, higher chance variation, and hence reduced sensitivity for measuring the effect of the RBT initiative compared with serious casualty crashes. The results are shown in Table 4 below.

Table 4

Estimated net percentage changes in high alcohol hour fatal crashes in Melbourne and in rural Victoria during 1990 & 1991

Intervention Period	Net change in Melbourne# & 90% confidence interval	Net change in rural Victoria# & 90% confidence interval
1990 (ARIMA model)	-24.2%* (-1.4% to -41.8%)	2.6%ns (32.8% to -20.7%)
1991 (Regression model)	- 3.6%ns (66.4% to -44.1%)	- 1.2%ns (42.0% to -31.3%)

ONE-TAILED SIGNIFICANCE TESTING FOR NET REDUCTIONS IN MELBOURNE AT 0.05 LEVEL, CORRESPONDING TO 90% CONFIDENCE INTERVALS

* Statistically significant at $p < 0.05$ level ns not significant at the 0.05 level

Using Sydney as a comparison area for Melbourne, the netted percentage changes show that there was a statistically significant 24% decrease in high alcohol hour fatal crashes in Melbourne in 1990, but no statistically significant effect in 1991 .

Using rural NSW as a comparison area for rural Victoria, the netted percentage changes show that there was no statistically significant effect of the initiative on high alcohol hour fatal crashes in 1990 or in 1991. The confidence limits were, however, very wide for these estimates which reduces the chances of showing a significant effect.

6.3 Conclusions drawn from multivariate time series evaluation

The findings of the present study indicate that the RBT initiative (in its entirety) resulted in an 18% reduction in high alcohol hour serious casualty crashes and a 24% reduction in high alcohol hour fatal crashes in Melbourne in 1990, but no statistically significant effect during 1991.

In rural Victoria, high alcohol hour serious casualty crashes decreased by 13% in 1990 and by 24% in 1991, whilst there were no statistically significant effects in high alcohol hour fatal crashes in rural Victoria in 1990 nor 1991.

The conclusiveness of these findings depends on the adequacy of unemployment rate as an indicator of changes in travel during high alcohol hours, the appropriateness of NSW as a comparison area to take into account the effects of "other" factors (other than unemployment rate) influential in Victoria during the intervention period, and the assumption of minimal effects of speed camera operations in Victoria during high alcohol hours.

7.0 COMPARISON OF RESULTS FROM THE TWO EVALUATION STUDIES

The results reported by the two methodologies are compared below. Only results for 1990 are shown because the first study considered effects for 1990 only. Rural 1 results from the first study are compared to rural Victoria results reported in the second evaluation.

Table 5

Comparison of results of the two evaluation methodologies - estimates of net effects on fatal and serious casualty crashes (during high alcohol hours) in Melbourne and rural Victoria in 1990

Crashes (in high alcohol hours) in treatment areas	Quasi-experimental time series estimated net % reduction 90% confidence interval (one-tailed 5% significance)	Multivariate time series estimated net % reduction 90% confidence interval (one-tailed 5% significance)
Melbourne serious casualty crashes	3.6% ns (-18.7% to 25.9%)	-17.9%** (-26.8% to -7.9%)
Rural serious casualty crashes	-15.2%** [R1 v. R2] (-29.5% to -0.9%)	-12.8%** [RVIC v. RNSW] (-21.1% to -3.7%)
Melbourne fatal crashes	-19.0%* (-42.1% to 4.1%)	-24.2%** (-41.8% to -1.4%)
Rural fatal crashes	-2.9%ns [R1 v. R2] (-37.8% to 32.0%)	2.6%ns [RVIC v. RNSW] (-20.7% to 32.8%)

*statistically significant at $p < 0.1$; **statistically significant at $p < 0.05$; ns not statistically significant

The different results were obtained using different analysis methods, the first using a forecasting model and no covariates, whilst the second used an intervention analysis (assessing a step reduction with the introduction of the initiative), a multiplicative data structure (natural logarithms taken of the variables in the models) and unemployment rate as a covariate. In addition the rural results for the first method are based on an intra-State comparison whilst the second uses an inter-State comparison area (rural NSW). Thus it is not possible to compare the rural estimates directly.

