

**THE INTERACTION BETWEEN SPEED CAMERA
ENFORCEMENT AND SPEED-RELATED MASS
MEDIA PUBLICITY IN VICTORIA**

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The interaction between speed camera enforcement and speed-related mass media publicity in Victoria

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Abstract:

The objective of this study was to measure the presence of any interaction between the effect of mobile covert speed camera enforcement and the effect of intensive mass media road safety publicity with speed-related themes. Previous research had shown the individual effect of each of these powerful road safety programs in Victoria, but had not been able to conclusively assess their interaction effect.

During 1999, the Victoria Police varied the levels of speed camera activity substantially in four Melbourne police districts according to a systematic plan. Camera hours were increased or reduced by 50% or 100% in respective districts for a month at a time, during two separate months when speed-related mass media advertising was present and during two months when it was absent. Other Melbourne police districts remained unchanged. Monthly frequencies of casualty crashes, and their severe injury outcome, in each district during 1996-2000 were analysed using Poisson Regression Modelling and Logistic Regression, respectively, to test statistically the effects of the enforcement, publicity and their interaction. In these analyses, the enforcement was represented by five levels of speeding tickets emanating from camera activity during the previous month in the same district, and the publicity by a measure of retained awareness of past and current television advertising intensities.

Reductions in crash frequency were associated monotonically with increasing levels of speed camera ticketing, and there was a statistically significant 41% reduction in fatal crash outcome associated with very high camera activity. High publicity awareness was associated with 12% reduction in crash frequency, but publicity appeared to be unrelated to crash severity. The interaction between the enforcement and publicity was not statistically significant. When two styles of speed-related publicity were analysed separately, the above results were seen to be due to emotive-style rather than enforcement-style advertising.

It was concluded that there was no evidence of an interaction between the effects of speed camera ticketing and speed-related publicity awareness on the frequency of casualty crashes. The effect of speed-related publicity during 1996-2000 was due to advertising with emotive styles.

This research questions strategic principles suggesting that speed camera enforcement and speed-related mass media publicity should operate together to produce maximum effect. However, the study considered changes in speed camera hours of only one month duration. Longer periods of increased speed camera activity may produce greater effects and different interactions with mass media publicity.

Key Words:

(IRRD except when marked*)

Speed, speed camera, enforcement, publicity, advertising, crashes, injury, analysis.

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PREFACE

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The views expressed in this report are those of the authors and are not necessarily those of any of the persons acknowledged above.

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EXECUTIVE SUMMARY

Background

The Transport Accident Commission and the Victoria Police work together to ensure that advertising campaigns and enforcement programs are coordinated, often with enforcement and advertising programs targeting similar high-risk behaviours. In the speed domain, the combined effect of enforcement and publicity may be simply additive, or potentially synergistic where the combined effect may be larger than expected given the effect of either program on its own.

It was considered important to understand how speed camera enforcement and speed-related publicity interact, specifically in relation to their effect on the risk of casualty crashes and the injury severity of the crash outcomes. The study also aimed to determine whether varying the levels and co-presentation of publicity and enforcement resulted in a change in perception of the level of speed enforcement and TAC advertising, and whether there was a change in self reported driving behaviour and perceived risk of being caught when speeding.

Previous research conducted by MUARC indicates that the speed camera program conducted by the Police and the road safety publicity program conducted by the TAC are individually linked to reductions in crashes, however, little is understood about the interaction between these two programs.

During 1999, speed camera operations were planned to increase in two Melbourne Police Districts, by either 50% or 100% for a month at a time, during two selected months when TAC speed-related publicity was present and two months when it was absent. One of this project's objectives was to examine the effects on crashes in the two Districts, and also the effects in Districts in which camera operations were reduced, since this had also occurred. In addition, the project also included a component that surveyed drivers' perceptions and reported driver behaviour in response to the increased speed enforcement and the related publicity.

Crash Analysis

A preliminary analysis of the crash data was undertaken to examine the direct effects of the changed levels of speed camera hours, during the presence or absence of speed-related publicity, in the Districts and during the months in 1999 when these changes occurred. The preliminary analysis did not hypothesise nor examine any delayed or residual effects of the enforcement or publicity. The preliminary analysis was also limited in that only the months when speed camera enforcement conditions had been changed were considered, i.e. only crashes during April, June, August and November, thereby omitting the other months of the year. This analysis ignored substantial crash data that would increase the statistical power of the tests, particularly in relation to measuring the publicity effects.

The principal crash analysis took into account crash data from all of the months of the period 1996-2000, thus providing a more sensitive test of the presence of enforcement and publicity effects and their interaction. This analysis also included seasonality and year-level components, thereby offering a better explanation of the crash variations and increasing the sensitivity of the tests. The analysis represented the enforcement impact level by the number of speeding Traffic Infringement Notices (TINs) from offences detected in the same District during the previous month. It represented the advertising impact level by the Adstock of television TARPs (Target Audience Rating Points) in previous weeks. Adstock is a measure of retained awareness of past and current levels of TARPs, based on an exponential decay function (using a half-life of 5

weeks). The influence of TAC advertising (measured by Adstock) was considered in three different ways, namely:

- speed-related advertising (all styles)
- speed-related enforcement-style advertising
- speed-related emotive-style advertising.

The analysis was designed to be conservative, making as few assumptions about the relationships between crash outcomes and the explanatory factors as possible, especially the functional forms of the relationships. The aim was to develop models of monthly casualty crash frequencies and monthly crash severity levels for each Melbourne Police District as functions of the level of speed camera enforcement and the level of speed-related TAC advertising achieved per month, and the interaction between these two input factors. By doing this, the statistical significance of the interaction, and each of the main factors, was tested. Two statistical techniques belonging to the Generalised Linear Modelling family were used to analyse the effect of the enforcement and advertising on crash outcomes during 1996-2000. The first was Poisson Regression Modelling, to determine the effect on casualty crash frequency, and the second was Logistic Regression, to determine the effect on the severity of the crashes.

Surveys of Driver Perceptions and Reported Behaviour

Telephone surveys of drivers' awareness of the enforcement increases and publicity presence were conducted in each of the Police Districts in which speed camera activity had been increased in 1999, during the month of increase. There were five survey waves, each conducted over five to eight working days. A survey conducted in February (prior to the first enforcement period) acted as a baseline comparison to allow measurement of the relative effects on the perceived risk of detection of the increased enforcement in the context of the presence or absence of publicity relating to speeding. The surveys were conducted at the end of each relevant month to ensure that the enforcement and publicity had an opportunity to be observed.

The surveys of driver perception and self-reported behaviour were analysed and reported before information had been obtained on the actual enforcement and publicity levels and before any crash analysis had been conducted. The survey analysis had assumed that the effects of the increased enforcement and presence of speed-related publicity could be observed in surveys conducted at the end of months in which these changes occurred. Subsequently available data and reconsideration of likely effect mechanisms cast doubt on these expectations. The timing of the surveys was such that drivers were unlikely to have perceived the increase in speed camera activity, by either the receipt of one or more speeding TINs or knowledge of other drivers who had. The covert nature of speed camera operations would have minimised the perception through direct observation. For related reasons, the surveys were unable to provide evidence of the presence or absence of an interaction between the effects of the enforcement increase and the publicity presence. The survey results were considered inconclusive regarding the presence or absence of interaction effects. However, the survey results were conclusive about the effect of the speed-related publicity on the ratings of the perceived risk of detection for speeding.

Results and Conclusions

This study of the interaction of the effects of mobile covert speed camera enforcement and intensive speed-related mass media publicity in Victoria during 1996-2000 found the following results and reached the following conclusions:

1. There was no evidence of an interaction in the effects of the enforcement and the publicity on casualty crash frequency.

2. The number of speeding tickets detected by speed cameras in Melbourne Police Districts influenced the casualty crash frequency in the same district during the following month. Casualty crashes were reduced by 3.0% following months with very high levels of speeding tickets (more than 30% greater than average) and increased by 6.8% following months with very low levels of speeding tickets (less than 30% lower than average).
3. The risk of fatal outcome of the casualty crashes was also related to the number of speeding tickets detected in the district during the previous month. The fatality risk was reduced by 41% following months with very high levels of speeding tickets and increased by 44% following months with very low levels of speeding tickets.
4. High levels of awareness of TAC speed-related publicity with emotive styles produced casualty crash reductions in Melbourne during the months in which it occurred. Casualty crashes were reduced by 12-13% when awareness, measured by the Adstock of television advertising levels, of emotive-style speed-related publicity exceeded 500 Adstock units, compared with effects during lower levels of awareness of the publicity.
5. There was no evidence of an effect of the emotive-style speed-related publicity on the injury severity outcome of the casualty crashes.
6. Drivers' perceptions of the risk of detection when speeding was increased by high levels of awareness of the speed-related publicity, compared with the perception when the awareness was at medium levels.

The study also reached the following tentative conclusions:

7. There was an interaction effect on fatal casualty crash outcome when there were very high levels of speeding tickets in the previous month and high levels of awareness of enforcement-style speed-related publicity. The reduction in risk of fatal outcome was greater than expected from effects estimated when the enforcement and publicity operated alone at these levels.
8. There was no evidence that awareness of the speed-related publicity with enforcement styles contributed to casualty crash reductions during 1996-2000. This was not inconsistent with the apparent interaction of this type of publicity with the speed camera enforcement in terms of the effect on the severity outcome of casualty crashes (conclusion 7 above).

This study is limited in its ability to generalise to all circumstances of speed camera operations in conjunction with speed-related publicity because of the short (one-month) period during which speed camera hours were increased (and decreased) in selected Police Districts during 1999. The 1999 extreme variations in enforcement activity played an important role in the sensitivity of the crash analysis (though it should be noted that there were other months during 1996-2000 when TINs detected by speed cameras achieved very high and very low levels in individual Districts, thus also contributing to the sensitivity of the analysis).

It is possible that, with longer periods of change in speed camera levels, drivers may have developed stronger perceptions of the increased enforcement through personal experience of receiving TINs, knowledge of other drivers who had, and perhaps even direct observation of camera operations. A longer period of change may have led to stronger effects of the presence (or absence) of the enforcement on speed behaviour and hence on crashes. The interaction of these enforcement changes with speed-related publicity may also have been different, and the interaction may have been related to the style of publicity in different ways.

1 INTRODUCTION

Excessive speed has long been recognised as a major factor in road crashes, and has led to extensive research into the factors which contribute to speeding behaviour (Fildes & Lee, 1993; French, West, Elander, & Wilding, 1993; Gregersen & Bjurulf, 1996; Harrison, Fitzgerald, Pronk, & Fildes, 1998). Speed plays a substantial role in both accident severity and accident causation.

There is a clear relationship between speed and accident severity. The energy expended at the time of impact is a function of the mass of the vehicle multiplied by the velocity squared, thus slight increases in speed lead to a much greater increase in the kinetic energy to be dissipated in a crash. Therefore the greater the speed of the vehicle, the greater the likelihood of injury, severe injury or death (Cowley, 1987).

The link between accident causation and excessive speed is not as clear, although speed has been shown to play a contributory role in a percentage of accidents. Cooper (1997) reported that drivers who had committed 'excessive speed' violations, as opposed to exceeding the speed limit violations, were found to have twice the overall crash rate of drivers who exceeded limit, and these drivers were twice as likely to have unsafe speed associated with their crash involvement. An extensive review of the literature concluded that excessive speed was a factor in between 12% and 16% of all motor vehicle accidents (Fildes & Lee, 1993).

There are many factors which have been identified as contributing to speed choice, including both internal person-based factors and external environmental factors (Harrison et al., 1998). A variety of countermeasures have been developed, including environmental traffic-management devices, punishment by way of fines, and changing community attitudes towards speed through mass publicity campaigns. Monash University Accident Research Centre (MUARC) has evaluated many of these countermeasures (Newstead, Cameron, Gantzer, & Vulcan, 1995; Newstead, Cameron, & Narayan, 1998), including the Transport Accident Commission (TAC) road safety publicity campaigns, and various forms of enforcement activity such as Random Breath Testing (RBT) and speed camera use. There is good evidence that a number of factors (including various enforcement programs and public education programs) have contributed to the reduction of casualty crashes in Victoria.

The Transport Accident Commission and the Victoria Police work together to ensure that advertising campaigns and enforcement programs are coordinated, often with enforcement and advertising programs targeting similar high-risk behaviours. In the speed domain, the combined effect of enforcement and publicity may be simply additive, or potentially synergistic where the combined effect may be larger than expected given the effect of either program on its own.

It was considered important to understand how speed camera enforcement and speed-related publicity interact, specifically in relation to their effect on the risk of casualty crashes and the injury severity of the crash outcomes. The project also aimed to determine whether varying the levels and co-presentation of publicity and enforcement resulted in a change in perception of the level of speed enforcement and TAC advertising, and whether there was a change in self reported driving behaviour and perceived risk of being caught when speeding.

2 LITERATURE REVIEW¹

2.1 SPEEDING AND ENFORCEMENT

There has been a number of enforcement countermeasures implemented in Victoria in the last decade. Methods of enforcement include random breath testing (RBT) using "booze buses", speed cameras and special enforcement campaigns (Newstead et al., 1995). Mobile moving mode radar units for speed enforcement were introduced in August 1994 (Diamantopoulou, Cameron, & Shtifelman, 1998) and in October 1997 every police car was supplied with breath testing equipment so that drivers stopped for an offence could be breath tested (Cameron, Diamantopoulou, Mullan, Dyte, & Gantzer, 1997).

There is clear evidence that enforcement in general has an impact on driving speed (de Waard & Rooijers, 1994), and there is evidence that the method of enforcement is an important factor. Highly visible enforcement strategies act to remind road users that enforcement is present and potentially increases both the actual and the perceived risk of detection (Fildes & Lee, 1993). Non-visible enforcement acts to increase road user's sense of uncertainty and to prevent them from adapting their speeding behaviour at specific times and locations when speeding enforcement is clearly being carried out (Ostvik & Elvik, 1990). Stationary enforcement, such as a visible marked Police car, has a direct and local effect on traffic speed. This has been termed a distance halo effect and generally this effect has been found to exist for a few kilometres around the enforcement site (Zaal, 1994). Barnes (1984) found that many speeding drivers reduced their speed two kilometres before reaching the enforcement site, and that the effect lasted for about four to six kilometres past the enforcement site. Hauer, Ahlin and Bowser (1982) suggest that the downstream distance-halo effect is halved for every 900m from the site of visible, uniformed enforcement. The time halo effect has also been investigated and it was found that following six days of enforcement, the duration of the time halo for both radar and marked police car was of the order of ten days (Nilsson & Sjogren, 1981). Diamantopoulou et al (1998) reported that mobile speed enforcement (Moving Mode Radar) had little effect on casualty crashes beyond four days after the enforcement was present, in rural areas.

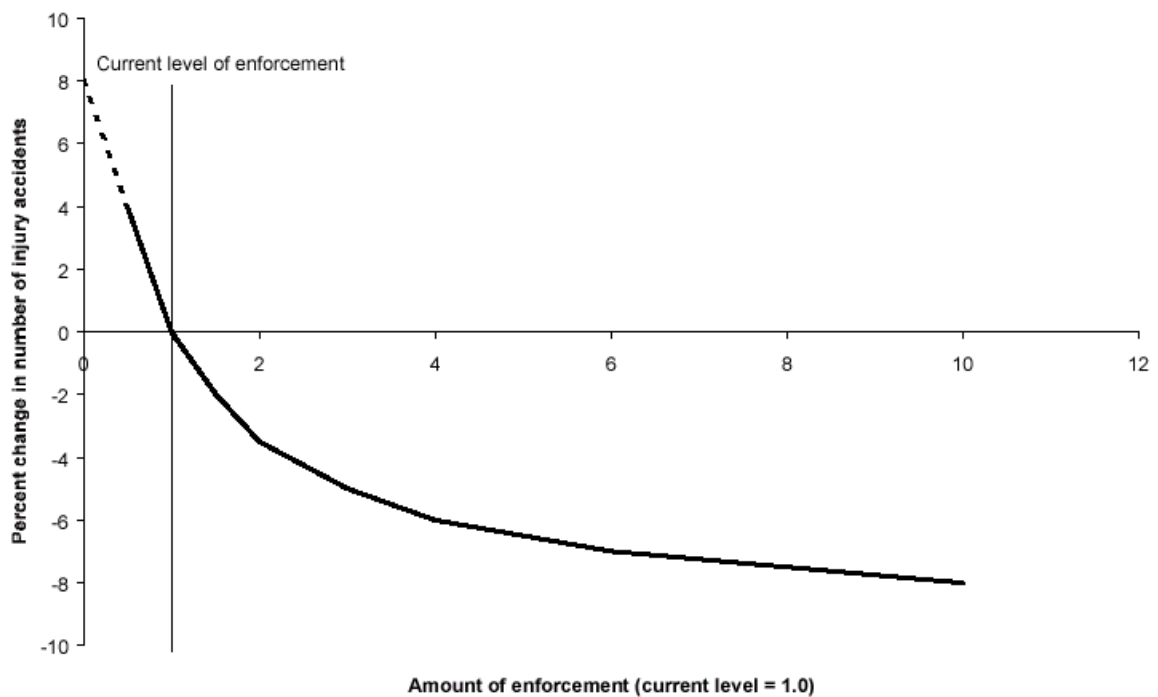
In order to be effective, enforcement probably needs to increase the perceived risk of detection by maintaining a certain level of objective probability of detection (Shinar & McKnight, 1985). This has been supported by Rothengatter (1988), who found that increasing apparent enforcement without changing the actual levels of objective enforcement does not influence speed choice, whereas an actual increase in enforcement does have the effect of reducing speeds. Thus, the perceived level of risk is increased in cases where the objective level of apprehension is increased. Generally, marked police cars or on-view stopping have the greatest impact on drivers' speed.

A review of the literature investigating the relationship between real changes in visible speed enforcement and the perceived risk of being caught had shown that enforcement must be increased by a significant degree before changes in perception of enforcement occur (Ostvik & Elvik, 1990; Bjørnskau & Elvik, 1992). It was reported that increasing enforcement on a given road by less than three times does not have an impact on subjective risk of detection. A five fold increase in enforcement has been found to increase the subjective risk of detection, and subsequently to result in a reduction in the percentage of offenders and a reduction in crashes by 20-30% (Ostvik & Elvik, 1990).

¹ This review was drafted by Emma Fitzgerald while a member of staff of the Monash University Accident Research Centre. The review has been modified and extended by the authors of this report.

A more recent review, of both manual and automatic enforcement techniques, does not support the existence of marked threshold effects (Elvik 2001). The relationship between the amount of enforcement and the level of road safety appears to be quite smooth, with no sharp discontinuities. Elvik reviewed a large number of studies of the effects of varied levels of traffic enforcement on casualty crashes and concluded that the relationship is of the form shown in Figure 2.1. Some forms of enforcement have more powerful effects than others, but in every case the relationship with crash reductions is not linear. Because of this, there is a level of enforcement activity where the additional saving in crashes may not be worth the additional cost of extra enforcement.

Figure 2.1: General relationship between traffic enforcement and crashes identified by Elvik (2001)



Mobile, covert speed camera operations have made a major contribution to the reduction in serious casualty crashes in Victoria, with an estimated percentage reduction of 10-11% each year (Newstead et al., 1998), although the extent to which an increase in enforcement might impact on drivers' perceptions of enforcement levels, and the mechanisms by which enforcement influences speed-related decisions and crashes are uncertain.

2.2 EFFECT OF PUBLICITY ON SPEED AND CRASHES

The Transport Accident Commission launched a mass media road safety advertising campaign in December 1989 in Victoria. Since this time there have been about fifty different media campaigns launched, each under a general theme, for example drink-driving, speed, concentration and use of restraints (Cameron & Newstead, 1996). The TAC have adopted different styles of advertising to communicate their message to the public, however there have been some common methods including using an 'emotive' and 'attention grabbing' style of advertising which highlights police enforcement capabilities as well as confronting high risk groups with the consequences of their behaviour. Other advertisements take an educational/informative slant.

The major objectives of the public education campaigns are:

1. To place road safety on the public agenda;
2. To increase road users perceived risk of detection or crashing, thereby deterring road users from unsafe behaviours;
3. To provide a supporting rationale for the police to undertake enforcement activity by realistically portraying the impact of road crashes upon individuals and the community;
4. To increase the perceived risk of being detected by the police; and
5. To provide information to support decision making to adopt safer forms of behaviour (Healy & Forsyth, 1996)

Approximately two thirds of expenditure is devoted to television advertising. In conjunction with television advertising the TAC advertise on the radio, the press, outdoor advertising (including mobile billboards), Sky Channel and cinema to reinforce or complement the main messages from the television advertisements (Healy & Forsyth, 1996).

A number of studies have investigated the means by which advertising produces its effect. It has been shown that there are delayed and carryover effects of the main messages, and that advertising does not necessarily produce its full effect in the week it is shown, nor do its effects stop at the end of that week (Cameron, Haworth, Oxley, Newstead, & Le, 1993). A “trigger threshold” for advertising has been established, and is the point at which people become aware of the main message. A burst of intensive advertising at the beginning of a campaign is generally effective in reaching this threshold. The “trigger threshold” has been described as consisting of an average of three viewings of the advertisement (Cameron & Newstead, 1996). This does not however give an indication of the number of viewings by the target audience as opposed to the broader audience.

It has been found that the awareness of advertising decays exponentially with time, which has been expressed in terms of its half-life or the number of weeks after which only half the audience is aware of the message (Broadbent 1979, 1984).

There have been suggestions the effect of these advertisements may become less with time as the audience becomes sensitised to them. Indeed, weak evidence has been found of advertising wearout, in that the impact of the TAC advertising may be diminishing over time (Fry, 1996).

TAC advertisements are intended to make a strong impression on the audience. A study investigated audience reaction to a sample of the TAC’s road safety advertisements (Harrison & Senserrick, 1999). It was found that:

- Attitudes to the TAC approach were generally positive;
- Six types of responses were identified - two represented reactions to the positive and uncomfortable emotional content of the advertisements respectively. The remaining four were more cognitive in nature and, represented reactions to the seriousness of the content, the simplicity of its delivery, content that included an element of irresponsibility, and the originality of the advertisement and its information content;

- The likelihood of an advertisement resulting in a behaviour change was associated with its originality or information content and its ability to evoke uncomfortable reactions;
- Emotional content is an important perceptual dimension and the analysis found that the advertisements divided into two groups, emotive advertisements and enforcement advertisements; and
- The advertisements in the emotive group were seen as more serious, less pleasant, and more emotional than those in the enforcement group. They were also perceived to be more effective (in terms of self-reported behaviour change), more relevant and more credible.

An earlier American study investigated the difference in responses of women and men to traffic safety messages (Morris, Lynch, Swinehart, & Lanza, 1994). Both men and women were found to be fairly knowledgeable about advertising and marketing strategies, and both sexes reported that the age of the presenter should be close to their own age. They reported that they wanted to see realism and personal reference, and both men and women felt that the threat of financial costs (fines and insurance) was a potentially effective appeal. Alternatively, females responded more favourably to emotional appeals than males and felt that humorous approaches detracted from the seriousness of the material presented, while many men preferred this approach. Females generally had no objections to publicity with an explicit message to take a given action, while most of the males in this sample found this approach authoritarian. The female participants were not as concerned about production values as were men, and they were more likely to watch an entire advertisement, as opposed to men, who would change the channel if they disliked the first few seconds of the advertisement. Women more often than men perceived the information conveyed in publicity as relevant to others in their lives as well as to themselves. They felt the gender of the narrator or protagonist was not important in communicating a safety message, and they were sensitive to the potential for negative gender-stereotyping in traffic safety advertising.

The TAC publicity campaign in Victoria has been found to have a substantial influence on crash reduction. There have been reductions in crashes in all of the areas targeted by the TAC, which have been directly attributed to the advertising campaigns. Newstead et al (1995) estimated that drink-drive publicity contributed to a 7% reduction in overall level in serious trauma in Victoria in 1990-93 compared to a base year of 1988. The speed-related publicity was estimated to have contributed to approximately 8% decrease in crash numbers for each year between 1991 and 1993 in comparison with 1988 as the base year. There has been no formal evaluation of fatigue related campaigns as it is difficult to attribute fatigue as the cause of a crash. An increase in restraint use has been found, the greatest increase being for rear seat passengers aged 18-25 (from 55.8% to 83.6%) (Diamantopoulou, Dyte, & Cameron, 1996).

There was a specific evaluation of the effect of publicity supporting the speed camera program during "low alcohol hours"², which was launched in April 1990 (Cameron et al., 1993). During the period from April to June 1990, when there was negligible camera use but high levels of television publicity, there was a 24% reduction in casualty crashes and a 29% reduction in their injury severity. A second stage of this evaluation linked the monthly levels of television advertising with the variations in casualty crashes during low alcohol hours on 1990-91, and a statistically significant relationship for all TAC publicity and for the speed-related publicity in

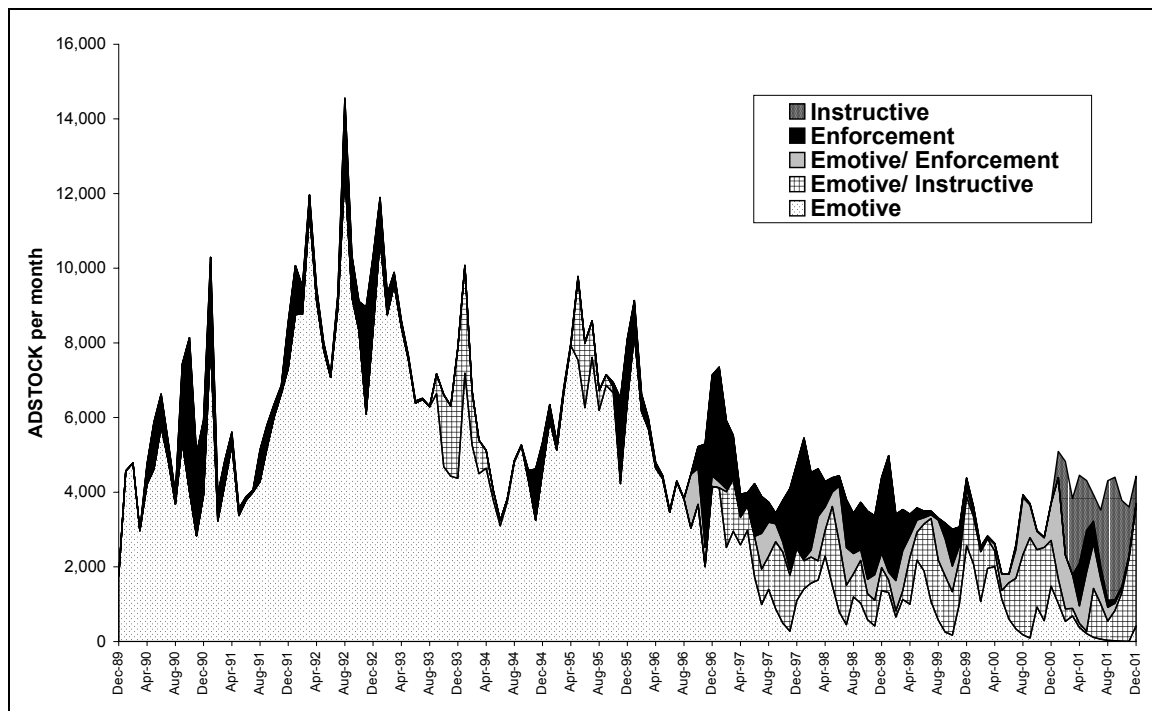
² The "high alcohol hours" of the week (i.e. 4pm Sunday to 6am Monday, 6pm to 6am on Monday to Thursday nights, 4pm Friday to 8am Saturday, and 2pm Saturday to 10am Sunday) are those periods when the percentage of drivers killed or admitted to hospital with a blood alcohol content exceeding 0.05% was about 36% (Harrison, 1990). The "low alcohol hours" are the converse of these periods, during which less than 4% of the driver of serious casualties had blood alcohol content exceeding 0.05%.

particular. A New Zealand study reported that after two years, reductions of 14-26% in speed-related crashes could be attributed to a advertising campaign which had been based on Victoria's TAC road safety publicity campaigns (Graham, 1998).