Disparate measured net effects for Melbourne serious casualty crashes were estimated, as well as vastly different confidence intervals. A closer examination of the two modelling approaches was undertaken in order to explain this difference.

The inclusion of unemployment rate as a covariate in the modelling of the second RBT evaluation, would theoretically seem to be a major difference between the two analysis methods. In order to make the two sets of results more comparable, the data from the second RBT evaluation were reanalysed without the unemployment covariate using multiple regression Intervention Analysis (all data were modelled using both ARIMA Intervention Analysis and multiple regression Intervention Analysis in the second

study, and it was found that the multiple regression analysis had provided similar results to the ARIMA analysis).

All estimates increased slightly when unemployment rate was not directly taken into account suggesting that it accounts for a slightly greater proportion of the change. However, the fact that the estimates only slightly increase suggested that, in 1990 at least, unemployment rate as directly measured in the second study did not account for a large amount of the reduction in high alcohol hour serious casualty and fatal crashes. This is also supported by the similarity of the net estimates from the two different methods (shown in Table 5).

The new results for Melbourne and Sydney from the second study were compared with the estimated changes for Melbourne and Sydney using the first method, as were the net estimates, as shown in Table 6.

Table 6

Comparison of ARIMA forecasting v. multiple regression Intervention Analysis (no covariate) results for Melbourne and Sydney high alcohol hour serious casualty crashes

Crashes (in high alcohol hours) in treatment areas	Quasi-experimental time series (ARIMA forecasting) estimated % reduction	Multivariate time series (multiple regression Intervention Analysis, no covariate) estimated % reduction
% reduction Melbourne serious casualty crashes	-6.5%	-31.1%
% reduction Sydney serious casualty crashes	-10.1%	-15.2%
Estimated net % reduction (reflecting RBT effect) in Melbourne serious casualty crashes	3.6%	-18.7%

The estimated percentage changes shown above revealed that the source of the different estimates pertains to the estimated percentage change for Melbourne serious casualty crashes in (high alcohol hours). The model from the second evaluation estimates a greater percentage decrease in serious casualty crashes in Melbourne than the first.

Closer consideration of the two types of models revealed that whilst the data from the whole period (1983-1989) is used in the forecasting model, it is more responsive to the change in trend in the series prior to the intervention, which began falling in mid 1989. Taking this into account, the predicted number of crashes were directed downward. The modelling in the second approach uses seasonal differencing only, placing equal weight in the trend through the 12 months previous to the intervention.

The change in trend in this crash series made it difficult to predict the estimated change in crashes in the intervention period for this area. Depending on the importance given to this new trend in the modelling process, different expected values are obtained, leading to vastly different net estimates of change. The change in trend in 1989 is complex changing direction prior to the implementation of the initiative. Whether this was to become a long-term trend cannot be determined. However, this change in the series needs to be considered when interpreting results of evaluations such as these.

8.0 CONCLUSIONS

Two different evaluation methods and statistical methodologies were used to evaluate the impact of RBT on severe road crashes in high alcohol hours of the week during 1990. The second evaluation also estimated effects during 1991.

Findings for 1990

The quasi-experimental time series analysis found:

- a 19% reduction in fatal crashes (in high alcohol times of the week) in Melbourne due to the initiative, but no change in serious casualty crashes
- a 15% reduction in serious casualty crashes (in high alcohol hours) in the Rural 1 area (mainly the rural area around Melbourne), but no change in fatal crashes; a more tentative attribution of this effect to the initiative was made given the pattern of results.