The MUARC research (Cameron et al 1993; Newstead et al 1995) has been questioned by White et al (2000) who re-analysed the data to establish whether the claimed effects of the TAC publicity were real. In their response, Cameron and Newstead (2000) pointed out that White et al's analysis had strengthened the evidence for the beneficial effect on crashes of TAC's speed-related advertising during 1990-93. White et al's analysis also provided support for the relationship between crash reductions and the number of speeding tickets issued as a result of speed camera detections, first identified by Cameron et al (1992).

The mix of styles of TAC's speed-related advertising has changed since these earlier studies found effects. In line with TAC's road safety advertising generally (Figure 2.2), the use of almost exclusively emotive-style advertisements during the early 1990's has changed to include a greater proportion of those with enforcement-style and those combining emotion with enforcement or instructive elements. Adstock (Broadbent 1979) is a measure of retained awareness of past and current levels of advertising (see Section 6.5) and is a function of advertising intensity. Thus the findings relating to predominantly emotive-style speed-related TAC advertising used during the early 1990's may not be applicable to the advertising mix used during more recent years, in particular the speed-related advertising during 1996-2000 which was the focus of this study.

Figure 2.2: Adstock of TAC television advertising in Melbourne, December 1989 to December 2001



The possibility that different effects of the TAC speed-related advertising may be applicable during the late 1990's was suggested by a preliminary study which analysed serious casualty crash trends in Melbourne during July 1996 to October 1998 in a similar way to the analysis by Newstead et al (1995). Crash trends during the period up to June 1996 were also analysed. The analysis of the earlier period was able to find statistically significant links between speed-related Adstock and crashes, but the analysis of the later period did not (Diamantopoulou et al 1999). This result may have been due to the relatively short duration of the second period.

2.3 INTERACTION BETWEEN ENFORCEMENT AND PUBLICITY

Although analyses have generally separated the effects of enforcement and publicity, or have evaluated the effect of one in the context of the other, an 'integration' effect on driver behaviour and crashes was expected to be a significant contributory factor (Healy & Forsyth, 1996).

Wise (1996) noted that the first hallmark of an effective mass media campaign is that it is specifically linked with other elements of a comprehensive intervention. The publicity campaign which accompanied the new speed camera program (introduced in December 1989) aimed to increase "the perception of the level of camera operations and their legitimacy, as well as building a community agenda about speeding and safety" (Cameron, Cavallo, & Gilbert, 1992). Many of the TAC advertisements have aimed to support Police enforcement activities (Cameron & Newstead, 1996). There is little research that has aimed to untangle the relationship between enforcement activity and accompanying publicity campaigns.

An evaluation of the rural random breath testing and publicity program in Victoria during 1993-94 estimated the effects of the enforcement conditional on the level of publicity awareness present at the time the RBT activity was operating. Reductions in serious casualty crashes occurred when "Police cars alone were operating (22% reduction), and especially at times of *medium drink-driving* publicity awareness" (33%). Interestingly, when there were high levels of drink driving publicity accompanying the use of RBT, or when combinations of cars and buses were operating together, there was little evidence of crash reduction. In fact, in regions and weeks influenced by car and bus combinations, an increase of 148% in HAH serious casualty crashes occurred when *high publicity* awareness accompanied the enforcement (Cameron et al., 1997). This result was explained as the result of drivers using relatively unsafe minor roads, presumably to avoid the RBT, and this occurred specifically when there was a high level of publicity. This explanation has been supported by the results of surveys of rural hotel patrons (Harrison, 1996, Harrison and Fitzharris, 1999).

When moving mode radar use was accompanied by publicity specific to that enforcement device, a 28% reduction in casualty crashes was found which was marginally statistically significant ($p = 0.07$). It was found that when the publicity was specific to this type of speed enforcement, the effect was stronger than when compared to a more general speed-related publicity (Diamantopoulou, Cameron, & Shtifelman, 1998). When the enforcement was accompanied by high levels of general speed-related publicity, the effects were less, with an 11% reduction in crashes (not statistically significant). The strongest effect on casualty crashes in rural Victoria occurred when the mobile radar enforcement was accompanied by high levels of specific mobile radar publicity, and the effects were strongest one to four days after the enforcement was present.

In summary, both road safety publicity and speeding-specific enforcement has been shown to contribute to a reduction in crashes. It is a common practice to link publicity campaigns with enforcement strategies, and there is some evidence that interaction effects exist. There is however no clear understanding of the means by which varying levels of publicity and speed camera enforcement impact on drivers' perceptions of the risk of detection, their speeding behaviour, or involvement in serious crashes. This project was designed to provide a level of understanding of these issues.

3 STUDY OUTLINE

Previous research conducted by MUARC indicates that the speed camera program conducted by the Police and the road safety publicity program conducted by the Transport Accident Commission, TAC, are individually linked to reductions in crashes, however, little is understood about the interaction between these two programs. The aim of this current study is to explore this interaction using casualty crash frequencies and crash severity as outcome measures in a study using an experimental design.

3.1 BACKGROUND

A proposed experimental study to examine the interaction between speed camera enforcement and levels of supporting publicity was included in the MUARC's research program in 1996. This study proposed that Victoria be divided into a number of regions and that each region be randomly allocated times of :

- a) no enforcement or publicity,
- b) enforcement only,
- c) publicity only, and
- d) both enforcement and publicity.

The study was proposed because previous MUARC studies of the separate effects of speed cameras and TAC speed-related publicity had been unable to quantify their synergistic effect on crashes.

A related project had been planned by (then) Superintendent John Bodinnar of the Traffic Camera Office of the Victoria Police. Two areas exhibiting relatively low crash frequencies and relatively low incidences of speeding would be identified, and in these areas the speed camera hours would be reduced. Camera hours would be increased in two other areas with relatively high crash frequencies and incidences of speeding. Pre-existing enforcement levels would be retained in the remainder of Victoria to provide a control comparison.

An integrated study was planned but was unable to be proceed because of the planned impending outsourcing of speed camera operations and image processing. The project was revived in November 1998 after the outsourcing to LMT Australia³ (now Tenix Solutions) had been completed.

3.2 PROJECT OBJECTIVES

During 1999, speed camera operations were planned to increase in two Melbourne Police Districts, by either 50% or 100% for a month at a time, during two selected months when TAC speed-related publicity was present and two months when it was absent. One of the project's objectives was to examine the effects on crashes in the two Districts, and also the effects in Districts in which camera operations were reduced, if this occurred.

³ LMT (Lockheed Martin Corporation and the Tenix Group) is a provider of infringement processing services to Governments at all levels in Australia, New Zealand and Southeast Asia.

In addition, the project also included a component that surveyed drivers' perceptions and reported driver behaviour in response to the increased speed enforcement, and the related publicity. The results of the survey component of the project are described in Chapter 7.

3.3 METHODOLOGY

Initial discussions relating to the proposed methodology for this project focused on the use of a crash-based evaluation. This outcome measure has a number of limitations. While a crash-based evaluation can identify changes in crash rates associated with periods of speed enforcement or publicity it cannot account for the changes or the mechanisms underlying them.

In view of this, a survey of the impact of speed enforcement and publicity on drivers' perceptions and behaviour was added to complement the results obtained in the crash-based analysis. The survey results would explore the reasons and mechanisms underlying behaviour changes.

3.4 STUDY DESIGN

It was considered that a quasi-experimental study design would be appropriate for this crash-based evaluation. This type of design would allow for an effective evaluation of the impact of speed enforcement, publicity and an interaction between the two on crash rates. To satisfy the requirements of such a design there was a need to define periods of speed-related publicity and non-publicity, and periods with varying levels of Police speed camera enforcement.

MUARC research has identified a link between speed camera use and reductions in the number and severity of crashes. For this reason MUARC did not consider it ethical to propose to remove or reduce this effective countermeasure. However, due to resource constraints, the Police had to consider this possibility.

Some previous research suggested that small changes in Police traffic enforcement activity may not be detected by drivers (and therefore may not translate into reductions in crashes or in behavioural changes), and that quite large increases in the actual levels of Police traffic enforcement are required to increase drivers' perceived risk of detection for speeding (Ostvik and Elvik, 1990). This evidence suggested that the increases in the levels of the speed camera enforcement may need to be large in order to achieve measurable effects.

3.5 GENERAL DESIGN

A quasi-experimental design was adopted to investigate the interaction between road safety speed-related publicity and speed camera enforcement on crash outcomes. Victoria Police and their private speed camera operators (LMT Australia) were able to increase the amount of speed enforcement in two Police Districts by factors of 50% and 100% during various months in 1999. These months coincided with planned periods of speed-related and no speed-related publicity funded by the Transport Accident Commission in various media. The combination of publicity and enforcement is shown in Table 3.1.

Table 3.1 Basic Experimental Design

		ENFORCEMENT LEVEL	
		50% increase on normal speed camera operational levels	100% increase on normal speed camera operational levels
PUBLICITY	Speed-related publicity present	50% increase in enforcement & publicity present	100% increase in enforcement & publicity present
	Speed-related publicity absent	50% increase in enforcement & publicity absent	100% increase in enforcement & publicity absent

The initial crash-based analysis made use of casualty crash data from prior years, 1996-1998 and from the year after the experiment i.e. 2000 to act as comparison crashes to measure the changes that occurred during the increases in the enforcement. In addition crashes from other metropolitan Districts in Victoria where there had been no change in enforcement levels during 1999 were used as a comparison group to account for changes other than increases in speed camera enforcement that may have occurred during the evaluation period. Thus, the design of the initial crash analysis was as shown in Table 3.2, with the addition of the inclusion of prior and post years' crash data as an additional comparison.

Table 3.2 Experimental Design for Crash Analysis

		ENFORCEMENT LEVEL		
		No change in enforcement levels (other Metropolitan Police Districts used as controls)	50% increase on normal speed camera operational levels	100% increase in normal speed camera operational levels
PUBLICITY	Speed-related publicity present	Publicity & no change in enforcement	Publicity & 50% increase in enforcement	Publicity & 100% increase in enforcement
	Speed-related publicity absent	No publicity & no change in enforcement	No publicity & 50% increase in enforcement	No publicity & 100% increase in enforcement

A more comprehensive crash analysis was subsequently defined which made fuller use of the crash data over the period 1996-2000 and allowed for delayed or residual effects of the enforcement and publicity. The design of this analysis is given in Chapter 6 following the preliminary analysis.

Table 3.3 shows the timing of the enforcement program incorporating the publicity periods and use of the Police Districts that acted as the comparison group during the months of 1999, whilst Figure 3.1 displays the location of each Melbourne Police District. Table 3.3 reflects Police reaction to the experimental design. The design had not intended there to be enforcement reductions. The Police decided that this was necessary because of resource constraints.

Table 3.3 Timing of Enforcement, Publicity & Survey Component of the Evaluation

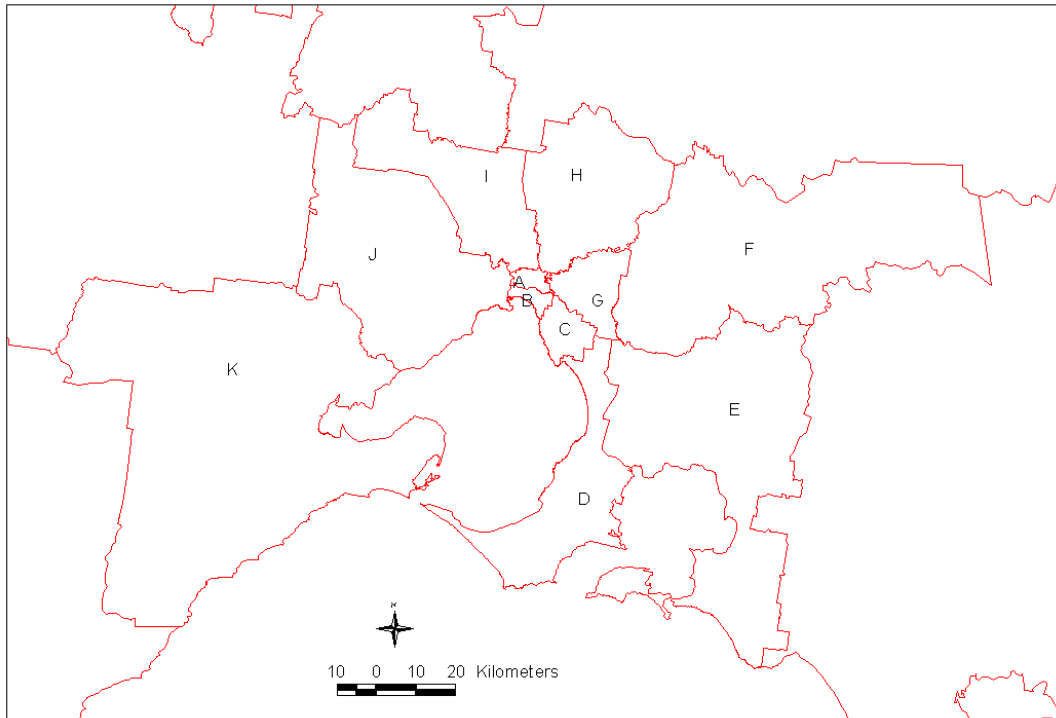
Police District	MONTH DURING 1999											
	Jan	Feb	Mar	Apr <i>Publicity absent</i>	May	Jun <i>Publicity present</i>	Jul	Aug <i>Publicity absent</i>	Sep	Oct	Nov <i>Publicity present</i>	Dec
E				N+100		Y+50		N+50			Y+100	
I				N+50		Y+100		N+100			Y+50	
C				N-100		Y-50		N-50			Y-100	
H				N-50		Y-100		N-100			Y-50	
B, D, F, G, J, K*				no change		no change		no change			No change	

* Other Metropolitan Police Districts with no change in speed camera enforcement – used as a comparison group of crashes (Note: District A did not have speed camera operations)

The notation used in Table 3.3 refers to eight (treatment) conditions that were defined for subsequent analysis as follows:

- T1.** 100% increase in speed camera hours with no publicity (N+100): This condition included data collected from E District in April and from I District in August.
- T2.** 100% increase in speed camera hours with publicity (Y+100): This condition included data collected from E District in November and from I District in June.
- T3.** 50% increase in speed camera hours with no publicity (N+50): This condition included data collected from E District in August and from I District in April.
- T4.** 50% increase in speed camera hours with publicity (Y+50): This condition included data collected from E District in June and from I District in November.
- T5.** No speed camera hours with no publicity (N-100): This condition included data collected from C District in April and from H District in August.
- T6.** No speed camera hours with publicity (Y-100): This condition included data collected from C District in November and from H District in June.
- T7.** 50% reduction in speed camera hours with no publicity (N-50): This condition included data collected from C District in August and from H District in April.
- T8.** 50% reduction in speed camera hours with publicity (Y-50): This condition included data collected from C District in June and from H District in November.

Figure 3.1 **Map of Melbourne Police Districts**



E and I:	Districts treated with increases in speed camera enforcement
C and H:	Districts treated with decreases in speed camera enforcement
B, D, F, G, J & K:	Districts where there had been no change in speed camera enforcement

The following chapter documents the monthly levels of speed camera operational hours actually achieved during 1999 in the Police Districts that had changed speed camera enforcement conditions. The monthly levels of TAC speed-related publicity achieved during 1999 are also presented.

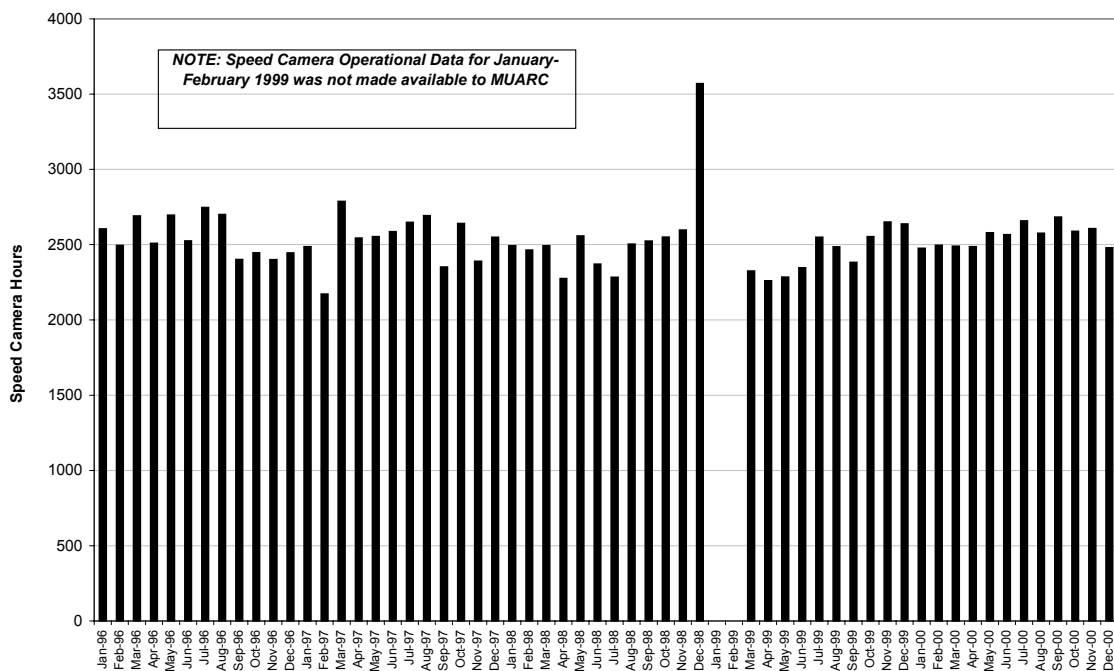
4 SPEED CAMERA OPERATIONS & SPEED-RELATED PUBLICITY

The following section documents the monthly number of speed camera hours of operation achieved in the treated Police Districts (the comparison Districts are documented in Appendix A). The monthly speed camera hours are shown for 1999, the year of changed enforcement conditions, as well as for the comparison years, 1996-1998 and 2000.

Figure 4.1 shows the number of speed camera hours of operation achieved for all Melbourne Police Districts. The monthly level of speed camera hours achieved remained relatively constant at approximately 2,515 hours. The exception was during December 1998 when the number of hours achieved was considerably greater than average at approximately 3,570 hours. A substantial increase in camera hours occurred in most Districts during this month.

It should be noted that speed camera operational data for January-February 1999 was not made available to MUARC so does not appear in the following charts for these months. This information was missing for reasons unassociated with the experimental study. Camera operations are understood to have been at normal levels during those two months.

Figure 4.1 Number of hours of speed camera operations achieved per month for the Melbourne Police Districts, 1996-2000



4.1 SPEED CAMERA HOURS PER MONTH

The following charts show the monthly number of speed camera hours achieved in the Police Districts that experienced either increased or decreased levels of speed camera enforcement during certain months of 1999.

Figure 4.2 displays the number of hours of speed camera operations achieved in **District E** during 1996-2000. During April 1999 and November 1999 it was planned that there would be a 100% increase in the level of speed camera hours achieved, whilst in June 1999 and August

1999 there would be a 50% increase in the level of speed camera hours. The actual increases achieved were a 96% increase in April compared to the previous month; a 98% increase in November compared to the previous month and 45% increases in June and August compared to the relevant previous months. Thus the actual increases matched the planned 100% and 50% increases fairly accurately for District E.

For the other months of 1996-2000, the number of speed camera hours achieved was relatively stable at about 270 hours per month on average. The exception was during December 1998 in which the number of speed camera hours was about 370 hours. This was because Police had increased their speed camera operations during that month. This increase did not affect the preliminary crash analysis, which used crashes in previous years as a reference level. This was because December was not one of the treated months in 1999, so December 1998 was not used.

Figure 4.2 Number of hours of speed camera operations per month for District E during 1996-2000

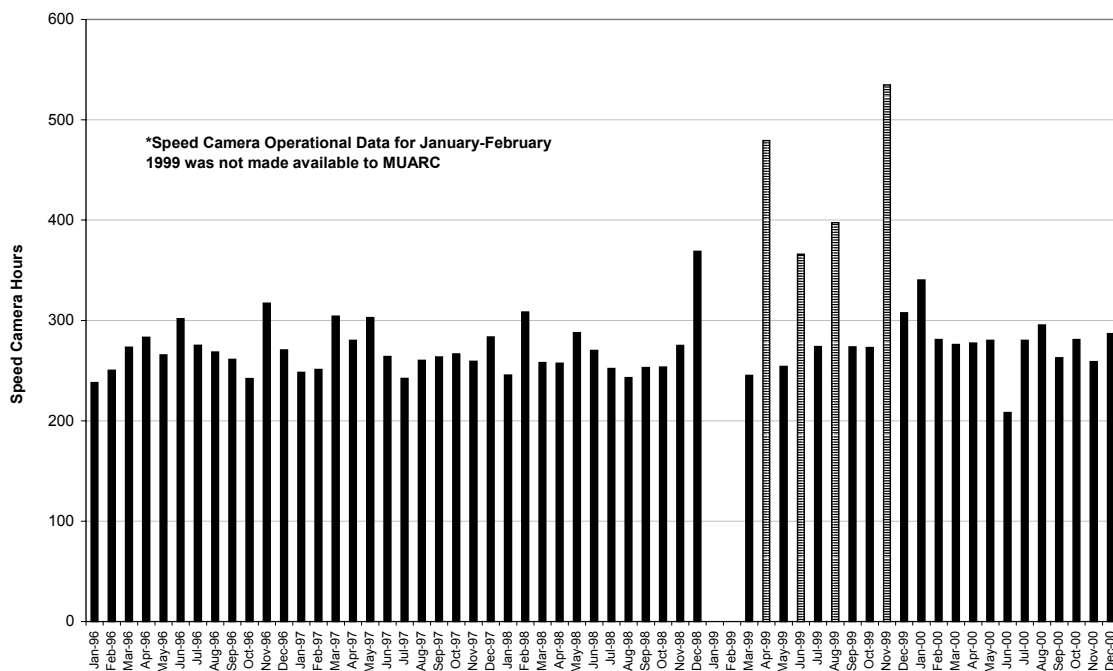


Figure 4.3 displays the number of hours of speed camera operations achieved in **District I** during 1996-2000. During June 1999 and August 1999 it was planned that there would be a 100% increase in the level of speed camera hours achieved, whilst in April 1999 and November 1999 there would be a 50% increase in the level of speed camera hours. The actual increases in speed camera hours achieved were a 50% increase in April, a 90% increase in June, a 97% increase in August and a 55% increase in November compared to the appropriate prior months. Hence the actual increases achieved in District I were approximately those that had been planned for the experimental months. For the other months of 1996-2000, the number of speed camera hours achieved in District I was relatively stable at about 270 hours per month on average.

Figure 4.3 Number of hours of speed camera operations per month for District I during 1996-2000

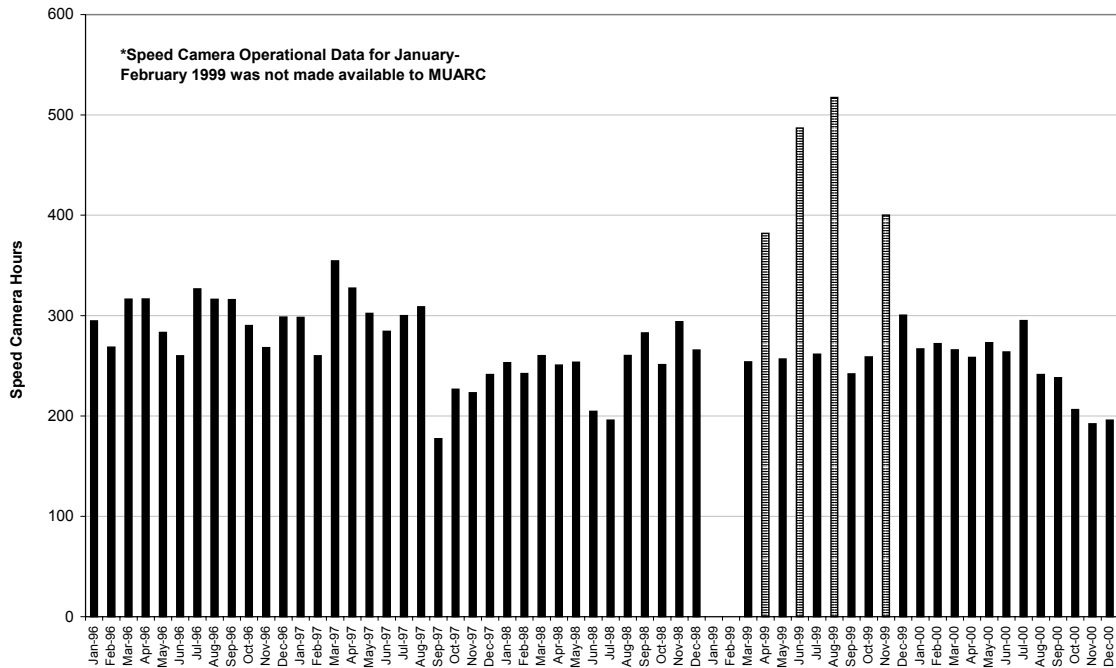


Figure 4.4 displays the number of hours of speed camera operations achieved in **District C** during 1996-2000. During April 1999 and November 1999 it was decided to have no speed camera operations in District C, whilst in June 1999 and August 1999 there would be a 50% reduction in the level of speed camera hours of operation. The actual reductions were a 37% reduction in June and a 47% reduction in August compared to the appropriate prior months. Thus the 50% reduction occurred only in August, approximately. For June the actual reduction was considerably less than 50%. During April and November there were no speed camera hours of operation as decided.

For the other months of 1996-2000, the number of speed camera hours achieved was relatively stable at about 265 hours per month on average. The exception was during December 1998 in which the number of speed camera hours was about 430 hours. This was because Police had increased their speed camera operations during that month across Melbourne.