The multivariate time series analysis found:

- a 24% reduction in fatal crashes and an 18% reduction in serious casualty crashes (in high alcohol hours) in Melbourne due to the initiative
- a 13% reduction in serious casualty crashes (in high alcohol hours) in rural Victoria ascribed to the initiative, but no change in fatal crashes.

The most significant finding from these studies is that the initiative reduced fatal crashes (in high alcohol hours) in Melbourne by around 19-24% relative to what was expected. This significant drop in high alcohol hour fatal crashes as measured by both studies is the strongest evidence of the effectiveness of the program, given that:

- high alcohol hour fatal crashes are more likely to be alcohol related, and
- large statistically significant reductions were found even though the smaller number and greater fluctuation of fatal crashes make it more difficult to estimate changes.

The first study found a 15% reduction in serious casualty crashes in the rural areas around Melbourne relative to the other rural areas in Victoria (where the RBT initiative

was expected to have had minimal effect). The second study found a 13% reduction in serious casualty crashes in the whole of rural Victoria relative to rural NSW (where no substantive change in RBT activity occurred during 1990). Both studies found no change in the corresponding rural fatal crashes however, which are considered to be more alcohol related (than serious casualty crashes) and thus likely to be affected by the RBT initiative. It is conceivable that reduced statistical sensitivity for measuring changes in rural fatal crashes (due to smaller numbers) means that an effect is difficult to detect. The absence of evidence for an effect on fatal crashes but evidence for a significant effect on serious casualty crashes provides tentative evidence of an effect of the RBT initiative in rural Victoria.

The effect on Melbourne serious casualty crashes was more difficult to estimate, given that a new decreasing trend in these crashes emerged shortly before the intervention. The choice of the appropriate model to represent the expected post-intervention trend, and hence estimated change, differed between the studies. The first study, using an estimate which emphasised the new road safety trend prior to the intervention, finds no statistically significant evidence that the RBT initiative had an effect over and above that which would have occurred if the pre-intervention trend had continued downward. It should be noted however, that this finding is also in part due to the wide confidence interval (-18.7% to 25.9%) in which the estimate lies. In contrast, the second study adopted a model which basically placed equal weight on the trend throughout the previous twelve month pre-intervention period and suggests that RBT reduced serious casualty crashes in Melbourne by between 8 and 27%.

Findings for 1991

The second evaluation also attempted to assess the effect of the initiative on these crashes in 1991. The results suggested that there was a statistically significant reduction in serious casualty crashes (in high alcohol hours) in rural Victoria only, and no change in fatal crashes (in high alcohol hours) in either Melbourne or the rural area. It must be noted however, that the confidence limits were very wide for fatal crash estimates in this period which reduces the chance of showing a significant effect and providing precise estimates. The findings for the 1991 period are also less conclusive because other (new or changing) factors may mask or weaken the effects further away in time from the beginning of the intervention.

REFERENCES

Cameron, M.H., Cavallo, A., & Sullivan, G. 1992, *Evaluation of the Random Breath Testing Initiative in Victoria 1989-1991. Multivariate time series approach*, Report No. 38, Monash University Accident Research Centre, Clayton, Victoria

Cameron, M.H., & Strang, P.M. 1982, 'Effect of intensified Random Breath Testing in Melbourne during 1978 and 1979', *Proceedings Eighth International Conference on Alcohol, Drugs and Traffic Safety*, Stockholm, Sweden

Drummond, A.E., Sullivan, G. & Cavallo A. 1992, *Evaluation of a Random Breath Testing Initiative in Victoria 1989-1990. Quasi-experimental time series approach*, Report No. 37, Monash University Accident Research Centre, Clayton, Victoria

Harrison, W.A. 1990, Update of alcohol times as a surrogate measure of alcohol-involvement in accidents, Research Note, Monash University Accident Research Centre, Clayton, Victoria

Homel, R.J. 1981, 'Penalties and the drink driver: A study of one thousand offenders', *Australian and New Zealand Journal of Criminology*, 14, pp 225-241