Figure 4.4 Number of hours of speed camera operations per month for District C during 1996-2000

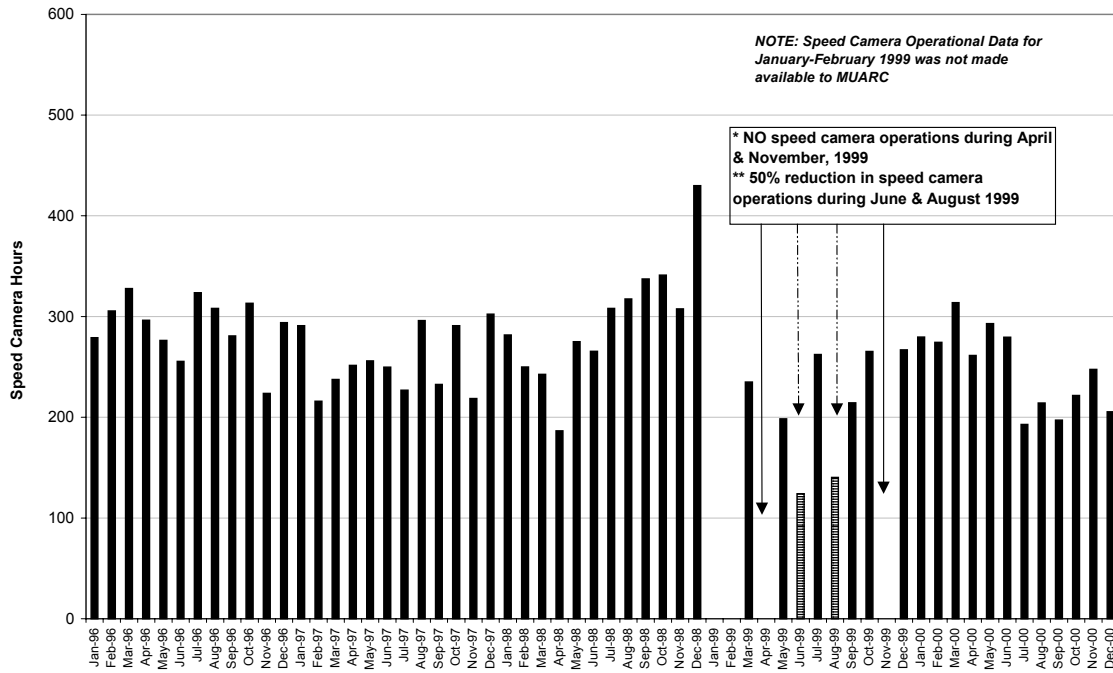
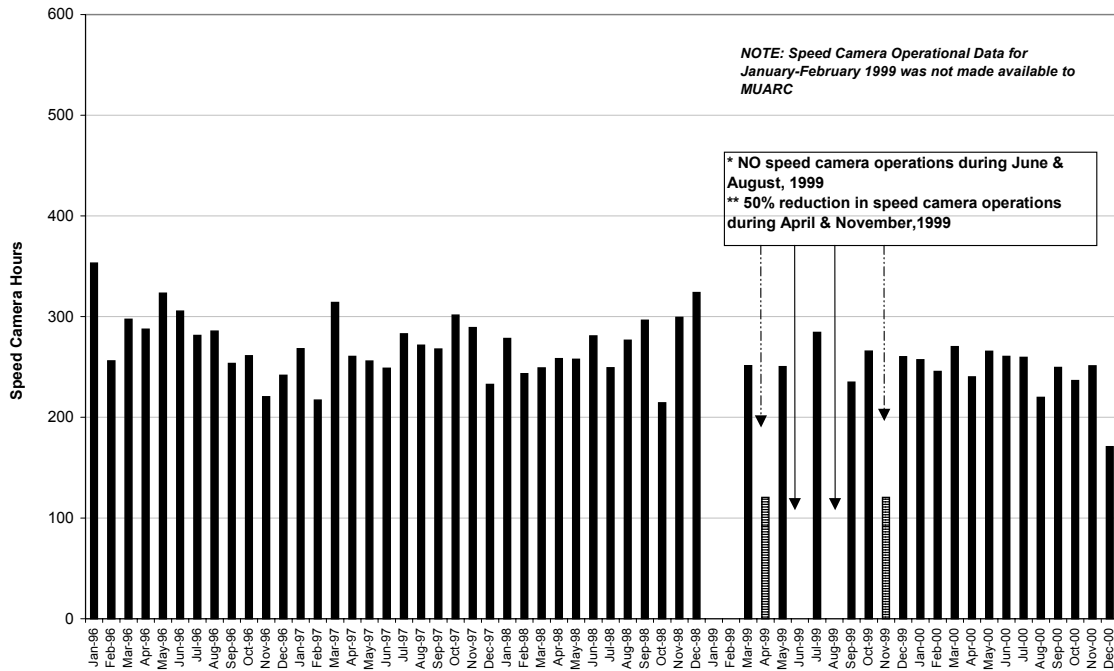


Figure 4.5 displays the number of hours of speed camera operations achieved in **District H** during 1996-2000. During April 1999 and November 1999 it was decided to have a 50% reduction in the level of speed camera hours of operation, whilst in June 1999 and August 1999 there would be no speed camera activity. For April and November the actual reductions were approximately 53% compared to the relevant previous months. For June and August there were no speed camera operations in District H as decided. These reductions in speed camera enforcement are evident from Figure 4.5.

For the other months of 1996-2000, the number of speed camera hours achieved in District H remained relatively stable at about 260 hours per month on average.

Figure 4.5 Number of hours of speed camera operations per month for District H during 1996-2000



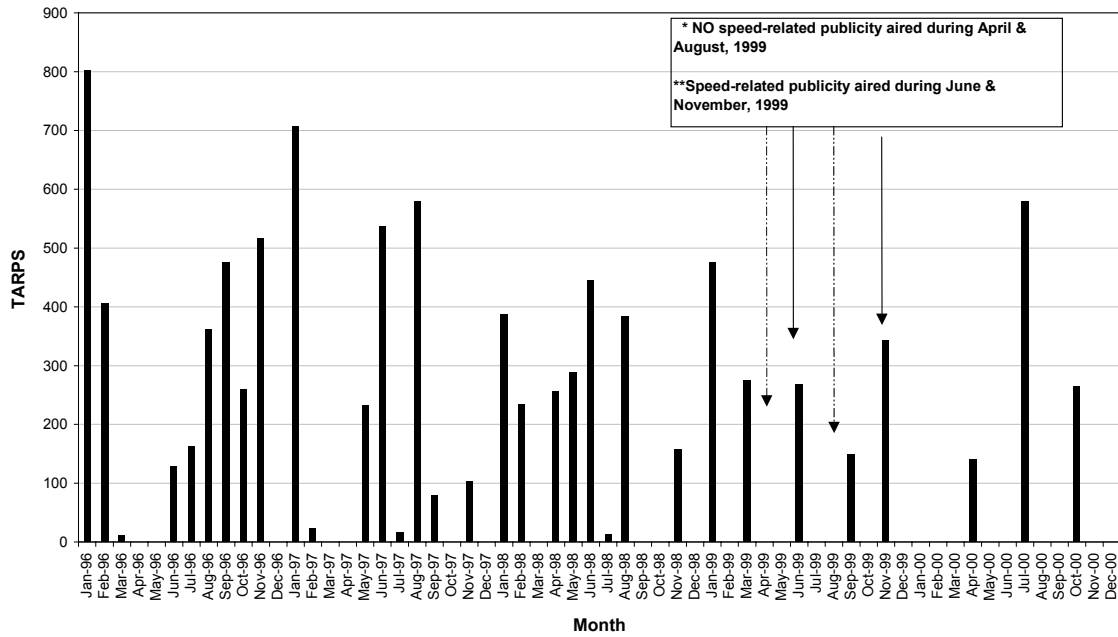
Charts analogous to Figures 4.2 to 4.5 can be found for the comparison districts in Appendix A.

4.2 SPEED-RELATED PUBLICITY

The television exposure of the TAC’s speed-related road safety advertisements was measured weekly using Target Audience Rating Points (TARPs), a measure of audience reach, during January-December 2000. TARPs are a summation of the Rating Points, or percentage of persons in the Target Audience in the viewing area estimated to be watching the specific television channel at the time of the advertisement.

Figure 4.6 gives the distribution of TARPs per month for 1996-2000. During the months in 1999 when there were changes in the levels of speed camera enforcement, the number of TARPs achieved for speed-related advertisements are shown in this chart. For April 1999 and August 1999 there were *no* speed-related advertisements shown on television hence no TARPs measured. These months will signify the times when there was no speed-related publicity accompanying the enforcement. During June 1999 and November 1999 speed-related road safety advertisements were aired on television with corresponding TARPs of about 270 and 340 units, respectively.

Figure 4.6 Target Audience Ratings Points (TARPs) achieved per month for speed-related TAC road safety advertising for Melbourne: January 1996-December 2001



5 PRELIMINARY CRASH ANALYSIS

A preliminary analysis of the crash data was undertaken to examine the direct effects of the changed levels of speed camera hours, during the presence or absence of speed-related publicity, in the Districts and during the months when these changes occurred. The preliminary analysis did not hypothesise nor examine any delayed or residual effects of the enforcement or publicity. It examined the crash outcomes associated with each of the eight treatment conditions (see Section 3.5) separately and did not, at this stage, test for the presence of an interaction between the enforcement and publicity.

5.1 TRENDS IN THE CRASH DATA

Figure 5.1 and Figure 5.2 show the annual number of casualty crashes that occurred in each Metropolitan District considered in the crash analysis during 1996-2000. These were plotted, particularly for the comparison Districts (i.e. Districts B, D, F, G, J & K), to see if the crash trends during 1996 to 2000 were relatively stable. During 1996-1998 the crash numbers in the comparison Districts were relatively stable – fluctuating by about 1%-2% each year, and averaging about 7,160 per year (Figure 5.1). There was an approximate 1.6% increase on this average during 1999, and another 1.7% increase in 2000. Because the annual casualty crash frequencies in the comparison Districts remained relatively stable during 1996 to 2000, these crashes were combined in the preliminary crash analysis.

Figure 5.1 Annual casualty crash numbers for the comparison group (Metropolitan Police Districts B, D, F, G, J & K): 1996-2000

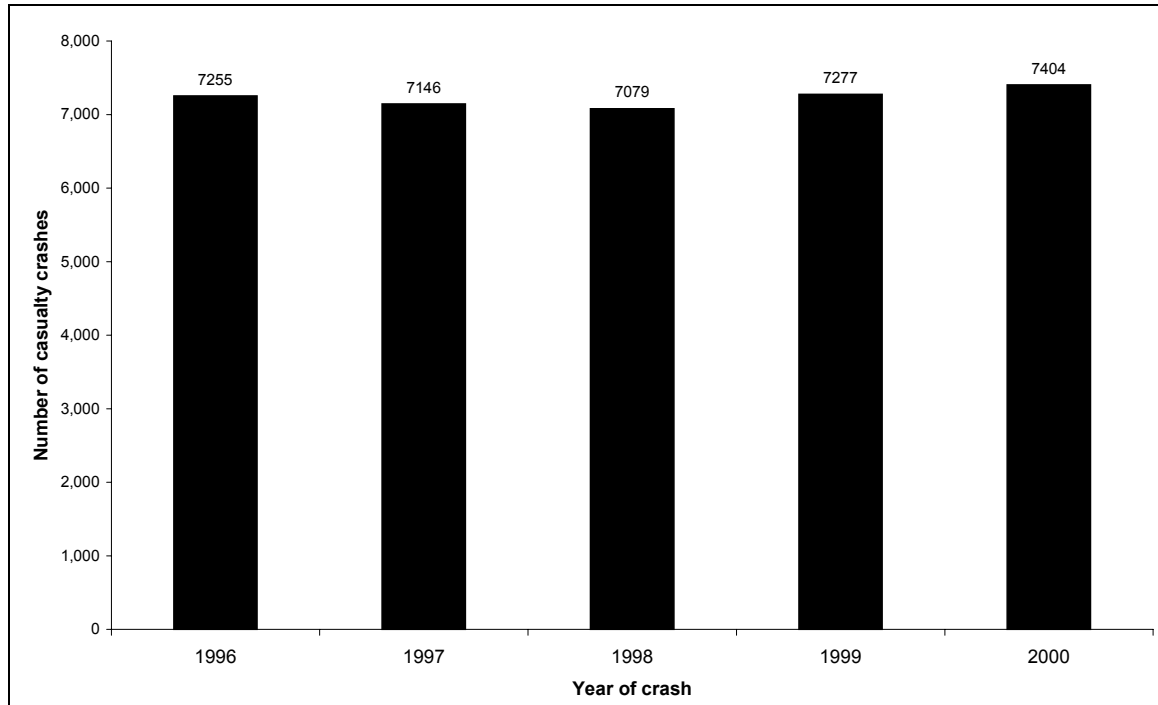
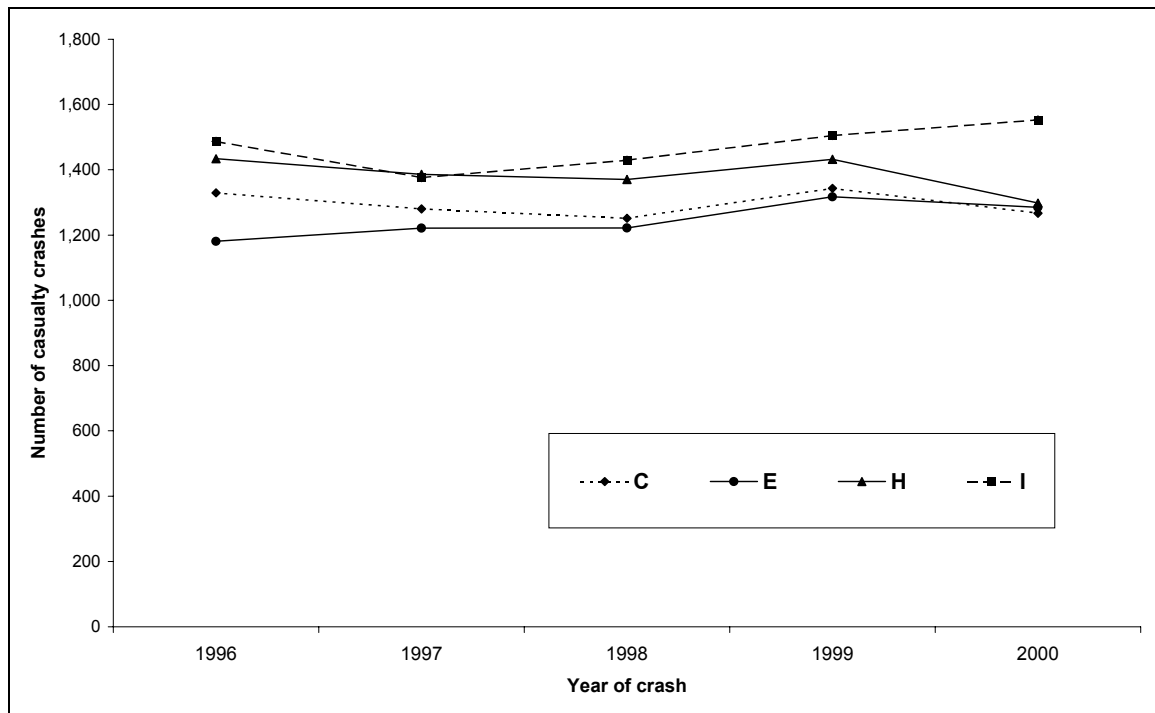


Figure 5.2 Annual number of casualty crashes for each treated District: 1996-2000



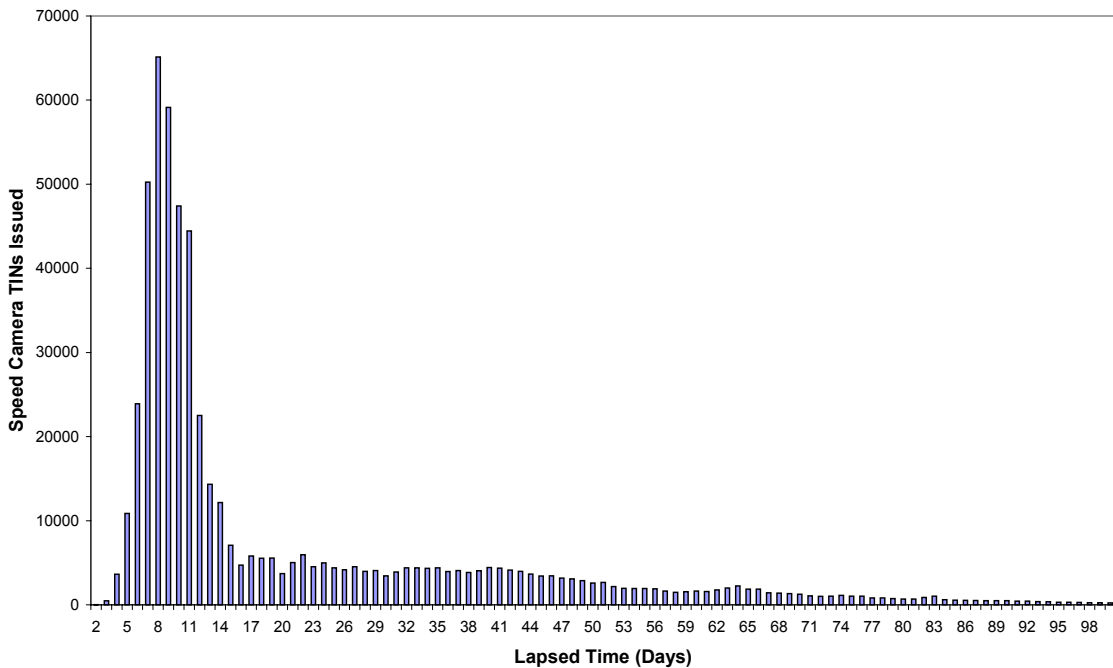
5.2 CRASH OUTCOME MEASURES

For the crash analysis, the outcome measures considered were both changes in the *number of casualty crashes* that occurred during the period of increased enforcement as well as changes in *crash severity*.

For the crash severity outcome measure, the casualty crashes were divided into those that had resulted in a fatality or serious injury, denoted as serious casualty crashes and those that resulted in a minor injury. The proportion that were fatal or serious measured crash severity.

It was considered reasonable, for the purposes of the preliminary analysis, to expect that crash effects will occur in the same months as the changed enforcement because of the relatively short lapsed time between the date of the speeding offence and the date the speeding traffic infringement notice (TIN) was issued. During 1999 about 60% of speed camera TINs were issued within 7 to 14 days from the date of the offence (Figure 5.3). Thus at least some of the crash effects should be reflected in the month in which the enforcement occurred. However, for offences that occurred towards the end of the month, the changed enforcement conditions may not be reflected in that month's crashes but rather in the next month's crashes. This possibility was considered to weaken the preliminary analysis (and was addressed in later analysis reported in Chapter 6).

Figure 5.3 Lapsed time between speed camera offence detection date and TIN issue date during 1999 (excluding lapsed times > 100 days)



The aim of the preliminary analysis was to see if there had been (i) a change in casualty crash frequency and/or (ii) a change in crash severity (i.e. a change in the proportion of casualty crashes that resulted in a fatality or serious injury) associated with each of the treatment conditions in the months and Districts in which they occurred.

5.3 PRELIMINARY ANALYSIS METHOD

5.3.1 Casualty Crash Frequency

The number of casualty crashes that occurred in the Police Districts during the months in 1999 when there were changed speed camera enforcement conditions were compared with:

- i. the annual average number of casualty crashes that occurred in the same Districts during the same months three years earlier (1996-1998);
- ii. the number of casualty crashes that occurred in the same Districts during the same months one year later (2000), and
- iii. the annual average number of casualty crashes that occurred in the same Districts during the same months for combined four years 1996-1998 and 2000.

These estimates, expressed as percentage changes, represented an initial estimate of the effect of the changed levels of speed camera enforcement.

The possible effects of other factors affecting crashes during the same months were taken into account by analysing the changes in casualty crash frequencies that occurred in the Metropolitan Police Districts that had not had any changed speed camera enforcement conditions during the

relevant months of 1999 (i.e. Districts B, D, F, G, J & K). These crashes were assumed to be relatively unaffected by the changed speed camera enforcement conditions during 1999. The percentage change in this 'comparison' group of crashes was considered to measure the effects of other factors that may have affected crashes during the same months as the speed camera enforcement changes.

To estimate the difference between the percentage change in the 'treated' crashes and the percentage change in the 'comparison' crash group, a *net percentage change* was calculated. The net percentage change was considered to estimate the effect of the change in speed camera enforcement, after the effects of other factors had been taken into account.

5.3.2 Crash Severity

The net percentage change in crash severity was calculated in a similar way to the net percentage change in crash frequency but with another dimension added, the severity of the crash (i.e. a serious casualty crash or a minor injury crash). This net percentage change gave the change in the proportion of casualty crashes that were serious which occurred during the period of changed speed camera enforcement conditions in the treatment Districts, relative to that *expected from the crash experience* in the same Districts when the enforcement level was unchanged, and taking into account other factors via the comparison Districts.

Appendix B gives the estimated net percentage change in casualty crash frequency and crash severity that occurred under each treatment condition. Details of the calculations and the methods of testing the statistical significance of each type of percentage change are also given in the Appendix.

5.4 SUMMARY OF PRELIMINARY ANALYSIS

For the four treatment conditions in which speed camera enforcement levels were increased in appropriate Districts during 1999, a summary of the main findings with the comparison Districts are given in Table 5.1.

Table 5.1 Summary of main findings for Districts that had increased levels of speed camera enforcement

LEVEL OF SPEED CAMERA ENFORCEMENT INCREASE	Speed-related publicity PRESENT	Speed-related publicity ABSENT
100% increase	Significant reduction in <i>crash severity (T2)</i>	Non-significant reduction in <i>crash frequency (T1)</i>
50% increase	Significant increase in casualty crash frequency (T4)	Significant reduction in <i>casualty crash frequency (T3)</i> Non-significant reduction in <i>crash severity (T3)</i>

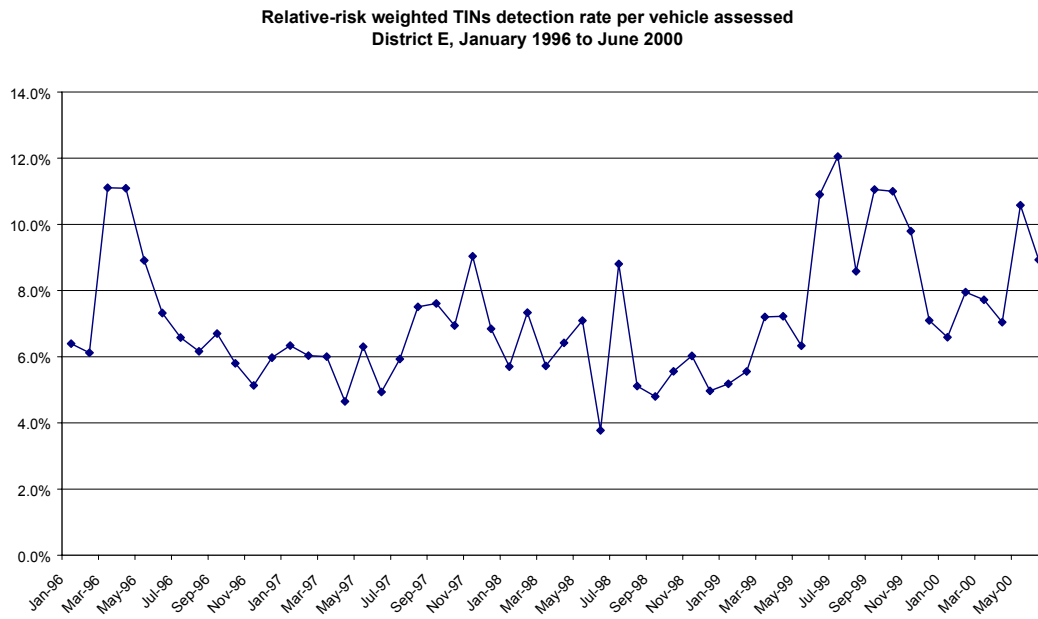
There were no statistically significant changes in crash frequency or crash severity associated with the treatment conditions where the speed camera enforcement levels had decreased by 50% or 100% (see Appendix B).

There appeared to be evidence of a statistically significant increase in casualty crash frequency associated with the treatment condition of a 50% enforcement increase with publicity present (i.e. District E in June 1999 & District I in November 1999). This increase in casualty crash frequency was found in comparison to the untreated Melbourne Districts. Closer examination of the data found that the increase was mainly due to the relatively large number of casualty crashes that occurred in District E in June. When only District I was considered in the analysis, a net 2.7% reduction in casualty crash frequency was found.

The increase in casualty crash frequency found for this treatment condition may also have been due to an artifact in the analysis method used or the way in which the measures of enforcement and advertising were defined. An alternative method of analysis and alternative measures of enforcement and advertising are described below.

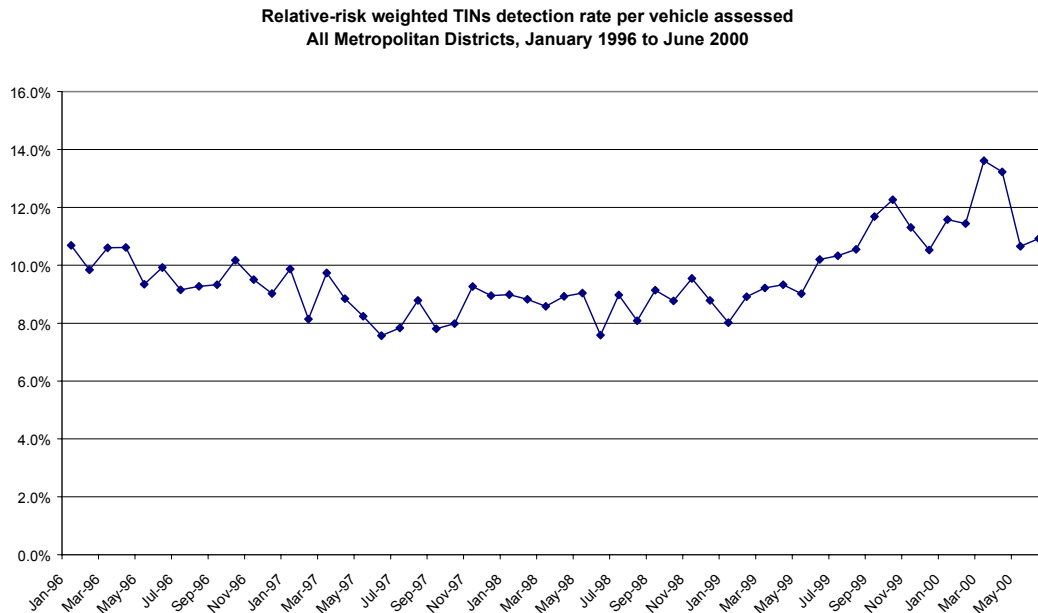
It was also noted that the months of June and July, and September and October, 1999 were associated with relatively high speeding offence detection rates in District E, particularly for the relatively high risk speeding offences. Figure 5.4 shows the monthly offence rates for vehicles assessed by speed cameras in District E, where the offences of exceeding the speed limit by 16-29 km/h and by 30 km/h or above, respectively, have been weighted by the relative risk associated with these behaviours in urban areas, found by Kloeden et al (2002).

Figure 5.4 Speeding offence rate detected by speed cameras in District E



If the speed camera detection rate can be considered a reliable measure of speeding on Melbourne roads, then Figure 5.4 suggests that (especially risky) speeding was at a relatively high level in District E during June 1999. This was in contrast with the offence detection rate during that month across all Melbourne Police Districts (Figure 5.5). The relatively high level of risky speeding may explain the statistically significant increase in casualty crashes in District E in June 1999, reported in Table 5.1.

Figure 5.5 Speeding offence rate detected by speed cameras in all Melbourne Districts



5.5 LIMITATIONS OF PRELIMINARY ANALYSIS

The relative interaction between enforcement levels and associated publicity was not examined in the preliminary analysis. Only the separate effects of each of the eight treatment combinations on casualty crash frequency were examined.

The preliminary analysis was also limited in that only the months when speed camera enforcement conditions had been changed were considered. That is, only crashes during April, June, August and November were considered in the analysis, thereby omitting the other months of the year and ignoring substantial crash data that could increase the statistical power of the tests, particularly in relation to measuring the publicity effects.

A method of analysis (eg. a type of time series analysis) which takes into account crash data from all of the months of the evaluation period 1996-2000 would provide a more sensitive test of the presence of enforcement and publicity effects and their interaction. This analysis would also include seasonality and trend components, thereby offering a better explanation of the crash variations and increasing the sensitivity of the tests.

The preliminary analysis also made the following implicit assumptions:

1. The influence of the enforcement change occurred throughout the month of change and did not extend beyond it. In contrast, past speed camera research suggests that the principal influence on crashes is the receipt of the speeding TINs arising from camera activity, typically 7-14 days after the camera session, and that the effects commenced from that date for up to three weeks (Cameron et al 1992, Rogerson et al 1994, Newstead et al 1995). Thus substantial effects during the month following the enforcement change could be expected in addition to, and perhaps greater than, any effects during the month of change.
2. The influence of the TAC speed-related television advertising was throughout the month in which it appeared and did not extend beyond it. In contrast, past MUARC research has shown that the awareness of TAC speed-related advertising has a half-life of about 5 weeks and a substantial retained base-level (Cameron et al 1999). Thus the awareness of speed-related publicity during months when the publicity was considered absent (April and August 1999) may have been retained in drivers' minds due to publicity in previous months.
3. The speed-related advertising (which used emotive styles during June and November 1999) potentially interacted with the increased speed camera activity, and that advertising with other themes and styles did not. In contrast, past MUARC research has suggested that drivers discriminate only between emotive and enforcement-related advertising, no matter what theme (Harrison and Senserrick 2000). Other MUARC research has shown that a speed enforcement-related advertisement, specifically related to moving mode radar speed detection units, magnified the effect of that enforcement on crashes (Diamantopoulou et al 1998).
4. The influence of the enforcement change was only in the Police District in which the change occurred. There were possible contamination effects in adjacent Districts. This would have reduced the sensitivity of the preliminary analysis in its ability to detect treatment effects.

6 ENFORCEMENT AND PUBLICITY INTERACTION EFFECTS ON CRASHES

6.1 BACKGROUND

As outlined in the earlier chapters, during 1999 the Victoria Police varied the levels of speed camera activity substantially in four Police Districts according to a systematic plan aimed at providing information on the effects of the enforcement, the supporting TAC publicity, and particularly the interaction between these two programs. This was the first time in many years that the Police had varied their enforcement operations in a way that facilitates scientific research. Previous MUARC research on the two programs has relied on natural operational variation to provide a basis for seeking relationships with road crashes. For this reason, it was important that a comprehensive analysis of the 1999 variations in enforcement and publicity be undertaken in a way that allows the interaction effects to be examined.

6.2 ANALYSIS ISSUES AND AIMS

Based on the findings and limitations of the preliminary analysis, it was decided that the main issues for the comprehensive crash analysis were:

1. Representing the enforcement impact level by the number of speeding TINS received in a month (but detected in current and previous months). The TINS should be categorised into high, medium and low levels, and effects examined for each level, rather than assuming any functional relationship between TINS and crash outcomes.
2. Representing the advertising impact level by the Adstock of television TARPs in previous weeks. Adstock (Broadbent 1979) is a measure of retained awareness of past and current levels of TARPs, based on an exponential decay function (using a half-life of 5 weeks). This should be categorised into high and low levels, rather than assuming any functional relationship with crash outcomes.
3. Considering the influence of TAC advertising (measured by Adstock) in three different ways, namely:
 - (a) speed-related advertising (all styles)
 - (b) speed-related enforcement-style advertising
 - (c) speed-related emotive-style advertising.Separate consideration of the enforcement-style and emotive-style advertising was undertaken because of the possibility that the enforcement-style advertising may interact differently with the speed camera enforcement, perhaps displaying greater synergy with the enforcement than emotive-style advertising. (Diamantopoulou et al 1998 found a related effect for advertising supporting moving mode radar speed enforcement.) The Adstock of enforcement-style advertising, with either drink-driving or speeding-related themes, was also considered but did not display any statistically significant links with crash outcomes.
4. Ignoring contamination effects in adjacent Districts, because most motorists become aware of the enforcement presence principally through the receipt of a speeding TIN, which specifies the location of the camera when the offence occurred.
5. Including trend and seasonal effects in the representation of crash outcomes over the five years 1996-2000. The representation of these effects is likely to increase the sensitivity of the statistical tests by reducing apparent chance variation. It will also serve to remove potential bias from the estimates of the effects of the factors of interest. To avoid any

assumptions of functional form, the trend would be represented by a yearly step change in the level of the series and the seasonality by eleven dummy step variables, for each District. Both would be treated as categorical variables in the analysis, without any assumptions of functional form.

6. Testing the statistical significance of parameters representing the step effects of the enforcement levels, advertising levels, and the interaction between these two, using generalised linear models of the crash outcomes (crash frequency and crash severity, respectively) by District and month during 1996-2000.

The analysis was designed to be conservative, making as few assumptions about the relationships between crash outcomes and the explanatory factors as possible, especially the functional forms of the relationships. It was decided that if the parameter estimates are suggestive of monotonic effects, a subsequent step may be to develop models of crash outcomes as functions of enforcement levels (measured by TINs issued in the month), advertising levels (measured by Adstock), an interaction term, and trend and seasonality.

It was expected that the analysis would produce more definitive results regarding the presence of interaction effects than the preliminary crash analysis conducted earlier. The parameterisation of the generalised linear models was expected to be more conclusive in answering the research question.

In summary, the aim of this further analysis was to develop models of monthly casualty crash frequencies and monthly crash severity levels for each Melbourne Police District⁴ as functions of the level of speed camera enforcement and the level of speed-related TAC advertising achieved per month, and the interaction between these two input factors. By doing this, the statistical significance of the interaction, and each of the main factors, can be tested.

6.3 CRASH DATA

For the evaluation period 1996-2000, the road trauma outcome criteria considered were:

- Number of casualty crashes, per month per district
- Proportion of the casualty crashes which were serious (resulting in death or serious injury), per month per district
- Proportion of the casualty crashes which were fatal, per month per district

6.4 SPEED ENFORCEMENT DATA

It was intended that the level of speed camera enforcement would be represented by TINs issued per month in each district. Ideally, the TINs *issuance date* should have been used to represent the enforcement impact level. Past research suggested an influence on crashes around camera sites for up to three weeks after the TINs were received, thus the issuance date TINs may more accurately reflect the impact on crashes. However, due to incomplete data of TINs issuance for the years 1999 and 2000, the data on TINs based on the *actual speed offence date* was used instead of the TINs issuance date. Figure 6.1 to Figure 6.4 show the TINs by month of offence detection for Districts E, I, C and H.

⁴ District A was not considered because for most of the analysis period, 1996-2000, speed camera operations were not conducted in this District.

Generally, speeding offence TINs are issued approximately 1-2 weeks after speed offence occurrence. Thus a change in behaviour that may influence crash outcomes may be expected to occur during the month following that in which the speeding offence occurred. To compensate for this time discrepancy in speed offence occurrence and the potential effect on crashes, the speed camera offences were ‘lagged’ one month (i.e. one month earlier than the month of crash occurrence), so that they could be approximately comparable to the month in which TINs issuance has its expected effect on crash rates. Hence the TINs detected in one month were considered to affect the following month’s crashes.

Figure 6.1 Monthly TINs detected in Police District E

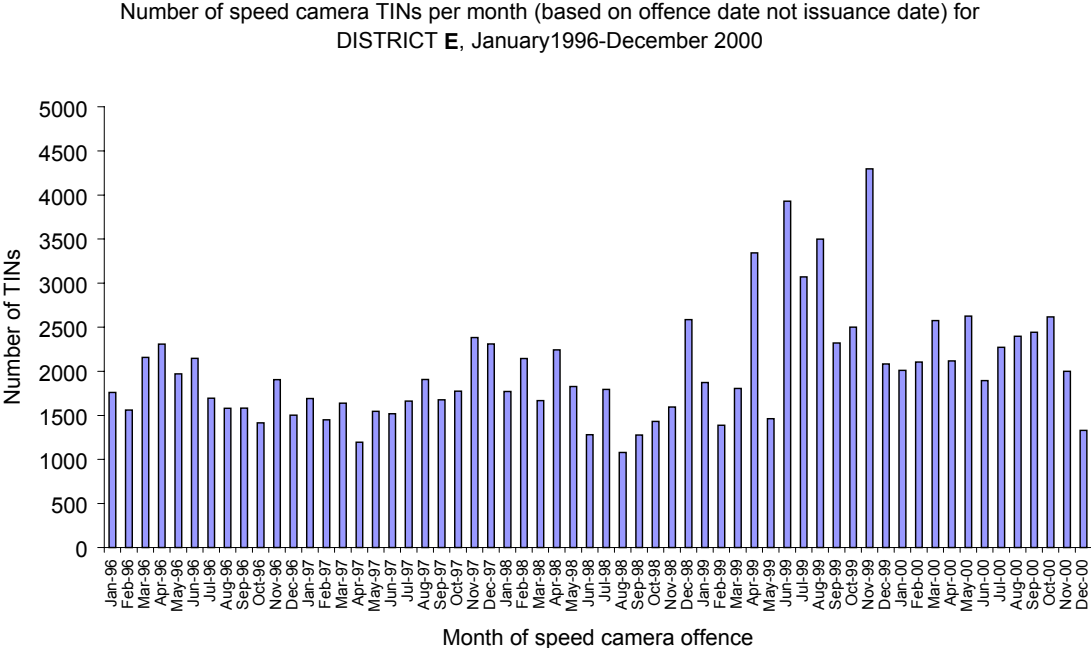
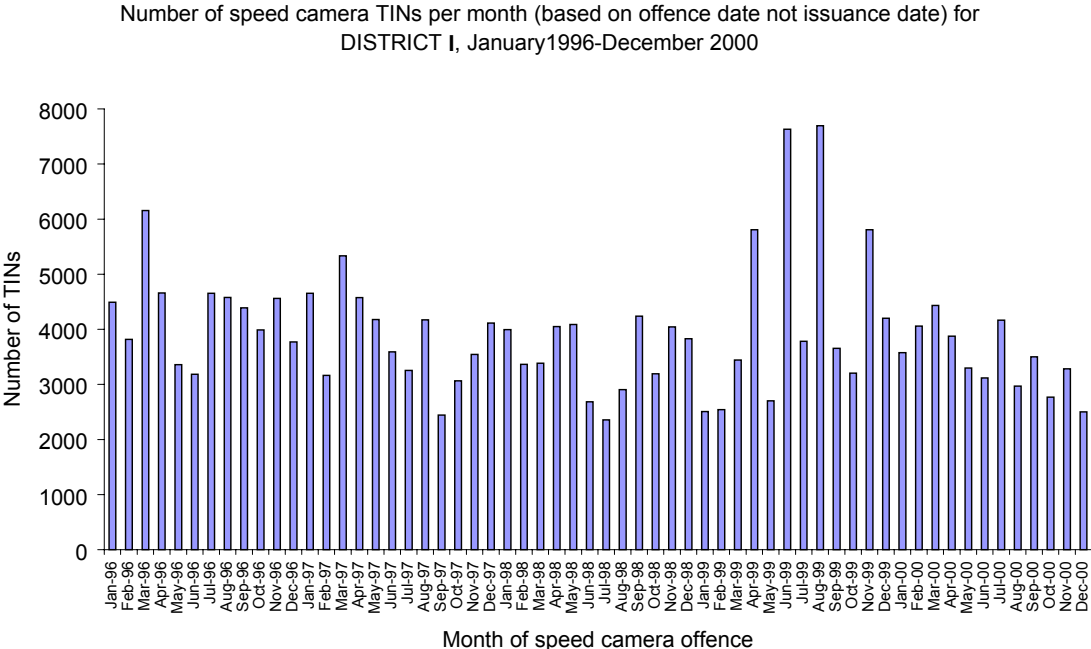


Figure 6.2 Monthly TINs detected in Police District I



There were substantial increases in the number of speed offences detected in Districts E and I during April, June, August and November 1999, corresponding to the months when speed camera hours were increased by approximately 50% or 100% in those months, according to the experimental design for this study.

The figures also show considerable variation in the number of TINs detected during other months in 1996-2000, a period when the speed camera operational hours per month were relatively stable (apart from December 1998). A relatively high level of TINs detected during December 1998 is apparent in District E but not in District I.

In part because of this substantial variation in monthly TINs detected throughout 1996-2000, not just in 1999 (as expected), it was decided that the analysis should examine relationships between monthly crash outcomes and the enforcement (represented by the speed camera TINs detected in the previous month) *throughout* the period 1996-2000. By making use of 60 months of crash data for each District, not just 12 months, it was expected that this would increase the statistical sensitivity of the tests for any enforcement effects and their interaction with speed-related publicity.

Thus, in contrast with the original study design focussed on effects during 1999, the study became an examination of the effects of variations in speed camera enforcement (measured by TINs), speed-related TAC advertising (measured by Adstock), and their interaction, over the whole period 1996-2000. The 1999 peaks in enforcement activity played a role in providing some extremes in the level of enforcement, but were no longer the principal focus of the crash analysis.

Figure 6.3 Monthly TINs detected in Police District C

Number of speed camera TINs per month (based on offence date not issuance date) for DISTRICT C, January 1996-December 2000

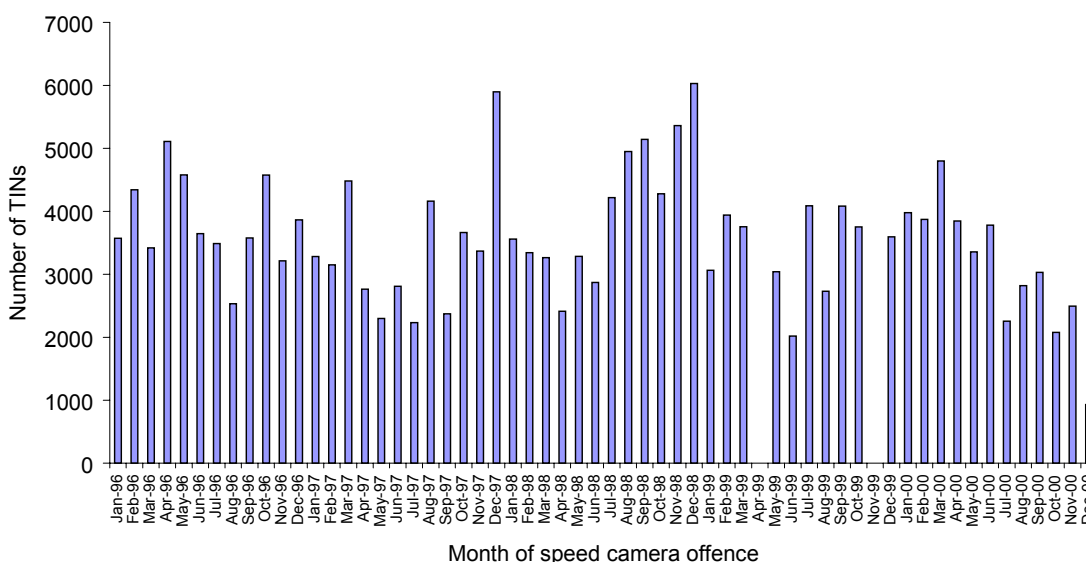
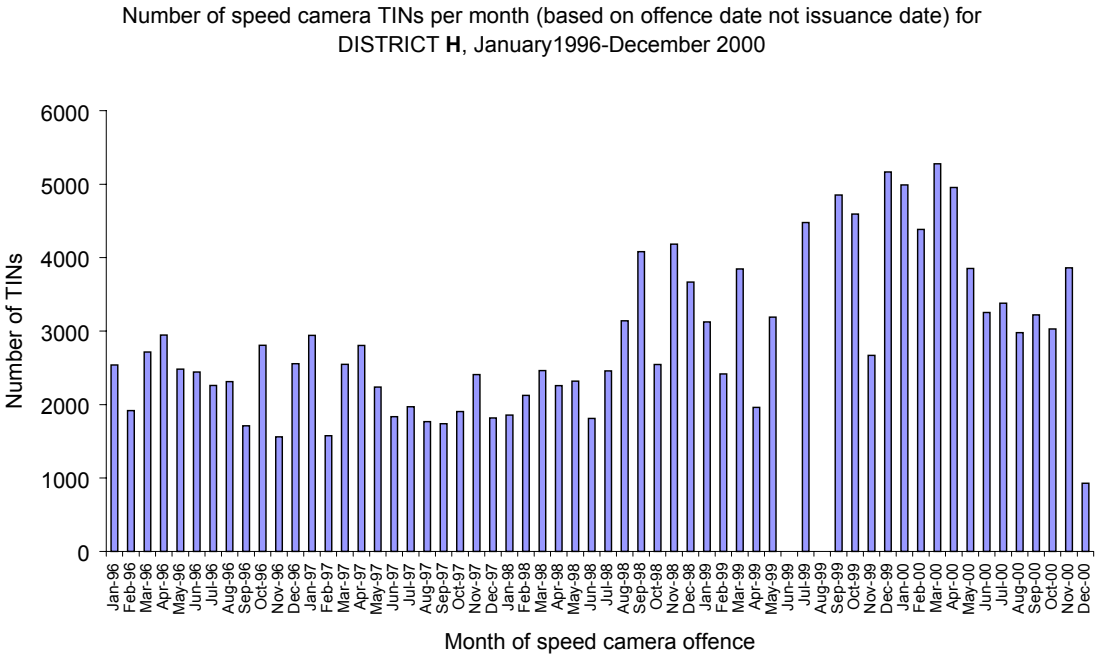


Figure 6.4 Monthly TINs detected in Police District H



As expected, in the Districts where the level of speed camera activity was reduced, there were consequential reductions in the number of speeding offences detected. There were none detected in District C during April and November, and in District H during June and August, when the cameras were deployed elsewhere. There were also apparent reductions in offences detected in these Districts during the months in which camera hours were reduced by approximately 50%.

The monthly variation in the number of TINs detected in Metropolitan Police Districts which were not subject to variation in speed camera operations is shown in Appendix C.

The detected speed offences were divided into 5 categories indicating whether the level of speed camera detections for a particular month in a particular district was considered Very Low (LL), Low (L), Medium (M), High (H) or Very High (HH). These categories were determined on the basis of the average monthly TINs value for a given district, plus or minus 10% and 30% of the average. That is:

- LL = Very Low (<30% less than the average)
- L = Low (Between 10% and 30% less than the average)
- M = Average (Between 10% less and 10% more than the average)
- H = High (Between 10% and 30% more than the average)
- HH = Very High (>30% more than the average)

The TINs categorisation was district and month based. Each district had different rates of speed camera offences and thus required different values for each of the 5 category boundaries. These values for each district are shown in Table 6.1.

Table 6.1 **Categorisation of monthly speed camera TINs for each Police District**

District	- 30%	-10%	Average	+ 10%	+ 30%
B	1768	2273	2526	2778	3283
C	2547	3274	3638	4002	4729
D	1487	1912	2125	2337	2762
E	1399	1799	1999	2199	2598
F	1926	2476	2751	3027	3577
G	3356	4315	4794	5274	6232
H	1941	2495	2773	3050	3604
I	2789	3586	3985	4383	5180
J	2063	2653	2948	3242	3832
K	1971	2534	2816	3097	3660

For example, in District B, the monthly level of TINs detected by speed cameras was classified into one of the following categories during each month of 1996-2000:

- LL: <1763
- L: 1768 ≤ L < 2273
- M: 2273 ≤ M ≤ 2778
- H: 2778 < H ≤ 3283
- HH: >3283

The complete matrix of lagged speed offence detections, categorised for each month within each district based on the above table, is shown in Appendix D.

6.5 SPEED-RELATED ADVERTISING DATA

The advertising impact level per month was represented by the Adstock of TARPs in previous weeks (using a half-life of 5 weeks), categorised into high and low levels. This representation was applied to TARPs covering the period 1996-2000. The category boundaries for discriminating between high and low levels of Adstock depended on the specific style of speed-related advertising considered (see below).

Adstock was first developed by Broadbent (1979) to describe the way that the audience's retained awareness is related to current and past levels of advertising measured by TARPs. MUARC has used Adstock among a set of predictors of road trauma trends in a number of studies (Cameron et al 1993, 1997; Newstead et al 1995, 1998) based on the assumption that awareness of the advertising messages may have influenced behaviour. Later studies by Broadbent (1984) and MUARC (Cameron et al 1999) found that, as well as an exponential decay in awareness with time, there appears to be a base level of awareness for the more-impactful advertising programs.

When Cameron et al (1999) related the awareness of TAC speed-related advertising to Adstock during 1995-1998, they found that the emotive-style advertising appeared to have a stronger influence on awareness levels than the enforcement-style advertising. Other MUARC research has shown that these two advertising styles may have varying effects on people in terms of advertising impact and awareness (Harrison and Senserrick 2000). Emotive-style advertisements were perceived to be more serious, relevant and credible, and more effective (in

terms of self-reported behaviour change). It may be expected that different advertising styles had differing effects on crash outcomes.

The influence of TAC advertising (represented by Adstock) was measured in three different ways, in parallel analyses, namely:

- speed-related advertising (all styles)
- speed-related enforcement-style⁵ advertising
- speed-related emotive-style⁶ advertising.

The advertisements classified by style are presented in Table 6.2. Advertisements launched prior to 1996 (the start of the evaluation period) are also included because the advertising was quantified by the Adstock function which represents **past** as well as current levels of publicity awareness.

Table 6.2 TAC Speed-related advertisements by STYLE: 1996-2000

Advertisement Title	Style	Launch Date
Beach Road	Emotive	April 1990
Speed camera	Enforcement	April 1990
Tracey	Emotive	August 1990
6 O’Clock News	Emotive	September 1993
Courtroom	Emotive	November 1993
Mum in a Hurry	Emotive	September 1995
Gravel Truck	Emotive	June 1996
Mobile Radar	Enforcement	November 1996
Laser	Enforcement	November 1996
10 kph less	Emotive/Instructive	May 1997
Covert	Enforcement	October 1997
Young Cops	Enforcement/Emotive	June 1998
Blame	Emotive	November 1999
Consequences	Enforcement	July 2000

The Adstock of different advertising styles was categorized into high and low levels of advertising using somewhat arbitrary cut-off points to discriminate between high and low levels. These cut-off points for each advertising style are shown on Figure 6.5 to Figure 6.7 representing each of the three advertising styles.

Television advertising in Melbourne covers the whole metropolitan area. Therefore, monthly Adstock was available only for the entire Melbourne area, not each District separately. The matrix indicating whether the advertising style was considered high or low for each style of advertising, by month in 1996-2000, is shown in Appendix E.

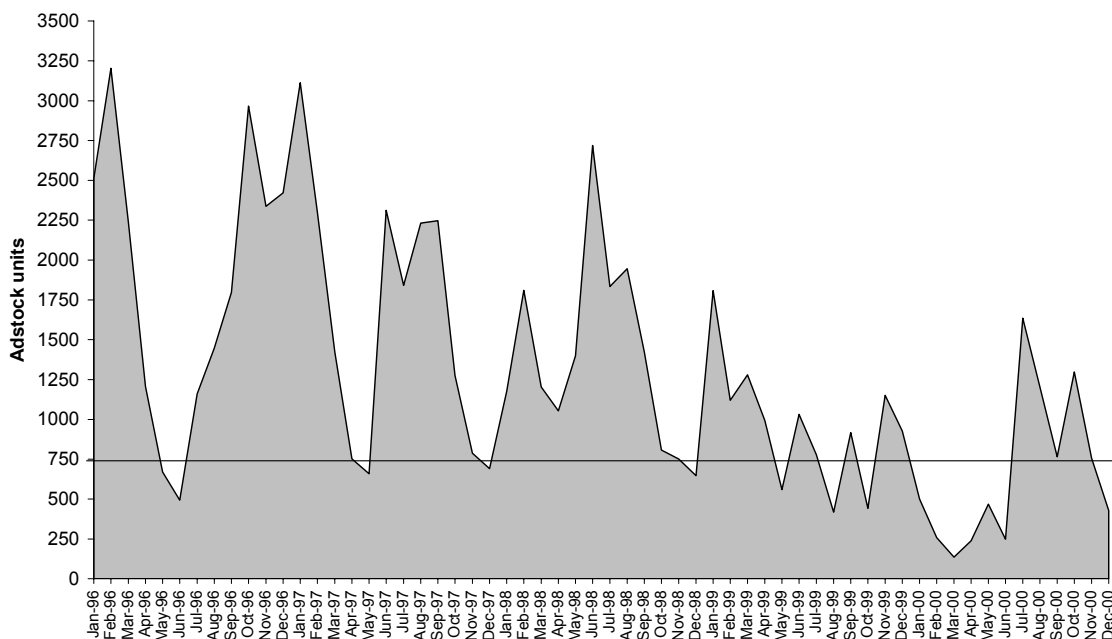
⁵ Also included one advertisement aired during the evaluation period, “Young Cops”, that was classed as a mix of enforcement/emotive styles.

⁶ Included one advertisement aired during the evaluation period, “10 kph less”, that was classified as a mix of emotive/instructive styles, as well as the “Young Cops” advertisement (i.e. a mix of emotive/enforcement styles).

6.5.1 Speed-related advertising awareness

Figure 6.5 shows the variation in speed-related advertising (all styles) from 1996 to 2000 in Adstock units. The advertising has been divided into high and low using a cut-off at 750 Adstock units, chosen to provide discrimination during 1999 in particular. The graph indicates that the advertising is cyclical in nature, that is, there were periods of high advertising awareness and periods of low. Speed-related advertising was a frequently-used theme from January 1996 to the end of 1998, after which there appeared to be a drop in advertising intensity for this particular theme.

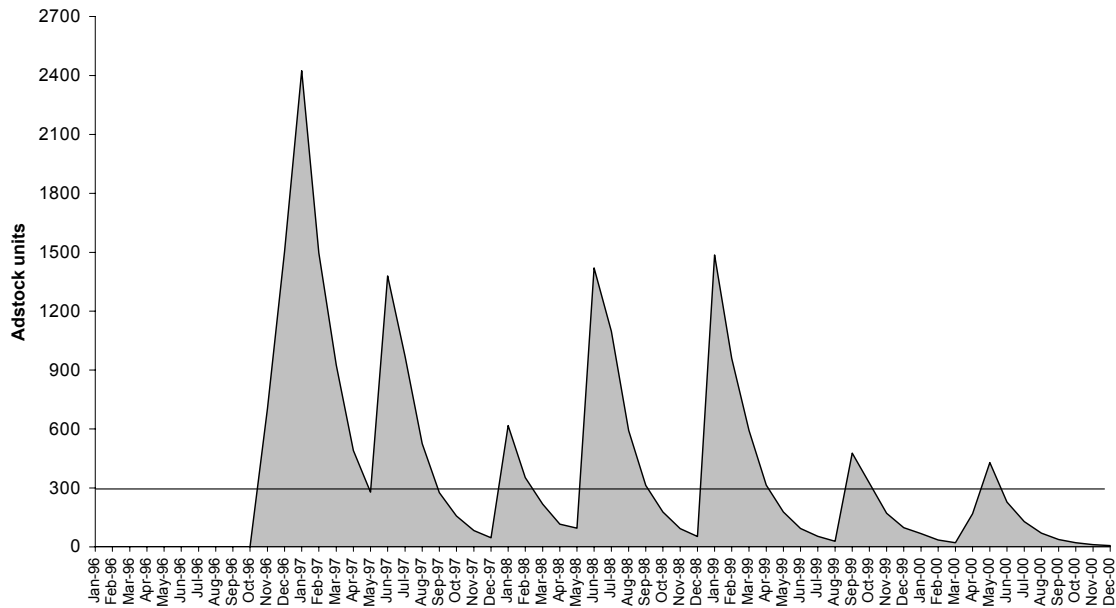
Figure 6.5 Speed-related Adstock per month, Melbourne 1996-2000



6.5.2 Speed-related enforcement-style advertising awareness

The enforcement-style advertising with speeding themes has been divided into high and low using a cut-off at 300 ADSTOCK units as shown on Figure 6.6. This type of advertising had not been used for many years until late 1996. The peaks in awareness of this advertising style occurred around January each year during 1997-1999 and around June during 1997-1998. The style was not so commonly used after mid-1999, so awareness levels were apparently relatively low during this period.

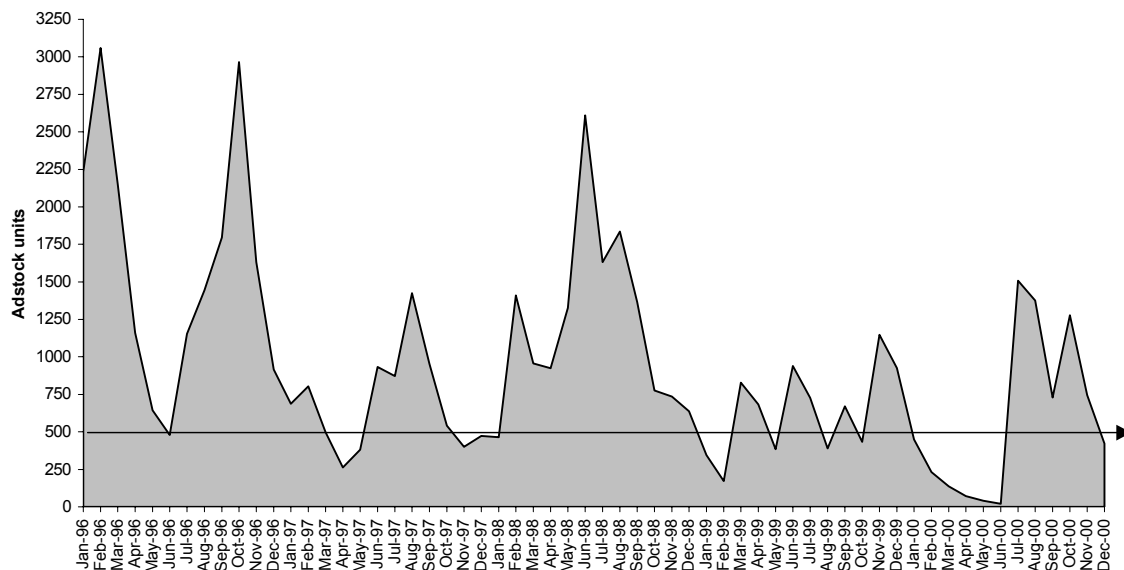
Figure 6.6 Speed-related Enforcement style (including enforcement/emotive style) Adstock per month, Melbourne 1996-2000



6.5.3 Speed-related emotive-style advertising awareness

The emotive-style advertising was less cyclical in nature and the trend appears to more variable than the enforcement style, as demonstrated in Figure 6.7. This was a common style of advertising with speed-related themes from 1996 to 1998. It appears to have increased in intensity near the end of 2000 after a reduction during 1999.

Figure 6.7 Speed-related Emotive style (including emotive/instructive and emotive/enforcement styles) Adstock per month, Melbourne 1996-2000



6.6 ANALYSIS METHODOLOGY

6.6.1 Types of analysis

Two statistical techniques, both belonging to the Generalised Linear Modelling family, were used to analyse the effect of speed camera enforcement and speed-related advertising on crash outcomes during 1996-2000. The first was a Poisson Regression Modelling approach, to determine the effect on casualty crash frequency, and the second was a Logistic Regression to determine the effect on the severity of the crashes.

Poisson Regression Modelling was used to model crash frequency. This technique assumes that the underlying distribution is not necessarily continuous. In the situation where crash frequency is modelled, it allows the choice of an appropriate error structure which will model the observed discrete crash frequency response by using a Poisson log-link function. This is also known as log-linear modelling. This function restricts the fitted values to positive values, which is realistic when modelling crash frequency and, being on a log scale, represents the multiplicative effect of a change in one of the independent variables. The Generalized Linear Modelling also allows a mixture of continuous and discrete independent variables to be modelled.

Logistic Regression was used in the analysis to model crash severity. This was analysed using two separate regressions, where the difference lay in the dependent variable. The first regression used the proportion of total casualty crashes that were fatal as the dependent variable, and the second regression considered the proportion of crashes that were serious casualty crashes. Serious casualty is defined as those that were either fatal or serious injury crashes. Whether the crash was fatal (or, alternatively, whether the crash was a serious casualty one) is a dichotomous response and therefore these crash severity rates are appropriately modelled using a logistic regression which models binary dependent variables as a function of independent variables.

6.6.2 Model Assumptions

The Poisson Regression Model and Logistic Regression make similar assumptions. Both techniques assume independence among the independent or explanatory variables. Multicollinearity leads to biased results and inflated standard errors, which leads to Type II errors, i.e. not rejecting the null hypothesis, when in fact the effect is real. They also both also assume that the model has been correctly specified and that all relevant variables have been included in the model and irrelevant variables not included.

The Hosmer and Lemeshow (1989) goodness-of-fit test was carried out on each of the logistic regression models to determine whether the fitted model was an adequate fit. Each model produced a non-significant result thus suggesting an adequate fit.

6.6.3 Model Specification

The effect of speed camera enforcement and different styles of advertising on the crash number and severity was modelled, as well as any synergistic or interaction effect from any particular combination of enforcement and advertising. An interaction is when the effect of one level of a factor depends on the level of another factor. The effects of these factors may not be simply additive and may have a synergistic effect. There are potentially ten interactive combinations effects for each model analysed, that is, five levels of enforcement by two levels of advertising. The relevant hypotheses to test for an effect are:

$H_0:$	$\alpha_i = 0$	i.e. there is no enforcement effect,	where $i=1,2,3,4,5$
$H_1:$	$\alpha_i \neq 0$	i.e. there is an enforcement effect	
$H_0:$	$\beta_j = 0$	i.e. there is no advertising effect,	where $j=1,2$
$H_1:$	$\beta_j \neq 0$	i.e. there is an advertising effect	
$H_0:$	$\alpha\beta_{ij} = 0$	i.e. there is no interaction effect	
$H_1:$	$\alpha\beta_{ij} \neq 0$	i.e. there is an interaction effect	

However, in order to measure these effects, all other influences on crash frequency and crash severity rate should be accounted for in the model.

It was seen in Figure 5.2 that the different districts have different crash frequencies. This was allowed for in the model by specifying a dummy variable which modelled the district as a fixed factor. Since monthly crash frequency was analysed, it was hypothesised that some kind of seasonal effect could be expected where, across the years, there may be months of high crash frequency and months of low crash frequency. This was modelled by using a dummy indicator variable to represent each month of crash. To capture any yearly trends over the five-year period 1996–2000, an indicator variable to represent year of crash was specified.

The model also allowed for any interactions between the district, year and month. This was done by including two-way interaction terms in the model. The Month by Year interaction assumes seasonality effects are not the same every year. Including the District by Month and District by Year interactions, allows the effect of month and yearly trend to vary by district as well. A Month by Year by District three-way interaction term was not included in the model as this would serve to effectively explain all of the variation in crash outcomes by itself and leave no purpose for the modelling process.

The representation of these additional effects is likely to increase the sensitivity of the statistical tests by reducing apparent chance variation. These variables, as well as the variables of interest, are explained in Equation 1 (see below) which represents the general model used in the analysis.

6.6.4 Analysis Models

There were three models considered to test the effect of speed camera enforcement, publicity, and the interaction effect of both together, on crash frequency and crash severity. These models are summarised in Table 6.3.

Table 6.3 Model Summary

Model	Speed Camera Enforcement	Advertising Theme / Style
1	Five categories based on TINs detected*	Speed-related (all styles)
2	"	Speed-related Enforcement style
3	"	Speed-related Emotive style

* Traffic Infringement Notices for speeding offences detected in the District during the previous month

The principal difference in Models 1-3 related to the different advertising styles as described in Section 6.5.

The general model and specification of independent variables for the Poisson Regression Modelling and the Logistic Regression were the same, but the dependent variable was different for the different types of techniques. The Poisson Regression modelled the casualty crash

frequency, whereas the Logistic Regression modelled the binary outcomes of (i) fatal or non-fatal casualty crash, and (ii) serious or non-serious casualty crash. The following Equation 1 represents the crash analysis model.

Equation 1 General Equation used in the Poisson Regression and Logistic Regression

$$\text{Log (Crash}_{ijklm}) = \alpha + \beta_{1i} * \text{District}_i + \beta_{2j} * \text{Month}_j + \beta_{3k} * \text{Year}_k + \beta_{4l} * \text{TIN}_{S_{l(t-1)}} + \beta_{5m} * \text{Advertising}_m + \beta_{6lm} * (\text{TIN}_{S_{l(t-1)}} * \text{Advertising}_m) + \beta_{7jk} * (\text{Month}_j * \text{Year}_k) + \beta_{8ij} * (\text{District}_i * \text{Month}_j) + \beta_{9ik} * (\text{District}_i * \text{Year}_k) + \varepsilon_{ijklm}$$

Where,

- Crash = No. of casualty crashes, for the Poisson Regression analysis.
P/(1-P), for the Logistic Regression, where P is the probability of (i) fatal or (ii) serious casualty outcome in a crash.
- District = District effect for district i
where i = B, C, D, E, F, G, H, I, J, K.
- Month = Dummy variable for each of the 12 months
where j = Jan, Feb, ... , Dec.
- Year = Dummy variable for each of the 5 years
where k = 1996, 1997, 1998, 1999, 2000.
- TINs = Categorical coding of speeding offences detected in the District during the previous month into 5 levels, as described in section 6.4. Reference level = Medium.
where l = 1,2,3,4,5
- Advertising = Categorical coding of advertising Adstock into High and Low, as described in section 6.5. Reference level = Low.
where m = 1,2
- TINs*Advertising = Interaction effect of TINs and advertising at different levels.
- Month*Year = Allows seasonality to change across years.
- District*Month = Allows seasonality to vary by district.
- District*Year = Allows yearly trends to vary by district

6.6.5 Goodness of Fit

The scaled deviance of each of the Poisson Regression models was assessed to determine whether the regression model gave an adequate fit. If the regression model is an adequate fit, then the ratio of deviance to the degrees of freedom should be close to one. Each of the models gave a scaled deviance of approximately 1.2 which suggests an adequate model.

Under the Poisson Regression Modelling analysis, when comparing the scaled deviances between competing models it was found that all three models had approximately the same

value. Therefore this test did not discriminate between the models to help decide which best fitted the crash data and best represented reality.

6.6.6 Inclusion of interaction term

The statistical significance of the interaction term in the models was determined by examining the change in scaled deviance in a reduced model, which did not include the interaction term, in comparison with a saturated model, which included the term. The scaled deviance is a measure of the goodness of fit and is able to distinguish between competing models regarding whether an effect helps to explain any additional variation in the model. The relevant hypothesis is:

H ₀ :	Reduced Model without additional effect	i.e. effect = 0
H ₁ :	Model with additional effect	i.e. effect ≠ 0

The scaled deviance of the Enforcement by Publicity interaction was analysed to see if the term contributed to explaining the variation in the model. It was found that when testing the interaction for significance, a non-significant result was found for all models (see detailed results below). Therefore it could be concluded that the interaction term is not necessary to be included in the model to help explain the effects of speed camera enforcement and publicity, and did not contribute to explaining the variation in the crash outcomes.

6.7 MODELLING RESULTS

The full model, Equation 1, was fitted to the monthly crash outcomes over the five years 1996-2000 (60 months) and the ten Police Districts (600 observations in all). When the crash outcome was the number of casualty crashes, the equation fitted was the Poisson Regression Model. When the crash outcome was a dichotomous variable representing the severity of the casualty crashes (see Section 6.3), the equation fitted was the Logistic Regression. While the models aimed at a comprehensive representation of the 600 crash outcomes in each case, the principal focus was on the enforcement and publicity factors and their interaction.

The results for each of the three styles of speed-related publicity considered, outlined in Table 6.3, are given below. The tables present only the modelling results for the variables of interest - speed camera enforcement, publicity and the enforcement/publicity interaction. All other variables as specified above in Equation 1 were included to help explain the crash outcomes, but were otherwise of limited interest and are therefore not presented. However, to determine the effect of the principal factors, the analysis needed to consider the influence of all factors, including the district, month and year variables.

6.7.1 Interpretation of Results

The Poisson Regression Model coefficient estimates are interpretable multiplicatively as a percentage change, holding all else constant in the model. The direction of an effect is defined by whether the coefficient is positive or negative, indicating an increase or decrease in the dependent variable, the number of casualty crashes. For example, at low levels of enforcement we might expect a positive coefficient to suggest that with lower levels of enforcement, there would be an increase in crash frequency. The 95% confidence limits for the percentage change are interpreted in the same way.

Interpretation for the Logistic Regression is slightly different to that of the Poisson Regression Model. The coefficient is given in terms of the log odds and this is more interpretable as an odds ratio (relative risk) by taking the exponent. Odds ratios are given in the relevant tables below. If the odds ratio is greater than one, then the particular effect is associated with higher odds of fatal or serious casualty outcome of the casualty crashes. Again, the 95% confidence limits are interpreted in the same way as odds ratios.

Each effect is compared to a reference group. For the level of enforcement, the reference group is the Medium level of TINs detected. By choosing an average level as the reference group, it was more convenient to interpret effects from the lower and higher levels in relation to an average group and whether the effects are in the expected direction, i.e. an increase or decrease. The publicity reference group was selected to be Low level. A negative coefficient associated with the effect would suggest that high levels of advertising awareness are associated with a decrease in crash frequency.

The signs of the coefficients of the interaction terms are directly interpretable but need to be considered in conjunction with the parameterisation (particularly reference levels) of the two main effects (enforcement and publicity) in order to determine direction. Each combination of enforcement and publicity levels which include a reference group for one of these factors (Medium enforcement and Low publicity, respectively) becomes a reference level for the interaction. The other interaction coefficients represent an adjustment for the effect when the two main effect coefficients are combined.

The Poisson Regression Modelling uses an asymptotic chi-square test to test for statistical significance of each individual level of effect, compared to the reference group. For the logistic regression, the Wald chi-square value tests the hypothesis that a particular total effect (all levels) is zero. The associated p-value (value of statistical significance) is shown beside each chi-square statistic. All significant values at the 5% value have been highlighted.

6.7.2 Model 1: Speed Camera TINs & Speed-related Advertising (all styles)

6.7.2.1 *Number of casualty crashes*

Table 6.4 shows the estimated coefficients of the enforcement, publicity and interaction terms in the Poisson Regression Modelling of monthly casualty crashes. The coefficients for district, month, year and their interactions are not presented because, although statistically significant, these factors are not relevant to the tests for the presence of enforcement and publicity effects.

Table 6.4 Model 1 Poisson Regression Table of Estimates

Parameter	d.f	Percentage Change	Percentage Change CI		Chi-Square	p-value
			Lower	Upper		
Enforcement						
Very Low	1	6.82	-1.63	15.99	2.46	0.116
Low	1	3.62	-2.10	9.67	1.51	0.220
High	1	-2.11	-7.21	3.27	0.61	0.435
Very High	1	-3.00	-8.23	2.52	1.17	0.280
Medium	0	0.00	0.00	0.00	.	.
Publicity						
High	1	-12.20	-22.62	-0.39	4.08	0.043
Low	0	0	.	.	.	.
Enforcement * Publicity						
Very Low * High	1	-4.35	-12.46	4.50	0.97	0.324
Very Low * Low	0	0	.	.	.	.
Low * High	1	-1.29	-7.54	5.38	0.15	0.697
Low * Low	0	0	.	.	.	.
High * High	1	2.01	-4.37	8.83	0.37	0.546
High * Low	0	0	.	.	.	.
Very High * High	1	3.63	-3.35	11.14	1	0.316
Very High * Low	0	0	.	.	.	.
Average * High	0	0	.	.	.	.
Average * Low	0	0	.	.	.	.

A global test of the statistical significance of the interaction coefficients was undertaken by examining the increase in scaled deviance when the enforcement by publicity interaction was removed from the model. The increase in deviance was 3.42 on 4 d.f., which was not statistically significant ($p = 0.490$). None of the four interaction coefficients were individually statistically significant (Table 6.4). While not significant, the signs and magnitudes of the interaction coefficients were consistent with negative synergy, ie. when high enforcement and high publicity awareness operated together, their combined effect was less than expected from their individual effects.

A global test of the enforcement coefficients was also performed by examining the increase in scaled deviance when the enforcement factor was removed from the reduced model above. The increase was 6.53 on 4 d.f., which was only marginally statistically significant ($p = 0.163$). None of the enforcement coefficients were individually significant. However, their monotonic pattern of estimated effects was consistent with the expected enforcement effect, decreasing from an estimated 6.8% increase in casualty crashes associated with very low levels of enforcement, to a 3.0% decrease in crashes with very high levels of enforcement. The estimated effects for the intermediate levels of enforcement are consistent with the smooth relationship identified by Elvik (2001; see Section 2.1).

The coefficient of the publicity factor was statistically significant ($p = 0.043$) and, being dichotomous, this factor did not require a global test. High levels of speed-related advertising awareness were associated with a 12.2% reduction in casualty crashes, relative to the effect at low levels of awareness.

6.7.2.2 Adequacy of the crash frequency model

As noted in section 6.6.5, each of the Poisson Regression Models of monthly casualty crashes had scaled deviance approximately 1.2 times the degrees of freedom, suggesting that the model was an adequate fit to the data. Comparisons of the crash frequencies predicted by Model 1 with the actual monthly crashes in Districts E, I, C and H (the districts in which camera hours were manipulated during 1999) are shown in Figure 6.8 to Figure 6.11.

These figures confirm the relatively good fit of Model 1 to the monthly casualty crashes during 1996-2000 in all ten districts. It is noteworthy that Model 1 severely underestimates the actual crash frequency in District E during June 1999. It will be recalled that the relatively high number of crashes in this situation was apparently the source of the statistically significant increase associated with the combination of 50% increase in speed camera hours when speed-related publicity was present (see Section 5.4). That same month appeared to be associated with a relatively high level of risky speeding in District E (see Figure 5.4). There were no similar findings for District I in November 1999, the other situation in which 50% increase in camera hours was combined with the presence of speed-related publicity.

These observations confirm the limited nature of the preliminary analysis, which focused on only four months of crash outcomes compared with 60 months in the comprehensive analysis reported in this chapter. The finding from District E during June 1999 may have been artifactual, especially since it was not confirmed in District I during November 1999 under the same conditions. The comprehensive analysis was less susceptible to possibly chance fluctuations in speeding behaviour from month to month, which apparently occurred in District E during 1999. It was also more specifically focused on the likely effects of the changed enforcement on the crashes during periods subsequent to the month in which the change occurred (see Section 6.4).

Figure 6.8 Fit of Model 1 to District E crashes, 1996-2000

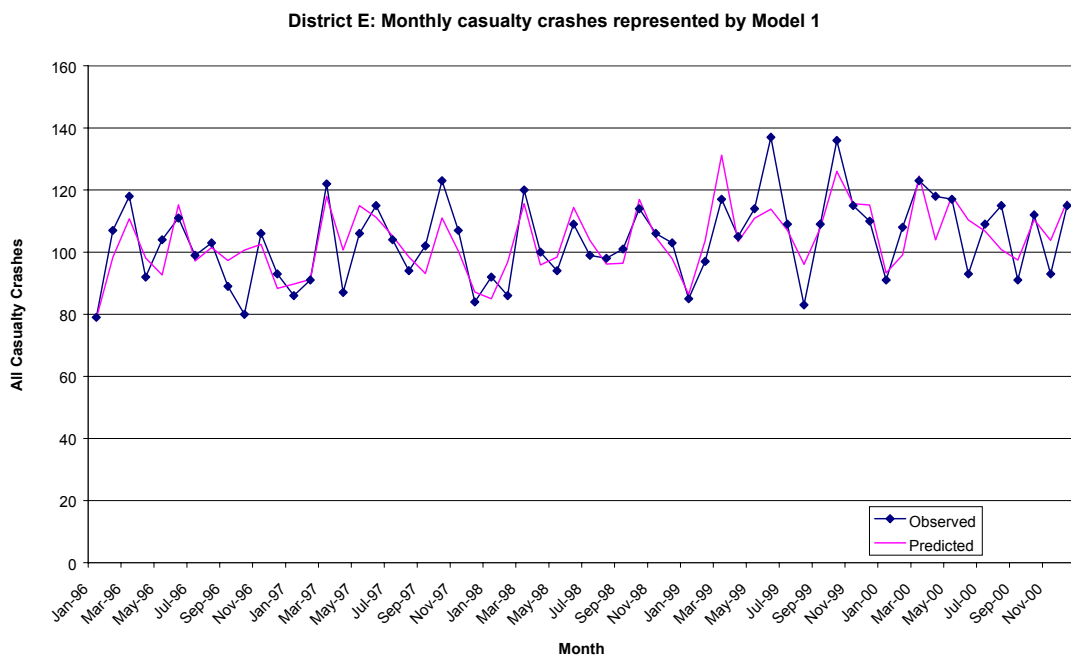


Figure 6.9 Fit of Model 1 to District I crashes, 1996-2000

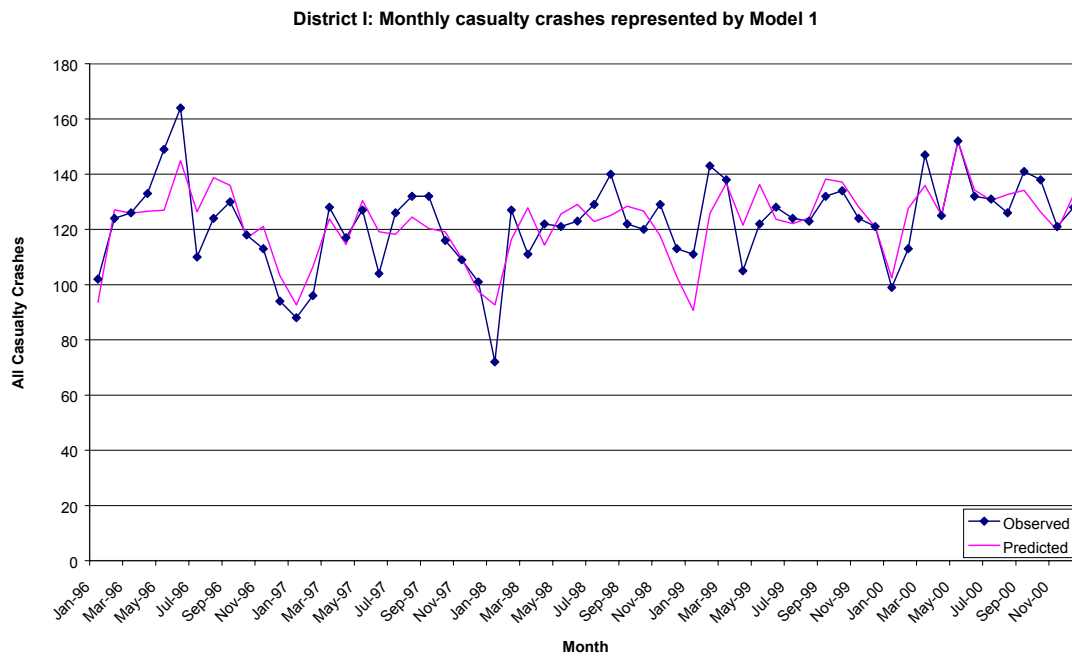


Figure 6.10 Fit of Model 1 to District C crashes, 1996-2000

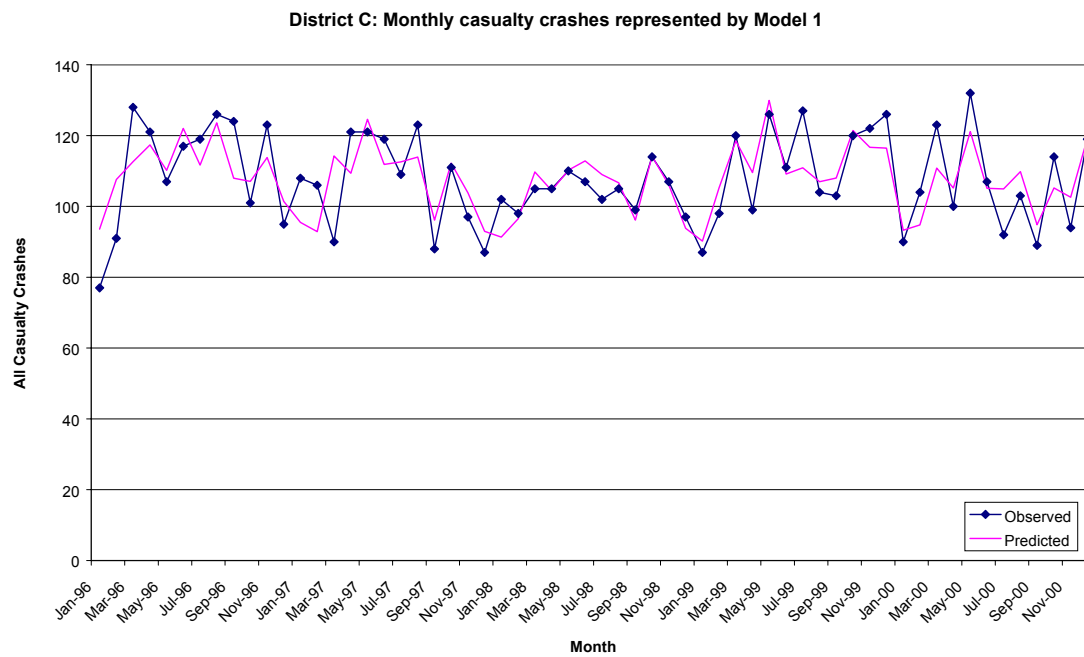
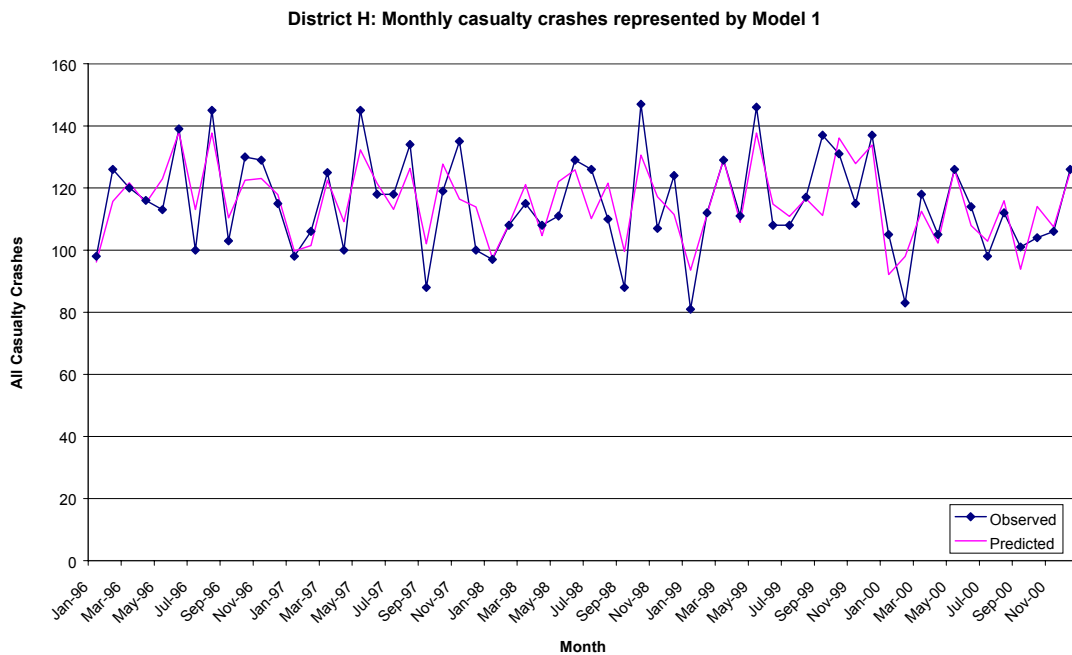


Figure 6.11 Fit of Model 1 to District H crashes



6.7.2.3 Casualty crash severity

The severity of the monthly casualty crashes was measured in two ways: (i) the proportion of such crashes resulting in a fatality, and (ii) the proportion of crashes resulting in death or serious injury. Logistic Regression was used to model these monthly proportions.

6.7.2.3.1 Fatal crash rate

Table 6.5 shows the Logistic Regression results for crash severity measured by the fatality rate, ie. the proportion of casualty crashes resulting in a fatality. The odds ratios measure the estimated relative risk that the casualty crash outcome will be fatal under the particular enforcement or publicity condition, relative to the risk under the condition of the reference category (ie. Medium enforcement and Low publicity, respectively).

Neither the enforcement by publicity interaction, nor the publicity awareness level, had a statistically significant effect on the fatality rate. Hence, while there are some apparently quite substantial departures in relative risk from one for these two factors, there is no reliable evidence that these effects are real and not due to chance.

In contrast, the level of speed camera enforcement measured by TINs detected in the previous month, was statistically significantly associated with the fatality rate. The odds ratio of 0.59 associated with Very High level of enforcement was individually statistically significantly different from one ($p = 0.035$), suggesting that the risk of fatal casualty crash outcome associated with speed camera offence detections at this level is 41% less than expected from medium levels of enforcement. The relative risk appears to range from 1.44 associated with Very Low levels of enforcement to 0.59 associated with Very High levels.

Table 6.5 Model 1 Logistic Regression estimates for fatal crash severity

Parameter	d.f	Odds Ratio	Odds Ratio 95% CI		Chi-Square	p-value
			Lower	Upper		
Enforcement						
Very Low	1	1.44	0.77	2.70	1.29	0.255
Low	1	0.94	0.60	1.49	0.06	0.803
High	1	0.97	0.63	1.49	0.03	0.872
Very High	1	0.59	0.36	0.96	4.47	0.035
Medium	0	.	.	.	.	.
Publicity						
High	1	1.80	0.60	5.36	1.10	0.294
Low	0	.	.	.	.	.
Enforcement * Publicity						
Very Low * High	1	0.69	0.35	1.36	1.16	0.281
Very Low * Low	0	.	.	.	.	.
Low * High	1	0.93	0.55	1.57	0.08	0.775
Low * Low	0	.	.	.	.	.
High * High	1	0.92	0.55	1.56	0.09	0.768
High * Low	0	.	.	.	.	.
Very High * High	1	1.54	0.83	2.83	1.88	0.171
Very High * Low	0	.	.	.	.	.
Average * High	0	.	.	.	.	.
Average * Low	0	.	.	.	.	.

6.7.2.3.2 Serious casualty crash rate

The Logistic Regression results for serious casualty rate (ie. the proportion of casualty crashes resulting in death or serious injury) did not suggest any statistically significant effects associated with the enforcement, publicity or enforcement by publicity interaction. For this reason, no regression estimates are presented here because there is no reliable evidence that the apparent effects were real and not due to chance.

6.7.3 Model 2: Speed Camera TINs & Speed-related Enforcement-style Advertising

The format and process of analysis for Model 2 was identical to Model 1, except that the Adstock of only the enforcement-style of speed-related advertising was considered as an explanatory factor (see Section 6.5.2). Model 1 had included the Adstock of all styles of speed-related advertising.

6.7.3.1 Number of casualty crashes

Table 6.6 shows the results of Poisson Regression Modelling of monthly casualty crashes for Model 2. The increase in scaled deviance when the enforcement by publicity interaction was removed from the model was 3.64 on 4 d.f., which was not statistically significant ($p = 0.457$). None of the four interaction coefficients were individually statistically significant. There was no clear pattern suggestive of positive or negative synergy in these non-significant coefficients. Overall, there was no apparent evidence of any interaction effect.

Table 6.6 Model 2 Poisson Regression Table of Estimates

Parameter	d.f	Percentage Change	Percentage Change CI		Chi-Square	p-value
			Lower	Upper		
Enforcement						
Very Low	1	0.99	-3.42	5.61	0.19	0.664
Low	1	3.62	0.23	7.13	4.39	0.036
High	1	-1.05	-4.62	2.64	0.32	0.571
Very High	1	-1.38	-5.09	2.46	0.51	0.476
Medium	0	0	0	0	.	.
Publicity						
High	1	14.57	1.22	29.69	4.630	0.032
Low	0	0	0	0	.	.
Enforcement * Publicity						
Very Low * High	1	3.19	-3.60	10.47	0.82	0.366
Very Low * Low	0	0	.	.	.	.
Low * High	1	-2.72	-7.83	2.66	1.01	0.315
Low * Low	0	0	.	.	.	.
High * High	1	0.68	-5.83	7.64	0.04	0.843
High * Low	0	0	.	.	.	.
Very High * High	1	1.27	-5.69	8.74	0.12	0.729
Very High * Low	0	0	.	.	.	.
Average * High	0	0	.	.	.	.
Average * Low	0	0	.	.	.	.

The global test of the effect of the enforcement factor was also not statistically significant. However, the coefficient associated with a Low level of enforcement was ($p = 0.036$). An estimated 3.6% increase in monthly casualty crashes was associated with this level of enforcement. However, the results suggested that Very Low enforcement was associated with only 0.99% increase in crashes (though this result was not necessarily reliable). The absence of a monotonic trend of effects on crash frequency associated with increasing levels of enforcement, in contrast with previous findings (Elvik 2001), casts doubt on the reliability of the set of estimates of the enforcement effects.

The coefficient of the publicity factor was statistically significant ($p = 0.032$) and the estimate suggested that High levels of enforcement-style speed-related advertising awareness were associated with a 14.6% increase in casualty crashes. This result was counter-intuitive, because at worst it could be expected that the advertising had no effect on crashes, but not actually increase the risk of a casualty crash. In part, this result may have been an artifact of the modelling brought about by the strong statistically significant effect of the emotive-style speed-related advertising (see Section 6.7.4.1), which in turn seemed to explain most of the effect of speed-related advertising of any style (Section 6.7.2.1).

During more than half of the months in 1996-2000, the level of awareness of TAC's enforcement-style speed-related advertising was low when the awareness of the emotive-style was high, or vice-versa (Table 6.7). Thus in the modelling described here, where the enforcement-style advertising replaced speed-related advertising of any style, the estimated effect of the advertising may have reversed its sign because the advertising factor was mainly a proxy for the *absence* of high awareness of the emotive-style advertising.

Table 6.7: Comparison of levels of awareness of the two styles of speed-related TAC advertising each month during 1996-2000

Awareness of enforcement-style advertising	Awareness of emotive-style advertising	
	High	Low
High	15	7
Low	26	12

This apparently artifactual effect of the inclusion of the enforcement-style advertising in the modelling, combined with the absence of a monotonic trend in the estimated enforcement effects, casts considerable doubt on the Model 2 representation of the monthly casualty crashes. For this reason, it may be difficult to reach conclusions about the effect of the enforcement-style advertising on casualty crash frequency (see discussion in Sections 9.1.3 and 9.3.3).

6.7.3.2 Casualty crash severity

As for Model 1, the severity of the monthly casualty crashes was measured in two ways in the analysis of Model 2: (i) the proportion of such crashes resulting in a fatality, and (ii) the proportion of crashes resulting in death or serious injury.

6.7.3.2.1 Fatal crash rate

Table 6.8 shows the Logistic Regression results when crash severity was measured by the fatality rate. The fatality rate was associated with the level of speed camera enforcement, with the odds ratio of 0.74 associated with Very High enforcement being statistically significant ($p = 0.052$). The odds ratio of 0.76 for High enforcement was similar and marginally statistically significant ($p = 0.069$). This suggests that the risk of fatal casualty crash outcome was 24-26% less at these levels of enforcement compared with medium and lower levels (the latter having odds ratios not significantly different from one).

However these relative risk estimates need to be tempered by the apparent interaction between the enforcement level and publicity awareness. While the odds ratio associated with High levels of awareness of the enforcement-style advertising was 0.56 (but not statistically significant), the combination of High level enforcement and High publicity awareness had a conditional odds ratio of 1.77 which was statistically significant ($p = 0.040$). Thus the estimated relative risk associated with this combination of enforcement and publicity was $1.77 \times 0.76 \times 0.56 = 0.75$, relative to the risk with medium enforcement and low publicity awareness. In contrast, the estimated relative risk associated with Very High enforcement and High publicity awareness was $0.74 \times 0.56 = 0.41$ (ignoring any adjustment by the conditional odds ratio of 1.16 because it was not statistically significant).

Thus, when there was an increase in the level of speed camera enforcement (measured by TINs detected in the previous month) during months when there was high awareness of enforcement-style speed-related advertising, there appeared to be a substantial reduction in the risk of fatal crash outcome when the enforcement level was very high but not when it was only high (see definitions in Section 6.4). The magnitude of this reduction in fatality rate is large enough to outweigh the apparent increase in casualty crash risk associated with high awareness of this type of publicity (assuming that the estimate of the effect of the publicity on crash risk is real and not an artifact of Model 2; see Section 6.7.3.1).

Table 6.8 Model 2 Logistic Regression estimates for fatal crash severity

Parameter	d.f	Odds Ratio	Odds Ratio 95% CI		Chi-Square	p-value
			Lower	Upper		
Enforcement						
Very Low	1	0.94	0.66	1.35	0.10	0.752
Low	1	0.90	0.69	1.17	0.65	0.421
High	1	0.76	0.56	1.02	3.30	0.069
Very High	1	0.74	0.55	1.00	3.76	0.052
Medium	0	.	.	.	.	.
Publicity						
High	1	0.56	0.19	1.61	1.17	0.279
Low	0	.	.	.	.	.
Enforcement * Publicity						
Very Low * High	1	1.22	0.71	2.11	0.51	0.474
Very Low * Low	0	.	.	.	.	.
Low * High	1	0.96	0.61	1.50	0.04	0.852
Low * Low	0	.	.	.	.	.
High * High	1	1.77	1.03	3.06	4.24	0.040
High * Low	0	.	.	.	.	.
Very High * High	1	1.16	0.63	2.11	0.23	0.634
Very High * Low	0	.	.	.	.	.
Average * High	0	.	.	.	.	.
Average * Low	0	.	.	.	.	.

6.7.3.2.2 *Serious casualty crash rate*

Table 6.9 shows the Logistic Regression results when crash severity was measured by the serious casualty rate. The results have similarities to those for the fatality rate, as may be expected since fatal crashes are included in serious casualty crashes, except that the variations in odds ratios were no more than 10% above or below the reference value (one) apart from one situation.

The serious casualty rate was associated with the level of enforcement to a limited degree, with only the odds ratio of 0.92 associated with High enforcement being statistically significant ($p = 0.038$). The odds ratio associated with the publicity level was close to one and not statistically significant. The combination of High level enforcement and High publicity awareness had a conditional odds ratio of 1.16 was statistically significant ($p = 0.050$).

Thus while there were some statistically significant associations between the serious casualty rate, the enforcement level, and the enforcement by publicity interaction, the magnitudes of the changes in relative risk were small by comparison with the apparent effects of the same factors on the fatality rate. This is consistent with the Model 1 analysis of the serious casualty rate, where no statistically significant effects of these factors were found (though there was a statistically significant effect on the fatality rate, as found for Model 2).

Table 6.9 Model 2 Logistic Regression estimates for serious casualty crash severity

Parameter	d.f	Odds Ratio	Odds Ratio		Chi-Square	p-value
			Lower	Upper		
Enforcement						
Very Low	1	0.98	0.89	2.70	0.15	0.696
Low	1	0.98	0.91	1.05	0.43	0.512
High	1	0.92	0.85	1.00	4.32	0.038
Very High	1	0.95	0.87	1.04	1.28	0.258
Medium	0	.	.	.	.	.
Publicity						
High	1	1.10	0.83	1.45	0.44	0.506
Low	0	.	.	.	.	.
Enforcement * Publicity						
Very Low * High	1	1.04	0.90	1.21	0.29	0.591
Very Low * Low	0	.	.	.	.	.
Low * High	1	1.01	0.89	1.13	0.01	0.936
Low * Low	0	.	.	.	.	.
High * High	1	1.16	1.00	1.34	3.84	0.050
High * Low	0	.	.	.	.	.
Very High * High	1	1.08	0.92	1.26	0.89	0.346
Very High * Low	0	.	.	.	.	.
Average * High	0	.	.	.	.	.
Average * Low	0	.	.	.	.	.

6.7.4 Model 3: Speed Camera TINs & Speed-related Emotive-style Advertising

The format and process of analysis for Model 3 was identical to Models 1 and 2, except that the Adstock of only the emotive-style of speed-related advertising was considered as an explanatory factor (see Section 6.5.2).

6.7.4.1 Number of casualty crashes

Table 6.10 shows the results of Poisson Regression Modelling of monthly casualty crashes for Model 3. The results are similar to those for Model 1 in which all styles of speed-related advertising were considered.

The increase in scaled deviance when the enforcement by publicity interaction was removed from the model was 3.35 on 4 d.f., which was not statistically significant ($p = 0.50$). None of the four interaction coefficients were individually statistically significant, but their signs and magnitudes were consistent with negative synergy between the enforcement and publicity (as observed for Model 1).

The global test of the effect of the enforcement factor was not statistically significant, and nor were any of the individual enforcement coefficients (Table 6.10). However, the monotonic pattern of estimated effects was consistent with the expected enforcement effect.

The coefficient of the publicity factor was statistically significant ($p = 0.036$), suggesting that High levels speed-related emotive-style advertising were associated with a 12.6% reduction in casualty crashes, relative to effects at low levels of awareness of this publicity.

Table 6.10 Model 3 Poisson Regression Table of Estimates

Parameter	d.f	Percentage Change	Percentage Change CI		Chi-Square	p-value
			Lower	Upper		
Enforcement						
Very Low	1	5.92	-0.89	13.20	2.88	0.090
Low	1	2.46	-2.57	7.75	0.9	0.344
High	1	-2.16	-7.08	3.04	0.68	0.409
Very High	1	-3.48	-8.66	2.00	1.58	0.209
Medium	0	0	.	.	.	.
Publicity						
High	1	-12.62	-22.97	-0.88	4.4	0.036
Low	0	0	.	.	.	.
Enforcement * Publicity						
Very Low * High	1	-3.62	-10.60	3.88	0.93	0.335
Very Low * Low	0	0	.	.	.	.
Low * High	1	0.16	-5.76	6.44	0	0.960
Low * Low	0	0	.	.	.	.
High * High	1	2.03	-4.42	8.92	0.36	0.547
High * Low	0	0	.	.	.	.
Very High * High	1	4.28	-2.81	11.88	1.36	0.243
Very High * Low	0	0	.	.	.	.
Average * High	0	0	.	.	.	.
Average * Low	0	0	.	.	.	.

As well as being similar to Model 1, the results of the Model 3 analysis are consistent with the expected effects of the enforcement and publicity found in previous research (at least the research relating principally to TAC's emotive-style speed-related advertising; see Section 2.2). This provides support for the conclusion that Models 1 and 3 provide similar good representations of the variations in monthly casualty crashes in the Melbourne Police Districts during 1996-2000. The same cannot be said for Model 2.

6.7.4.2 Casualty crash severity

As for Models 1 and 2, the severity of the monthly casualty crashes was measured in two ways in the analysis of Model 3: (i) the proportion of such crashes resulting in a fatality, and (ii) the proportion of crashes resulting in death or serious injury.

6.7.4.2.1 Fatal crash rate

The Logistic Regression results for the fatality rate did not suggest any statistically significant effects associated with the enforcement, publicity or enforcement by publicity interaction. No regression estimates are presented here because there is no reliable evidence that the apparent effects were real and not due to chance. There was one marginally significant result ($p = 0.064$) associated with very high levels of enforcement. This was similar to the statistically significant

finding from the Model 1 analysis of the fatality rate (Table 6.5), providing support for the presence of a real effect.

6.7.4.2.2 Serious casualty crash rate

The Logistic Regression analysis of serious casualty rate also did not produce any statistically significant effects. There was one marginally significant result ($p = 0.061$) associated with the interaction of high levels of enforcement and high levels of publicity. This was similar to the statistically significant finding from the Model 2 analysis of the serious casualty rate (Table 6.9).

7 DRIVER PERCEPTIONS AND REPORTED BEHAVIOUR⁷

7.1 GENERAL DESIGN

A quasi-experimental design was adopted to investigate the interaction between road safety publicity and enforcement on drivers' self-reported behaviour and perceptions. Victoria Police and their private speed-camera operators (LMT Australia) were able to increase the amount of speed enforcement in two Police Districts by factors of 50% and 100% at various times during 1999. These periods coincided with planned periods of speed-related and no speed-related publicity funded by the Transport Accident Commission in various media. The combination of publicity and enforcement is shown in Table 7.1.

Table 7.1: Basic Experimental Design

		ENFORCEMENT LEVEL	
		50% increase on normal speed camera operational levels	100% increase on normal speed camera operational levels
PUBLICITY	Speed-related publicity present	Publicity and 50% increase in enforcement	Publicity and 100% increase in enforcement
	No speed-related publicity	No publicity and 50% increase in enforcement	No publicity and 100% increase in enforcement

The study was conducted in two Police Districts in the Melbourne metropolitan area, selected by the Victoria Police for operational reasons. The two areas served to control (partially) for the potential influence of the time of the year on enforcement effects by counterbalancing the conditions as discussed below. Police Districts E and I were used.

The factorial design was complicated by the need to collect and incorporate data from a pre-program period to detect differences in the various outcome measures compared to a no-publicity/normal enforcement period. It was considered important to have pre-program data to serve as a comparison. The result of this was to direct part of the statistical analysis towards simple comparisons between the pre-program responses and the responses during various combinations of increased enforcement and publicity to detect the effects of increased enforcement under different publicity conditions.

7.2 TELEPHONE SURVEYS

Data were collected using random-number telephone surveys conducted by MUARC staff according to the timetable discussed below. The surveys were conducted in the evenings using

⁷ Material included in this chapter and the survey described therein were prepared and carried out by Warren Harrison and Emma Fitzgerald while members of staff of the Monash University Accident Research Centre. An interpretation of the results of the survey is given in the following chapter.

telephone numbers collected from the Melbourne telephone directory using random page numbers and column numbers and lists of appropriate suburbs for inclusion in the survey sample. Only licensed drivers were sampled.

There were five survey waves, each conducted over five to eight working days during the periods outlined in Table 7.2. In the analysis of the survey data, a pre-intervention survey conducted in February (prior to the first enforcement period) acted as a Baseline comparison to allow measurement of the relative effects on the perceived risk of detection of the two levels of increased enforcement (compared to each other and to the Baseline measures) in the context of the presence or absence of publicity relating to speeding.

The timing of components of the evaluation is shown in Table 7.2. The surveys were conducted at the end of each relevant month to ensure that the enforcement and publicity had an opportunity to be observed.

Table 7.2: Timing of Enforcement, Publicity, and Survey Components of Evaluation

	F	M	A No Publicity	M	J TAC Publicity	J	A No Publicity	S	O	N TAC Publicity
E District	◆		◆		◆		◆			◆
I District	◆		◆		◆		◆			◆

KEY

	50% increase in speed camera operational levels
	100% increase in speed camera operational levels
◆	Survey of perceived risk of detection etc.

The survey instrument incorporated items to collect information on the following:

- Driving exposure – including the amount and type of driving undertaken by participants
- The perceived risk of detection for speeding for other drivers and for the participant in the week following the survey.
- The crash-related anxiety of the driver when speeding in the week following the survey.
- The behavioural intentions of the driver regarding speeding in the week following the survey.
- The strength of speed-reduction influence of a number of factors.
- Some general attitude measures relating to driving and speeding.
- The detection and crash history of the participant.
- Information regarding recent contact with enforcement and recent exposure to road-safety publicity.

The perceived risk, crash-anxiety, and behavioural intention items collected data on each measure for four different driving conditions arranged in a two by two factorial structure. Responses to each item were provided for daytime, 60 and 100km/h speed zones, and night-time 60 and 100km/h speed zones. It was considered that contact with the speed camera program might influence driver responses differently in these driving situations.

7.3 ANALYSIS

The data collected from the two Districts were combined so that five conditions were defined for subsequent analysis:

- Preliminary data (P): This condition included data collected from both Districts in February, serving as a no-publicity and standard-enforcement period for comparison purposes.
- No publicity and 50% increase in enforcement (N50): This condition included data collected from I District in April and from E District in August.
- No publicity and 100% increase in enforcement (N100): This condition included data collected from I District in August and E District in April.
- Publicity and 50% increase in enforcement (Y50): This condition included data collected from I District in November and from E District in June.
- Publicity and 100% increase in enforcement (Y100): This condition included data collected from I District in June and E District in November.

The survey data sets contributing information about driver perceptions and behaviour under each enforcement/publicity condition are shown in Table 7.3.

Table 7.3: Symbols used to describe each survey data set, related to the level of speed camera increase (50% or 100%) and the presence (Y) or absence (N) of speed-related publicity

	F	M	A No Publicity	M	J TAC Publicity	J	A No Publicity	S	O	N TAC Publicity
E District	P *		N100		Y50		N50			Y100
I District	P		N50		Y100		N100			Y50

* Preliminary data (P) collected during month of no camera increase and no speed-related publicity

Responses to relevant items were then subjected to an analysis that had the broad intention of comparing the P condition with each of the other conditions to measure any changes in responses (compared to the no-publicity, standard enforcement condition). The analysis of the data for the evaluation of the enforcement and publicity program therefore involved a series of pairwise comparisons.

It was considered that such an analysis would fail to allow a comparison between the different publicity and enforcement conditions, however. It is possible that differences between the enforcement and publicity conditions would provide pointers towards the most effective approach. A subsequent analysis was conducted using the publicity and enforcement conditions as factors in a two by two design, with the intention of providing some guidance towards potentially-effective programs in future.

7.4 SAMPLE CHARACTERISTICS

In total, 6594 telephone calls were made from the Monash University Accident Research Centre to households in Police Districts E and I over the duration of the project. Of these, 233 calls resulted in an engaged signal, there was no driver at home in 370 cases, 778 calls resulted in being connected to an answering machine, there was no answer in 1616 cases, and 658 telephone numbers were not connected. Of calls which were successfully connected, 1822 (62%) people refused to participate, and 1115 (38%) people agreed to participate in the survey. The results of calls for each survey phase are shown in Table 7.4.

Table 7.4: Results of telephone calls in each survey phase

Result of call	Phase 1		Phase 2		Phase 3		Phase 4		Phase 5	
	N	%	N	%	N	%	N	%	N	%
Agreed	224	20	218	22	209	14	222	20	242	13
Refused	330	30	296	30	420	29	274	25	502	26
Refusal Rate	60%		58%		67%		55%		67%	
No driver in household	123	11	96	10	153	10	107	10	179	9
Not connected	204	18	184	19	402	27	258	23	568	30
No answer	98	9	102	10	173	12	142	13	261	14
Answering machine	93	8	56	6	60	4	64	6	97	5
Engaged	35	3	25	3	54	4	46	4	73	4

Analyses were conducted to determine whether those who agreed to participate in the survey differed from those who refused to participate. There was a significant relationship between refusal rate and sex of the participant ($\chi^2 = 13.1$, $p < .05$), where males were more likely to agree to participate in the survey than were females. There was also a significant relationship between refusal rate and age of the participant ($\chi^2 = 50.0$, $p < .05$), where people aged above 76 years were more likely to refuse to participate, and people aged between 41 and 50 years were more likely to agree to participate. It should be noted, however, that the people who refused to take part in the survey were less likely to report their age. Sixty-seven percent of the people who refused to take part in the survey did not report their age compared with only 1% of the people who agreed to take part in the survey.

There was a relationship between the survey phase and the refusal rate ($\chi^2 = 30.8$, $p < .05$). Refusal rates were higher in Phase 3 and Phase 5. The refusal rate was independent of the Police District in which people lived ($\chi^2 = 2.4$, $p > .05$).

Preliminary analysis of the data indicated an age and sex bias in the sample compared to expectations based on the most recent Victorian census data. This was corrected for in the analysis by weighting the data (by age and sex) according to data provided by the Australian Bureau of Statistics. All analyses from this point on were conducted using the weighted data, unless otherwise indicated.

7.5 RESULTS OF THE SURVEY ANALYSIS

7.5.1 Sample Description by Condition

The survey data were combined into five enforcement/publicity conditions (described in Section 7.3). Table 7.5 shows the characteristics of participants in each condition.

Table 7.5: Sample characteristics by condition⁸

	P	N50	N100	Y50	Y100	Significance
Age	44.7	43.3	42.6	42.3	45.4	Not significant
Males	111	102	109	120	99	Not significant
Females	108	102	122	138	86	
Exposure (hrs per week)	14.0	15.1	13.6	16.2	12.5	Not significant
Daytime driving	82.1%	78.2%	76.2%	76.4%	79.5%	Not significant
Urban driving	60.3%	55.3%	54.6%	59.8%	57.1%	Not significant
Work-related driving	20.0%	17.4%	13.5%	17.6%	14.4%	Not significant

The analysis reported in Table 7.5 suggests that the samples included in each condition were similar in terms of demographics and driving experience in an average week.

7.5.2 Awareness of Advertising

Participants were asked how often they had seen or heard road safety publicity on television and radio, and if they had what the main message or content of the publicity had been. Table 7.6 shows the mean number of advertisements participants in each condition could recall.

Table 7.6: Mean number of television and radio advertisements seen or heard, by condition

	P	N50	N100	Y50	Y100	Significance⁹
Mean television adverts.	6.7	5.9	4.7	6.3	4.6	$H_{(4)} = 21.4, p < .01$
Mean radio adverts.	5.5	2.3	2.6	3.7	2.5	$H_{(4)} = 14.8, p < .01$

Post-hoc tests using relatively conservative significance levels indicated that respondents in the P and Y50 conditions reported more television advertising than those in the Y100 and N100 conditions, and that those in the P condition reported more radio advertising than those in the N100 and Y100 conditions. The reason for these (small but significant) differences is uncertain.

Table 7.7 shows the number (and percentage) of participants in each condition who recalled speed-related messages in television and radio advertising (based on those who reported seeing road safety advertising in the two weeks prior to the surveys). Planned comparisons were

⁸ Significance testing of the differences between conditions involved a 2-way ANOVA for each item (excepting the disaggregation by sex), with Condition and Police District as factors. The sex data were analysed using a simple 2-way chi-square test of independence. All tests were conducted with a significance level of $p < .05$.

⁹ These data violated assumptions required for parametric statistical tests. The differences between conditions were analysed using the Kruskal-Wallis test based on ranks.

conducted to compare the speed-content recall in each post-condition with the recall in the pre-condition, and an additional comparison was planned to assess the difference between the two publicity conditions (Y50 and Y100) and the non-publicity conditions (P, N50, and N100).

Table 7.7: Recall of speed-related messages in television and radio road safety publicity

		P	N50	N100	Y50	Y100
TV	Recalled speed content	34	44	43	101	63
	Did not recall speed	131	90	92	100	71
	Percentage recall of speed	21.0%	32.8%	31.9%	50.2%	47.0%
	Pre-Post comparison ¹⁰		$\chi^2_{(1)} = 5.7,$ p<.04	$\chi^2_{(1)} = 4.9,$ p<.04	$\chi^2_{(1)} = 34.2,$ p<.04	$\chi^2_{(1)} = 23.5,$ p<.04
Radio	Recalled speed content	28	17	20	38	25
	Did not recall speed	68	43	38	47	37
	Percentage recall of speed	29.2%	28.3%	34.5%	44.7%	40.3%
	Pre-Post comparison		not sig.	Not sig.	$\chi^2_{(1)} = 4.7,$ p<.04	not sig.

The results in Table 7.7 suggest that recall of speed content in television advertising was greater in all post-conditions than it was in the pre-condition, and that recall of speed content in radio advertising in the Y50 condition was greater than that in the pre-condition.

The additional planned comparisons showed that speed recall in the publicity conditions (Y50 and Y100) was significantly greater than that in the three no-publicity conditions (P, N50, and N100) for both television advertising ($\chi^2_{(1)} = 36.0, p<.04$) and radio advertising ($\chi^2_{(1)} = 5.9, p<.04$).

Recall of speed-related content in the TAC advertising matched the general expectation, therefore, that the respondents in the publicity conditions would have seen more speed-related publicity than those in the non-publicity conditions, although the results in relation to radio (in the Y100 condition) were concerning, as was the stronger tendency of respondents to recall speed content in television advertising in the N50 and N100 conditions compared to the P condition.

7.5.3 Awareness of Enforcement

In addition to awareness of speed-related publicity, it was hoped that the increases in enforcement activity in the four conditions would be associated with an increase in perceived

¹⁰ This and subsequent comparisons between the pre-program (P) condition and the four post-conditions use a modified Bonferroni correction for the inflated family-wise type I error rates that result when multiple planned comparisons are used (Keppel, 1982). Under this procedure, the comparison-wise significance level is adjusted to ensure that the family-wise error rate (here the total type I error rate associated with the all planned comparisons in the television item) does not exceed some predetermined value. Under the modified Bonferroni procedure for planned comparisons, the family-wise type I error rate is set at a maximum determined by the degrees of freedom in the overall analysis (here, in the contingency table). For the analysis of the television publicity message recall item here, for example, the family-wise error rate is set to a maximum of 0.20, or 4 (degrees of freedom) times .05. The comparison-wise error rate or significance level is then determined by the number of planned comparisons – here there were five planned comparisons, so the comparison-wise significance level is p<.04, or .20 divided by the number of planned comparisons. This technique is only used where the number of planned comparisons exceeds the degrees of freedom.

enforcement activity. Awareness of recent enforcement activity is shown in Table 7.8, expressed both as whether enforcement activity had been seen, and the mean number of instances of activity reported by respondents. In each case, in addition to the pre-post comparisons, two additional comparisons were planned - between the two levels of enforcement (N50 and Y50 compared to N100 and Y100) and between the pre-condition and all the enforcement conditions combined. The modified Bonferroni technique resulted in a significance level of $p < .033$ for each comparison.

Table 7.8: Awareness of enforcement by condition

		P	N50	N100	Y50	Y100
Speed Cameras	Have seen enforcement	108	110	99	127	96
	Have not	105	82	121	126	82
	Percentage seeing enf.	50.7%	57.3%	45.0%	50.2%	53.9%
	Pre-Post comparison		not sig.	not sig.	not sig.	not sig.
	Mean instances seen	2.1	2.4	1.3	1.8	1.8
	Pre-Post Comparison ¹¹		not sig.	not sig.	not sig.	not sig.
Other Speed Enforce. Activity	Have seen enforcement	94	86	97	106	64
	Have not	120	107	123	148	114
	Percentage seeing enf.	43.9%	44.6%	44.1%	41.7%	36.0%
	Pre-Post comparison		not sig.	not sig.	not sig.	not sig.
	Mean instances seen	1.4	1.6	1.3	1.4	1.1
	Pre-Post Comparison		not sig.	not sig.	not sig.	$z = -2.2$, $p < .033$
Friends Seeing Speed Cameras	Have seen enforcement	72	61	44	72	52
	Have not	138	132	176	182	128
	Percentage seeing enf.	34.3%	31.6%	20.0%	28.3%	28.9%
	Pre-Post comparison		not sig.	$\chi^2_{(1)} = 11.1$, $p < .033$	not sig.	not sig.
	Mean instances seen	1.5	1.3	0.5	1.3	0.7
	Pre-Post Comparison		not sig.	$z = -4.3$, $p < .033$	$z = -2.2$, $p < .033$	$z = -2.2$, $p < .033$

The results in Table 7.8 suggest that awareness of speed enforcement activity did not change as expected. The results (including the additional analyses) were as follows:

- Awareness of Speed Cameras: There were no significant differences between the pre-condition and any of the post-conditions in either the number of people who reported seeing speed cameras in the preceding weeks, or in the average number of cameras seen in the same period. There was no overall difference between the total number of respondents who saw cameras in the four enforcement periods combined and the number who saw them in the pre-condition (50.7% in P, and 51.2% in the combined enforcement periods), and the enforcement conditions in which there was a 50% increase in enforcement did not differ significantly from those in which there was a 100% increase in enforcement in either the number of people who saw speed cameras or the number of times cameras were seen.
- Awareness of Other Speed Enforcement Activity: The results for respondents' awareness of other types of speed enforcement were the same as those for their awareness of speed

¹¹ Pre-post comparisons and other planned comparisons conducted using the number of instances of enforcement seen used the Mann-Whitney test (based on ranks). The results are reported here as z-value equivalents. The same modified Bonferroni technique was used to protect the family-wise error rate.

cameras, with the exception that the mean number of instances of speed enforcement activity seen in the Y100 condition was significantly less than that in the P condition (1.1 and 1.4 instances respectively in the two weeks prior to the surveys).

- Friends' Awareness of Speed Cameras: The only significant difference between the pre-condition and the individual enforcement conditions in the number of people who reported that friends had seen speed camera activity was that there were fewer friends aware of speed cameras in the N100 condition than in the P condition (20.0% compared to 34.3%). The number of times speed cameras were seen by respondents' friends was significantly less in the N100, Y50, and Y100 conditions than in the P condition. When all enforcement conditions were combined, the number of times cameras were seen by friends was significantly less than in the P condition (means of 1.0 and 1.5 instances respectively), and the number of instances in the N100 and Y100 conditions combined was significantly less than the number in the N50 and Y50 conditions combined (means of 0.6 and 1.3 respectively).

It is clear that increased levels of speed camera use in E and I Districts was not associated with a detectable increased level of awareness of speed camera operations in those Districts at the time of the surveys.

7.5.4 Perceived Risk of Detection

The perceived risk of detection for speeding was viewed as a key outcome measure in the present study. Participants were asked to rate their risk of detection if they drove 15km/h over the speed limit in two different times of day (day and night) and in two different speed zones (60 km/h and 100km/h). They were also asked to rate the risk of detection for a friend in the same circumstances.

Table 7.9 shows the mean responses of respondents to these items. A total of seven comparisons were planned for each item, resulting in a comparison-wise significance level of $p < .03$. The comparisons were:

- Comparisons between the P condition and each of the four post-conditions to assess the impact of each combination of enforcement increase and publicity on the perceived risk of detection. Any synergistic effects would be apparent in these comparisons.
- A comparison between the P condition and all the enforcement-increase post-conditions combined to assess the effect of any increase in enforcement activity.
- A comparison between the two levels of enforcement increase (the N50 and Y50 compared to the N100 and Y100) to assess the difference between a 50% and 100% increase in enforcement activity.
- A comparison between the two publicity conditions (the N50 and N100 compared to the Y50 and Y100 conditions) to assess the effect of speed-related publicity (in the context of enforcement increases) on the perceived risk of detection.

Table 7.9: Ratings of the perceived risk of detection¹²

	CONDITIONS ¹³						ENF. INCREASE ¹⁴		ADVERT. ¹⁵	
	P	N50	N100	Y50	Y100	ALL ENF	50%	100%	No	Yes
Risk of detection for self, 60km/h, daytime	4.3	3.8	4.1	4.7	4.5	4.2	4.3	4.3	4.0	4.6
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		p<.03	
Risk of detection for self, 100km/h, daytime	4.1	3.5	3.8	4.5	4.6	4.1	4.0	4.2	3.8	4.5
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		p<.03	
Risk of detection for self, 60km/h, nighttime	3.8	3.3	3.7	4.2	4.1	3.8	3.8	3.9	3.6	4.1
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		p<.03	
Risk of detection for self, 100km/h, nighttime	3.8	3.2	3.7	4.2	4.2	3.8	3.7	3.9	3.6	4.2
Significance		p<.03	n.s.	n.s.	n.s.	n.s.	n.s.		p<.03	
Risk of detection for others, 60km/h, daytime	3.8	3.8	3.6	3.9	4.3	3.9	3.9	3.9	3.7	4.1
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		p<.03	
Risk of detection for others, 100km/h, daytime	3.9	3.4	3.3	4.0	4.2	3.7	3.7	3.7	3.6	4.1
Significance		n.s.	p<.03	n.s.	n.s.	n.s.	n.s.		p<.03	
Risk of detection for others, 60km/h, nighttime	3.4	3.2	3.1	3.5	3.6	3.4	3.4	3.3	3.3	4.1
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		n.s.	
Risk of detection for others, 100km/h, nighttime	3.6	3.3	3.1	3.7	3.6	3.6	3.5	3.3	3.3	3.5
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		n.s.	

With two exceptions, the perceived risk of detection was not influenced by the enforcement and publicity activity in any of the post-conditions compared to the perceived risk of detection in the pre-condition. The only exceptions to this were for the risk of detection for driving in 100km/h zones at night (where the perceived risk was lower in the N50 condition than it was in the P condition), and for the risk of detection for other drivers driving in 100km/h zones during the day (where the perceived risk was lower in the N100 condition than in P). It is clearly the case that there were no detectable increases in the perceived risk of detection compared to the P condition.

Increasing the level of speed camera activity by 100% did not result in a significantly higher perceived risk of detection for speeding than increasing it by 50%.

¹² All comparisons reported in this Table were made using ANOVA with planned comparisons.

¹³ Contrasts here involved pairwise comparisons between P and each of the four enforcement/publicity conditions (samples of approximately 200 drivers per group), and between P and all the enforcement/publicity conditions combined (approximately 200 drivers compared with 800 drivers).

¹⁴ These comparisons were between the two enforcement increase levels (50% and 100%), with approximately 400 drivers per group.

¹⁵ These comparisons were between the two advertising levels (none and some), with approximately 400 drivers per group.

Publicity had a significant effect on all measures of the perceived risk of detection except for the perceived risk of detection for others at night in 60km/h and 100km/h zones. Thus, the speed-related publicity used by the TAC appears to have a broad impact on the perceived risk of detection.

7.5.5 Intention to Speed

Participants were asked to indicate the likelihood that they would speed in the next week. Results for this item are shown in Table 7.10. The analysis strategy for these items was as for the items presented in Table 7.9, with a significance level of $p < .03$.

Table 7.10: Intention to speed

	CONDITIONS ¹⁶						ENF. INCREASE ¹⁷		ADVERT. ¹⁸	
	P	N50	N100	Y50	Y100	ALL ENF	50%	100%	No	Yes
Speeding intent, 60km/h, daytime	1.9	1.5	1.8	1.8	1.9	1.8	1.7	1.8	1.8	1.9
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		n.s.	
Speeding intent, 100km/h, daytime	1.9	1.9	1.7	1.7	1.6	1.7	1.8	1.6	1.8	1.7
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		n.s.	
Speeding intent, 60km/h, nighttime	1.2	0.9	0.9	1.4	1.3	1.1	1.1	1.1	1.0	1.3
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		$p < .03$	
Speeding intent, 100km/h, nighttime	1.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Significance		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		n.s.	

There were no significant differences between the intention to speed in the P condition and any of the post-conditions or the combined post-conditions. There were no significant differences between speeding intentions in the 50% and 100% enforcement-increase conditions, and the presence of speed-related advertising had an effect only on the intention to speed in the nighttime 60km/h speed zone condition, where advertising was associated with an increase in the expressed intention to speed.

It is clear that there were no significant enforcement-related effects on the intention of respondents to drive over the speed limit.

¹⁶ Comparisons here involved pairwise comparisons between P and each of the four enforcement/publicity conditions, and between P and all the enforcement/publicity conditions combined.

¹⁷ These comparisons were between the two enforcement increase levels (50% and 100%).

¹⁸ These comparisons were between the two advertising levels (none and some).

7.5.6 Researchers' Discussion of Survey Results

The results reported above indicate that any enforcement-related effects on the perceived risk of detection for speeding or behavioural intentions were not substantial, and that there was no evidence of any synergy between the enforcement and publicity activity undertaken in the study.

The study was initially planned with an expectation that the increased levels of enforcement would be noticed, and it is hard to envisage enforcement having an effect on behaviour if it was not noticed initially. The results in Table 7.8 (and associated statistical analysis) convincingly suggests that respondents failed to notice the increase in enforcement activity, although it is clear that they were aware of the changing level of speed-content in the TAC publicity program. If respondents were not aware of increases in speed camera operations during the enforcement periods, it is unlikely that there would be any enforcement-related changes in the perceived risk of detection or the intention of respondents to speed. This expectation was confirmed in the analysis presented above.

There is some evidence that publicity levels influenced the perceived risk of detection for speeding when averaged across the enforcement increases, with the presence of TAC speed-related publicity being consistently associated with higher perceptions of the risk of detection. This increase in the risk of detection was not, however, reflected in the behavioural intentions regarding speeding.

The results need to be placed in the broader context of the enforcement literature reviewed earlier in the present report, where it was noted that there needs to be a substantial increase in [visible] traffic enforcement levels before drivers notice the change. Some research suggested a minimum of a 300% increase in enforcement levels. The changes in enforcement activity did not reach this level in the present study, so it may not be surprising that drivers did not notice an increase in enforcement. Assuming that the perceived risk of detection is based, in part, on the visible level of enforcement activity, it would be unreasonable to expect changes in either the perceived risk of detection or the behaviour of drivers.

One of the important aims of the present study was to assess the potential synergy between enforcement and publicity. The present study was unable to assess any synergistic effects as the increased enforcement levels were insufficient to be noticed by drivers in the two Police Districts. The failure to obtain a synergistic effect here should not be viewed as evidence that no such effect exists.

8 INTERPRETATION OF THE SURVEY RESULTS

The surveys of driver perception and self-reported behaviour were analysed and reported before information had been obtained on the actual enforcement and publicity levels (Chapter 4) and before any crash analysis had been conducted (Chapters 5 and 6). Thus the results and discussion in Chapter 7 had assumed that the study design was intact and that the effects of the increased speed camera enforcement and presence of speed-related publicity could be observed in surveys conducted at the end of months in which these changes occurred. Subsequently available data and reconsideration of likely effect mechanisms has cast doubt on these expectations.

8.1 TIMING OF ENFORCEMENT EFFECTS

As noted in Section 5.2, there is an interval between the date on which a speeding offence is detected by a speed camera and the traffic infringement notice (TIN) is received by the offending motorist. During 1999, this interval was around 7 to 14 days for about 60% of offenders, but could have been much longer for the remainder. Since the speed camera operations were relatively covert, the first opportunity for many speeding drivers to become aware of the increased camera activity in Districts E and I would have been receipt of a TIN. Receipt of a subsequent TIN in a short time interval may have provided strong indication of the increased enforcement, but by the time this had happened, the month of increased enforcement may have finished.

It was for this reason that the comprehensive crash analysis (Chapter 6) focused on the month following the substantial increases (and decreases) in TINs detected by speed cameras in each Police District. During 1999, the increased TINs were predominantly due to the increased camera hours in Districts E and I, and reductions were due to reduced hours in Districts C and H to provide the re-assigned cameras. (Other variations in the monthly levels of TINs detected throughout the analysis period 1996-2000 in all ten districts were used in the comprehensive crash analysis, but these variations were unplanned – apart from that due the increased camera hours in all districts during December 1998.)

From the point of view of the survey results, it is not surprising that there was little change in awareness of speed camera activity in Districts E and I, from the baseline survey in February 1999 to the survey at the end of each month of increased enforcement (Table 7.8). Speeding drivers detected by cameras would have had relatively little time to become aware of the increase, and other survey respondents may have been quite unaware due to the covert nature of the speed camera operations. Their perception of an enforcement increase would have relied primarily on word-of-mouth communication from detected drivers.

Thus the perception by drivers of the increase in speed camera hours, as measured by the surveys, relied on the visibility of the enforcement operations, which was relatively low, and on the receipt of (perhaps multiple) speeding TINs, many or most of which may have arrived after the survey date. It may have been better if the survey design had recognised these likely mechanisms and the surveys conducted at times or in ways which better measured the changes in perceptions due to TIN receipt or knowledge of other drivers who had received TINs.

8.2 TIMING OF PUBLICITY AWARENESS

As planned, there was no speed-related TAC publicity during April and August 1999, but there was during June and November that year. These months had been chosen for increases in speed camera hours, of either 50% or 100%, in the two Police Districts so that the interacting influence of the publicity on the enforcement effects could be studied.

However, there was speed-related TAC publicity during March and even more substantial publicity of the same type during January (Figure 4.6). This resulted in a high level of Adstock of speed-related television advertising carrying over to April (Figure 6.5 and Table 8.1).

Table 8.1: Survey design timing and Adstock of speed-related television advertising

Month in 1999: Publicity presence:	F	M	A No Publicity	M	J TAC Publicity	J	A No Publicity	S	O	N TAC Publicity
E District	P		N100		Y50		N50			Y100
I District	P		N50		Y100		N100			Y50
Speed-related Adstock	1121	1280	994	560	1031	779	418	917	442	1151

Key: Survey data sets related to level of speed camera increase (50% or 100%) and the presence (Y) or absence (N) of speed-related publicity. Preliminary data (P) collected during month of no camera increase and no speed-related publicity.

There was also a high level of Adstock of speed-related advertising in February 1999, the month in which the baseline survey of driver perceptions was conducted because it had been considered to represent normal levels of speed camera activity in the absence of speed-related publicity. Adstock of television advertising has been shown to be linked to awareness levels and, even though there was no speed-related publicity during that month, the awareness of previous publicity is likely to have been high. Similar remarks apply to April 1999.

Thus, in contrast to the planned study design, the surveys of driver perceptions in February, April, June and November 1999 are likely to have been influenced by high levels of awareness of previous as well as current speed-related advertising in the month. Only the survey conducted in August is likely to reflect conditions of low awareness of the advertising (418 Adstock units).

8.3 INTERPRETATION OF SURVEY CONTRASTS

The key results from the survey component relate to driver perceptions of the risk of detection if speeding 15 km/h over the speed limit (Table 7.9) and the likelihood of the driver speeding at that level during the next week (Table 7.10).

The risk of detection and the likelihood of speeding were measured on an 11-point scale ranging from 0 (“would never happen”) to 10 (“certain to happen”). The analysis of responses regarding the likelihood of speeding is not discussed here because the mean responses were relatively low (always less than 2), suggesting a heavily-skewed distribution which would have been relatively insensitive to effects.

The ratings of the perceived risk of detection during February 1999 (column “P” in Table 7.9) correspond to a period of High awareness of speed-related advertising (using definition given in Section 6.5.1) and normal speed camera activity. The columns labelled “Y50” and “Y100” also represent periods of High awareness of speed-related advertising, since the publicity aspect of the study design remained intact during June and November. However the ratings in the columns labelled “N50” and “N100” in fact represent the result of pooling surveys conducted under High (April) and Low (August) speed-related advertising awareness conditions, and could be considered to measure the average rating under High and Low awareness.

There were statistically significant differences across the survey conditions in the number of road safety television and radio advertisements recalled in the last two weeks (Table 7.6) and in the recall of the speed content of the television advertising (Table 7.7). In contrast, there were no statistically significant differences across the survey conditions in the awareness of speed camera activity (Table 7.8). As commented in Section 8.1, this lack of awareness of changes in speed camera activity at the end of the month was not surprising given the covert nature of camera operations and the delay in receipt of speeding TINs if offences were detected.

These awareness findings suggest that any differences in the ratings of perceived risk of detection contrasted in Table 7.9 were principally due to the influence of awareness of the speed-related publicity rather than the influence of enforcement increases of each magnitude. This is not to say that the enforcement increases had no influence on these perceptions, only that it is likely to have occurred after the survey at the end of the month, if it did occur.

Table 7.9 shows that there were general reductions in the perceived risk of detection between the baseline survey, P, (conducted under High awareness of speed-related advertising) and the conditions N50 and N100 (representing the average of Low and High awareness of the advertising). In contrast, there were general increases in the perceived risk of detection under each of the conditions Y50 and Y100 (corresponding to High awareness of the advertising at a time when the speed camera hours had increased, but respondents were generally unaware of this increase in enforcement).

None of these increases and decreases of the ratings of the risk of detection when speeding were statistically significant. Each contrast was based on average ratings calculated from two samples with approximately 200 respondents per sample. The statistical reliability of these contrasts will be discussed in Section 8.4. The largest differences in the ratings occurred when the baseline survey, P, was compared with the Y100 condition, resulting in an average increase in the ratings of 0.30 units (calculated from Table 7.9).

None of the contrasts in Table 7.9 labelled “ENF.[orcement] INCREASE” were statistically significant. This was not surprising, given previous remarks about respondents’ lack of awareness of changes in speed camera activity at the time of the surveys.

However, six out of eight of the contrasts labelled “ADVERT.[ising]” were statistically significant ($p < 0.03$). Based on the forgoing remarks, these contrasts represent tests of the difference in the perceived risk of detection under a condition reflecting the average of Low and High awareness of speed-related advertising (the “No” column) and the condition of High awareness of the advertising (the “Yes” column). Thus, the contrasts could be considered to measure the increase in ratings when the awareness of speed-related advertising increased from medium levels to high levels. The increases in speed camera activity were balanced in this contrast, so it would be reasonable to consider the increase in ratings as a publicity effect.

The ADVERT.[ising] contrasts were each based on average ratings calculated from two samples with approximately 400 respondents per sample. The average increase in the ratings of the risk

of detection was 0.54 units. The statistical reliability of this increase, in comparison with those tested in Table 7.9 based on smaller samples, will be discussed in Section 8.4.

8.4 STATISTICAL POWER OF SURVEY CONTRASTS

Table 7.9 gives the mean responses of each sample of drivers to their perception of each risk. The statistical significance of a test of difference between each pair of mean responses (the pairs are defined in the footnotes) is also indicated as either “n.s.” (not significant) or “ $p < .03$ ” (the traditional, single-comparison, significance probability, p , was less than 0.03). When such a statistical test is not significant, it is usual to conclude that the data provides no evidence of a difference in the true mean perceived risks of the population of drivers from which the sample has been drawn. It should be noted that this does not imply that there is no difference in the population means, only that the available data could not find a difference. Larger data sets drawn from the same populations may provide evidence of a difference in their means.

The statistical significance level of $p = 0.03$ is lower than the conventional (but arbitrary) maximum level commonly used, namely $p = 0.05$, or 5%. The researchers have chosen this level because of concern about the multiple number of comparisons made in Table 7.9, and hence the increase in the likelihood that an unacceptable proportion of comparisons will be judged “statistically significant” due to chance, rather than representing evidence of a real difference in the true mean perceived risks. Section 7.5.4 includes a rationale for calculating the lower level, based on the number of comparisons made in each row of Table 7.9. The aim was to achieve a global statistical significance level of $p = 0.05$ when the multiple comparisons are made.

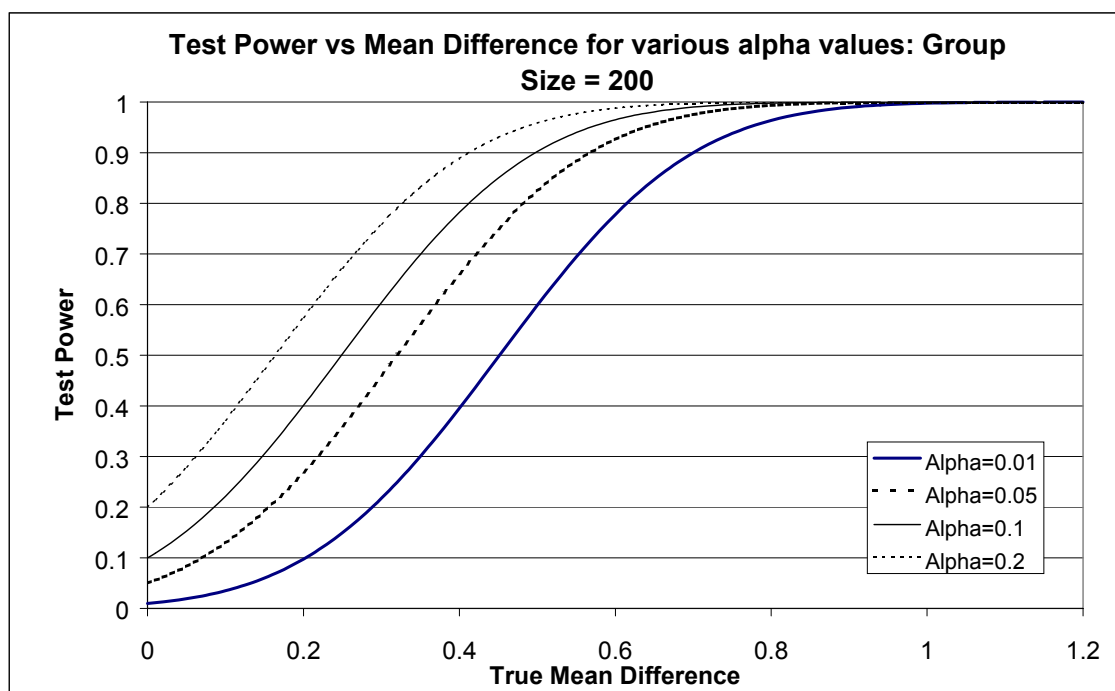
It is important to note that the choice of a statistical significance level of $p = 0.05$ is an arbitrary level, though commonly used. Its interpretation is that, by using it, the researcher is prepared to accept that there will be a 5% chance that the data suggests evidence of a real difference in the true mean perceived risks, whereas in fact there is no real difference (this is known as a Type I error). Another error that the researcher might make is to conclude that there is no real difference (because the data does not provide evidence of it), whereas there really is a difference in the true mean perceived risks (this is known as a Type II error). The probabilities of Type I and Type II errors are inversely related in comparisons like those in Table 7.9. Both probabilities can be reduced by increasing the samples of drivers compared.

The analysis shown in Table 7.9 has given attention to the Type I error probabilities in the comparisons made (by fixing a p -value for judging statistical significance), but has not addressed the possibility of Type II errors. There is a view that, in road safety program evaluation, it is more important to avoid Type II errors than Type I errors. This is because, if a Type II error is made, it would be falsely concluded that an effective program is ineffective. This is to be avoided, given the high potential benefits to society of an effective road trauma countermeasure. A discussion of the costs and benefits of right and wrong decisions in road safety program evaluation, in an empirical context, is given in Cameron (1989).

Nearly all of the contrasts in Table 7.9 based on comparisons of two groups of around 200 drivers were not statistically significant. There were apparent reductions in the perceived risks of detection for driver groups N50 and N100, compared with baseline group P, and apparent increases in the perceived risks for driver groups Y50 and Y100. (The interpretation of these changes in perceived risk, if real, have been discussed in Section 8.3.) The absence of statistical significance implies that the apparent reductions are consistent with no change or a small decrease in the true mean perceived risks, and that the apparent increases are consistent with no change or a small increase in the true risks. The comparisons of groups of around 200 sampled drivers may not have sufficient statistical power to discriminate between these possibilities.

Figure 8.1 shows the statistical power (the probability of avoiding a Type II error) of these tests based on samples of 200 drivers as a function of the true mean difference of the population ratings of the risk of detection. The power is also related to the significance level chosen, the probability of a Type I error (alpha).

Figure 8.1: Statistical power of contrasts in Table 7.9 based on 200 drivers per group



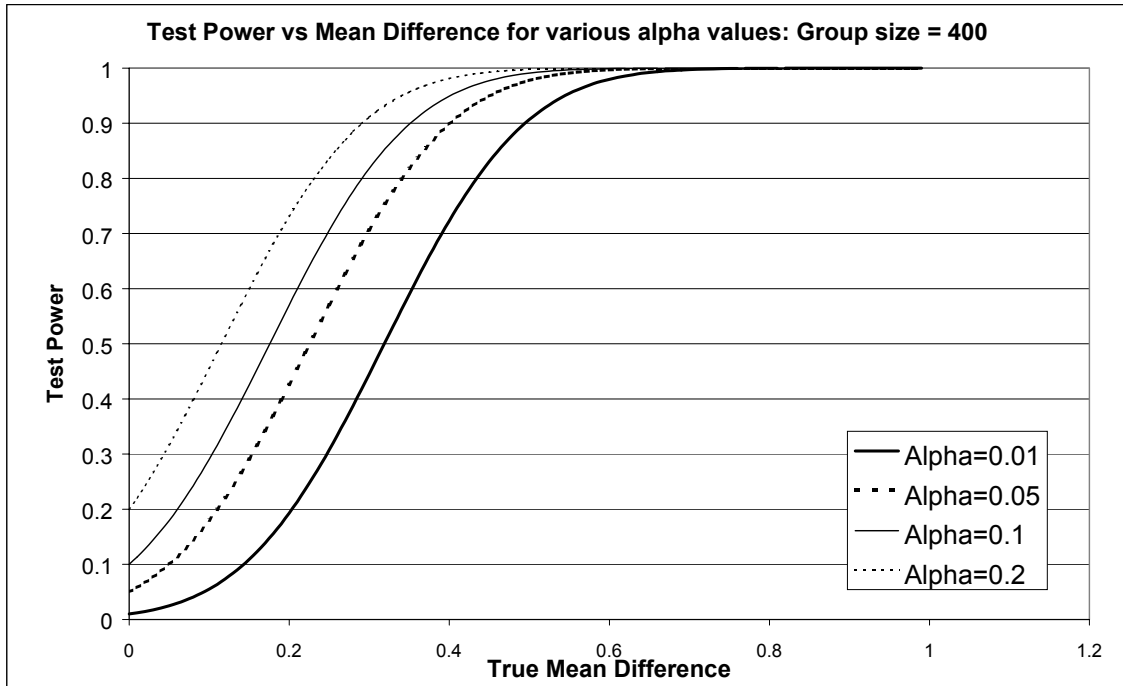
It can be seen that the power of the statistical test, based on samples of only 200, for judging the level of difference in the rating of the risk of detection observed in practice to be real, is modest. The largest average increase in ratings, when Y100 was compared with P in Table 7.9, was 0.3 units. If real, this increase would have been detected by the statistical tests with only 22% probability if 1% significance level was used and 46% probability if 5% level was used. (The actual power of these contrasts in Table 7.9 would have been between these two probabilities because the 3% significance level was used by the researchers.)

For higher power of detecting a change of this magnitude in the ratings (assuming it is real) based on these contrasts, the significance level would need to have been relaxed to, say, 10% or 20% chance of a Type I error. A real 0.3 increase in rating would then have been detected with probability of 60% or 76%, respectively, by the statistical tests based on samples of 200. The appropriateness of relaxing the significance level, for the purpose of avoiding a Type II error, has been discussed previously. What is clear is that the contrasts based on samples of respondents of only 200 per group, approximately, had relatively low power for detecting changes in the perceived risk of detection which may have been important. The test results given in Table 7.9 based on these relatively small samples were not really capable of judging whether there was or was not a real change in the perceived risk of detection. For this reason, these tests should be labelled inconclusive with regard to their ability to answer the research question (notwithstanding the interpretation which has been put on these tests in this chapter).

However, the contrasts in Table 7.9 based on samples of approximately 400 are a different question. Figure 8.2 shows the statistical power of these tests. It can be seen that these tests

would have detected a real increase in the ratings of 0.5 units or greater with power of at least 90% for all choices of the significance level (alpha). For the ADVERT.[ising] contrasts, the average increase in the ratings of the risk of detection was 0.54 units. If this increase in the perceived risk of detection for speeding among the population of drivers from which the samples were drawn was real, this would have been found by the statistical tests with 95% probability if 1% significance level was used and 99% probability if 5% level was used.

Figure 8.2: Statistical power of contrasts in Table 7.9 based on 400 drivers per group



Hence the statistically significant increases in ratings of the perceived risk of detection for speeding, associated with the ADVERT.[ising] contrast in Table 7.9, are real evidence of an effect of the speed-related publicity on the perceived risk. The probability of a Type I error was at most 0.03 and the probability of a Type II error was less than 0.05 if the effect had been 0.54 units or greater. On this basis, the ADVERT.[ising] contrast tests in Table 7.9 are conclusive evidence of a publicity effect because the risks of erroneous decisions are minimal.

9 GENERAL DISCUSSION AND CONCLUSIONS

9.1 DISCUSSION OF CRASH ANALYSIS

9.1.1 Preliminary crash analysis

The preliminary analysis was very limited in its ability to examine the effects of the enforcement, the publicity and their interaction on crashes. It focused only on the direct effects of the changed speed camera hours and the presence of speed-related publicity, in the districts and during the months in 1999 when these occurred. It did not examine any delayed or residual effects of either program, which were likely to have been substantial and, in the case of the enforcement, may have been greater than the direct effects.

By focusing on crashes during only four months of the year, the analysis was also weak statistically. The information on crashes during the years 1996-1998 and 2000 was not used to indicate trends and seasonal variations in the crash patterns over the full period 1996-2000, which would have improved the statistical power of the tests. While some statistically significant findings appeared in the preliminary analysis, in general this analysis should be considered inconclusive regarding the research questions of this study.

9.1.2 Analysis of enforcement and publicity interaction effects on crashes

The comprehensive crash analysis was designed principally to examine the interaction of the effects of levels of speed camera enforcement and the effect of speed-related publicity awareness on both casualty crash frequency and the injury severity of the crash outcomes. In this analysis, the enforcement was represented by five levels of the number of speeding TINs emanating from camera activity in the previous month, and the publicity was represented by whether the estimated retained awareness (Adstock) of past and current television advertising with speed-related themes was high or low. Casualty crashes each month during 1996-2000 in the ten Melbourne Police Districts were analysed using Poisson Regression Modelling, and Logistic Regression was used to analyse the severity of these same crashes in two ways: fatal outcome or serious casualty outcome.

In general, the analysis models incorporating enforcement, publicity, district, month, year and interaction effects provided adequate representations of the variations in monthly crash frequencies and severity outcomes. The exception was the model of casualty crash frequencies incorporating the awareness of speed-related publicity with enforcement-style messages. The estimates from this model did not display consistent increases in crashes associated with decreases in enforcement as expected from previous research, and suggested counter-intuitive increases in crashes associated with high awareness of the publicity. This latter finding may have been an artifactual effect of the modelling (see Section 6.7.3.1). These observations cast considerable doubt in this model as an adequate representation of monthly casualty crashes.

9.1.3 Effects on casualty crash frequency

So far as casualty crash frequency was concerned, there was no evidence of an interaction of the effects of the speed camera enforcement and speed-related publicity, when each of these road safety programs was represented as described above. Indeed, the statistically non-significant interaction estimates were consistent with negative synergy when all speed-related publicity and

emotive-style speed-related publicity were considered. (The direction of the interaction in the case of enforcement-style speed-related publicity could not be determined because of the unsatisfactory nature of the model.) These results provide no support for positive synergy, i.e. the combined effect of high speed camera enforcement and high speed-related publicity being greater than their individual effects. It is not likely that a larger study of this type would provide evidence of positive synergy by increasing the statistical power of the tests for its presence.

The estimated effects of changes in enforcement level were consistent with reductions in crashes associated with increased enforcement and increases in crashes associated with reduced enforcement. These enforcement effects changed monotonically over the five levels of enforcement, at least so far as the models incorporating all styles of speed-related publicity and the emotive-style speed-related publicity were concerned. While none of the apparent enforcement effects on casualty crashes were statistically significant, the pattern of results was consistent with a real effect. A larger study of this type may provide reliable evidence of such an effect.

In contrast, the estimated effects of the level of awareness of speed-related publicity was statistically significant in each of the models of casualty crash frequency. High levels of speed-related publicity were associated with 12-13% reduction in crashes. The exception to this was the enforcement-style speed-related publicity, which appeared to be associated with crash increases, but as noted earlier the modelling on which this result was based was unsatisfactory and the apparent effect may have been an artifact of the analysis. At the very least, it can be concluded that the apparent effect on casualty crashes from the speed-related publicity during 1996-2000 was due to the emotive-style publicity with this theme. The modelling results when this style of speed-related publicity was considered were similar to those when all styles of speed-related publicity were analysed, suggesting that the enforcement-style publicity contributed very little to casualty crash reductions.

9.1.4 Effects on casualty crash severity

When modelling the injury severity of the casualty crashes, the effect of the speed camera enforcement appeared to be greater on the risk of fatal outcome than on the risk of serious casualty. The fatality rate models generally included a statistically significant effect of the enforcement. The serious casualty rate was generally less influenced by the enforcement, publicity or their interaction and, when significant, the effects were relatively small.

When the awareness of all styles of speed-related publicity was considered, very high levels of enforcement were associated with a 41% lower risk of fatal casualty crash outcome compared with medium levels of enforcement. There was no reliable evidence of an interaction between the enforcement and publicity, nor of any effect of the publicity awareness level. When only the emotive-style publicity was considered, the apparent effects on the fatality rate were similar but none of the estimates were statistically significant.

When the enforcement-style speed-related publicity was considered, the fatality rate model suggested that both high and very high levels of enforcement were associated with less severe outcomes. The risk of fatal casualty crash outcome was 24-26% less at these levels of enforcement compared with medium and lower levels.

The only statistically significant interaction between the enforcement and publicity was found for the enforcement-style publicity, principally affecting the fatality rate (and, to some extent, also the serious casualty rate). During months when there was high awareness of this style of

publicity, there appeared to be a substantial reduction in the risk of fatal casualty crash outcome associated with very high enforcement levels but not with only high levels.

This appears to be evidence of a positive synergy between the speed camera enforcement, occurring when speeding offences were detected at very high levels in the previous month, and high levels of awareness of enforcement-style speed-related publicity were present. The effect on the risk of fatal outcome of the casualty crashes in the district appears to be greater than expected from these two road safety programs operating alone.

A conclusion of this type needs to be tempered by the observation that the effect of the enforcement-style speed-related publicity was associated with an increase in casualty crash frequency, though it should be noted that the modelling on which this was based was not satisfactory. Hence, while this apparent effect of the publicity on crashes is questionable, it is also worth noting that the magnitude of the reduction in fatality rate associated with very high enforcement combined with high enforcement-style publicity awareness would outweigh the apparent increase in casualty crash risk associated with this type of publicity (if this publicity effect is real). Thus it may be reasonable to combine very high speed camera enforcement with high levels of enforcement-style supporting publicity if the aim is specifically to reduce fatal crashes rather than casualty crashes in general.

9.2 DISCUSSION OF SURVEY COMPONENT

The survey component was designed to examine changes in drivers' perceptions of the risk of detection for speeding and their self-reported speeding intentions at the end of each month in which speed camera hours had been increased in Districts E and I, relative to a baseline measurement in February 1999. Two of the months with increased speed camera activity also had TAC speed-related publicity, whereas the other two did not, thus supposedly providing a contrast between changes in their perceptions and intentions under conditions of publicity presence compared with its absence.

The timing of the surveys was such that drivers were unlikely to have perceived the increase in speed camera activity, by either the receipt of one or more speeding TINs or knowledge of other drivers who had. The covert nature of speed camera operations would have minimised the perception through direct observation. This is not to suggest that the drivers may have become aware of the enforcement increases in subsequent months (and the effects on casualty crash frequency and fatal outcome of these crashes suggests that they did, in at least the following month). However, it was not surprising that the survey results did not find evidence of increased awareness of camera presence or any increase in the perceived risk of detection for speeding by the time of the surveys.

For related reasons, it is also not surprising that the survey results were unable to provide evidence of the presence or absence of an interaction between the effects of the enforcement increase and the publicity presence. (Other reasons included the survey design and the relatively small number of respondents used to measure driver perceptions and intentions under each enforcement/publicity condition.) If an interaction is hypothesised to work via the speed-related publicity increasing the awareness of speeding enforcement, then at the times of the surveys the drivers were probably not sufficiently aware that the speed camera activity had increased for the publicity to magnify this measurably, in months when the publicity was present. For a variety of reasons, including the lack of statistical power of the analysis used, the survey results should be considered inconclusive regarding the presence or absence of interaction effects.

However, the survey results were conclusive about the effect of the speed-related publicity on the ratings of the perceived risk of detection for speeding. When the responses of drivers exposed to conditions representing medium levels of awareness of speed-related advertising were compared with those exposed to high levels of awareness, there was a statistically significant increase in the perceived risk. The magnitude of the estimated increase was such that the tests were able to detect it with high probability, based on the available survey data. Thus there was minimal risk of an erroneous conclusion regarding this issue.

9.3 GENERAL DISCUSSION

9.3.1 Interaction effects

To a large extent the principal objective of this study was achieved, namely to examine the interaction of the effects of levels of speed camera enforcement and the effect of speed-related mass media publicity. The study was unable to find evidence of an interaction effect on casualty crash frequency. This finding applied when all styles of TAC speed-related publicity were considered and when only the emotive-style speed-related publicity was considered. The analysis could not be considered definitive in the case of enforcement-style speed-related publicity because of the unsatisfactory nature of the statistical modelling.

There was also an absence of evidence of an interaction effect on the severity outcome of the casualty crashes, except in the case of the fatality rate and when the speed-related publicity was of enforcement style. When the enforcement was at very high levels in the previous month and there was a high level of enforcement-style advertising, the reduction in risk of fatal outcome was greater than expected from the enforcement and publicity operating alone. This was the only evidence of an interaction effect found in the study. For a variety of reasons associated with counter-intuitive findings linking this type of publicity with crash increases, a conclusion that this interaction effect was real must be tentative.

The surveys of changes in drivers' perceptions and speeding intentions were not conclusive regarding the presence or absence of interaction effects on driver attitudes.

9.3.2 Effects of levels of speed camera activity

There was weak, but not statistically significant, evidence that the level of the number of speeding tickets (TINs) detected by speed cameras in the previous month was associated with casualty crash reductions in the same district. The evidence is strengthened by the monotonic pattern of increased crash reductions associated with increased TIN levels, and crash increases associated with reduced TIN levels. This finding suggests a real effect of the enforcement. The estimated effects ranged from a 3.0% decrease in casualty crashes associated with very high levels of TINs (more than 30% greater than average) to a 6.8% increase in crashes associated with very low levels (less than 30% lower than average).

There was also statistically significant evidence that very high levels of TINs in the previous month were associated with a reduction in the risk of fatal outcome of the casualty crashes. The estimated fatality risk ranged from 41% less than expected at very high levels of TINs compared with medium levels, to 44% greater than expected when very low levels of TINs were detected in the previous month.

The surveys of changes in drivers' perceptions and speeding intentions were not able to provide evidence of the effect of increased speed camera activity on driver attitudes. This was probably

because the surveys were conducted too early for the effect of the covert speed camera operations to have become apparent through the receipt of one or more TINs and/or word-of-mouth communication from other drivers who had received them.

9.3.3 Effects of speed-related mass media publicity

There was statistically significant evidence that high levels of awareness of speed-related TAC publicity (more than 750 television advertising Adstock units per month) were associated with reductions in casualty crashes. This finding appeared to derive from the effect of the emotive-style speed-related publicity (more than 500 Adstock units per month). Estimated casualty crash reductions of 12-13% were associated with these levels of awareness of the publicity, compared with lower levels. There was no evidence of an effect of the emotive-style publicity, nor speed-related publicity in total, on the severity outcome of the casualty crashes.

The study was inconclusive regarding the effects of the enforcement-style speed-related publicity, apart from a tentative conclusion related to an interaction effect with very high levels of enforcement so far as the risk of fatal crash outcome was concerned (see Section 9.3.1). The results suggested that the enforcement-style publicity contributed very little to the casualty crash reductions.

The surveys of drivers' perceptions of the risk of detection when speeding provided evidence that the perceived risk was associated with the level of awareness of the publicity. During times of high levels of awareness of speed-related advertising, the perceived risk was statistically significantly higher than that perceived during conditions representing medium levels of awareness.

This finding provides support for the finding that high levels of awareness of the speed-related publicity were associated with casualty crash reductions. An attitudinal shift with regard to the likelihood of being detected when speeding would seem to be a viable mechanism to explain the reduction in casualty crash risk, perhaps through a reduction in speed behaviour. The surprising finding is that the crash risk reduction was associated with the awareness of speed-related publicity with emotive style, and was apparently unrelated to the publicity with enforcement style. The survey analysis did not provide evidence to judge whether there were differential effects on driver perceptions related to the style of the publicity.

9.3.4 Limitations of the study

This study was limited in its ability to generalise to all circumstances of speed camera operations in conjunction with speed-related publicity because of the short (one-month) period during which speed camera hours were increased (and decreased) in selected police districts. It is possible that, with longer periods of change in speed camera levels, drivers may have developed stronger perceptions of the increased enforcement through personal experience of receiving TINs, knowledge of other drivers who had, and perhaps even direct observation of camera operations. A longer period of change may have led to stronger effects of the presence (or absence) of the enforcement on speed behaviour and hence on crashes. The interaction of these enforcement changes with speed-related publicity may also have been different, and the interaction may have been related to the style of publicity in different ways.

Another limitation of the study relates to our ability to determine the causal mechanisms of the observed effects of the enforcement changes and the publicity variations, especially during 1999 when the biggest changes were made in response to the study design. The surveys of driver

perceptions of speed enforcement and their speeding intentions were limited by their timing and could not uncover all that could have been learnt about the effects of the enforcement changes on driver attitudes. However, the surveys were able to provide some useful information about the influence of the publicity awareness on driver perceptions, when allowance was made for the fact that awareness levels varied differently from that expected during the study design. Larger numbers of respondents to provide more reliable estimates of driver perceptions for some of the key contrasts in the analysis may have provided useful information on the enforcement/publicity interaction, but again the timing of the surveys made this unlikely.

A missing component of the study related to causal mechanisms was observations of on-road speed behaviour. These could have been conducted throughout 1999, in the police districts where speed camera hours were changed, and in a number of other Melbourne districts to measure changes in speeds in the absence of enforcement changes. If sufficiently large to allow trends in excessive speeding as well as average speeds to be monitored, these surveys would have provided a powerful complement to the crash analysis presented here. It would have allowed interpretation of the changes in crash frequency and injury outcome in terms of specific speed behaviours and given insights into the particular causal mechanisms producing the road trauma savings.

9.4 CONCLUSIONS

This study of the interaction of the effects of mobile covert speed camera enforcement and intensive speed-related mass media publicity in Victoria during 1996-2000 reached the following conclusions:

1. There was no evidence of an interaction in the effects of the enforcement and the publicity on casualty crash frequency.
2. The number of speeding tickets detected by speed cameras in Melbourne Police Districts influenced the casualty crash frequency in the same district during the following month. Casualty crashes were reduced by 3.0% following months with very high levels of speeding tickets (more than 30% greater than average) and increased by 6.8% following months with very low levels of speeding tickets (less than 30% lower than average).
3. The risk of fatal outcome of the casualty crashes was also related to the number of speeding tickets detected in the district during the previous month. The fatality risk was reduced by 41% following months with very high levels of speeding tickets and increased by 44% following months with very low levels of speeding tickets.
4. High levels of awareness of TAC speed-related publicity with emotive styles produced casualty crash reductions in Melbourne during the months in which it occurred. Casualty crashes were reduced by 12-13% when awareness, measured by the Adstock of television advertising levels, of emotive-style speed-related publicity exceeded 500 Adstock units, compared with effects during lower levels of awareness of the publicity.
5. There was no evidence of an effect of the emotive-style speed-related publicity on the injury severity outcome of the casualty crashes.
6. Drivers' perceptions of the risk of detection when speeding was increased by high levels of awareness of the speed-related publicity, compared with the perception when the awareness was at medium levels.

The study also reached the following tentative conclusions:

7. There was an interaction effect on fatal casualty crash outcome when there were very high levels of speeding tickets in the previous month and high levels of awareness of enforcement-style speed-related publicity. The reduction in risk of fatal outcome was greater than expected from effects estimated when the enforcement and publicity operated alone at these levels.
8. There was no evidence that awareness of the speed-related publicity with enforcement styles contributed to casualty crash reductions during 1996-2000. This was not inconsistent with the apparent interaction of this type of publicity with the speed camera enforcement in terms of the effect on the severity outcome of casualty crashes (conclusion 7 above).

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11 APPENDIX A: Monthly Speed Camera Hours in the Comparison Districts

The graphs in this Appendix display the monthly number of speed camera hours achieved in the Police Districts that were *not treated* with changed levels of speed camera enforcement during 1999 – that is, the comparison Metropolitan Districts B, D, F, G, J & K for the period 1996-2000. Speed cameras were not used in District A during this period.

For **District B**, the number of speed camera hours achieved remained relatively stable at about 135 hours per month on average during 1996-2000 (Figure 4.6). The exception was during December 1998 in which the number of speed camera hours was about 190 hours. This was because Police had increased their speed camera operations during that month in Melbourne. This increase will not unduly affect the crash analysis because December was not one of the treated months in 1999, so December 1998 will not be used in the ‘before’ period. This applies to the other comparison Districts also.

For **District D**, the number of speed camera hours achieved remained relatively stable at about 270 hours per month on average during 1996-2000 (Figure 4.7). The exception was during December 1998 in which the number of speed camera hours was about 400 hours. Also there was a slight increasing trend in the number of speed camera hours achieved towards the second half of 2000.

It should also be noted that District D was part of the Enhanced Enforcement Program conducted by the Victoria Police and funded by the TAC during 8th August 1997- 18th September 1997. This program consisted of strategically planned increased levels of speed enforcement in addition to the usual levels in two Police Districts including District D. The levels of speed camera hours achieved in August and September 1997 were between 230-280 hours, not very different from the monthly average of 270 speed camera hours. Hence the increases in the levels of speed enforcement that occurred as part of the Enhanced Enforcement Program in August-September 1997 were not evident as increases in the actual levels of speed camera hours achieved.

For **District F**, the number of speed camera hours achieved remained relatively stable at about 270 hours per month on average during 1996-2000 (Figure 4.8). The exceptions were during December 1998 and during September 2000 in which the number of speed camera hours were about 375 and 380 hours, respectively.

For **District G**, the number of speed camera hours achieved remained relatively stable at about 260 hours per month on average during 1996-2000 (Figure 4.9). The exception was during December 1998 in which the number of speed camera hours was about 360 hours.

For **District J**, the number of speed camera hours achieved remained relatively stable at about 260 hours per month on average during 1996-2000 (Figure 4.10). The exception was during December 1998 in which the number of speed camera hours was about 440 hours. Also there was a slight increasing trend in the number of speed camera hours achieved in District J during the first half of 1997.

For **District K**, the number of speed camera hours achieved remained relatively stable at about 250 hours per month on average during 1996-2000 (Figure 4.11). The exception was during December 1998 in which the number of speed camera hours was about 420 hours.

Figure 11.1 Number of hours of speed camera operations per month for District B during 1996-2000

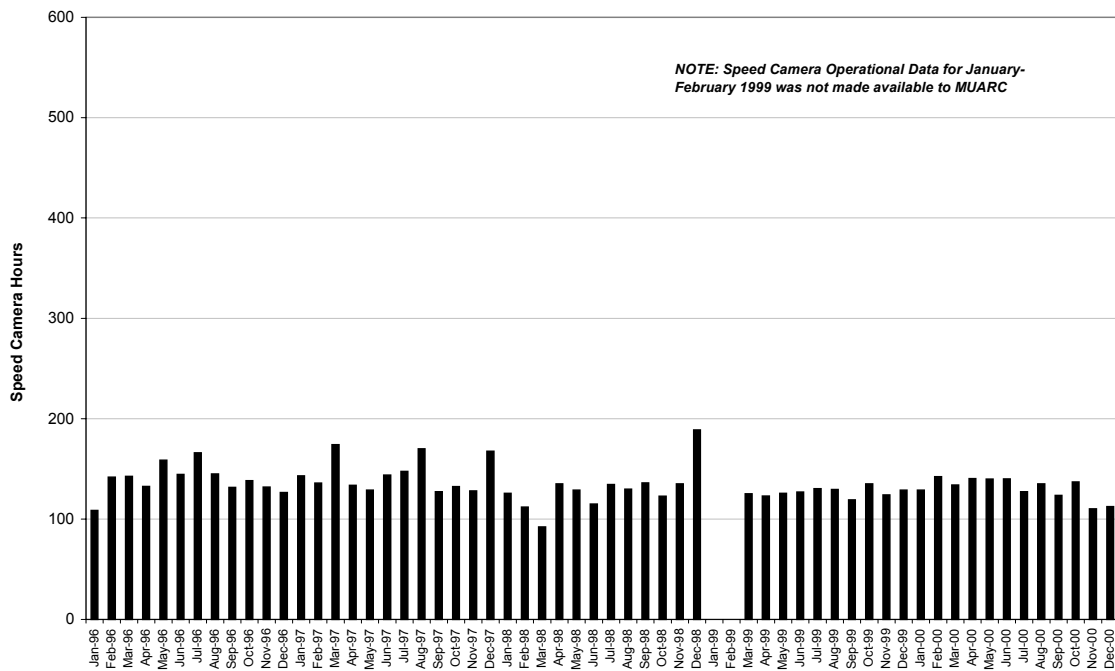


Figure 11.2 Number of hours of speed camera operations per month for District D during 1996-2000

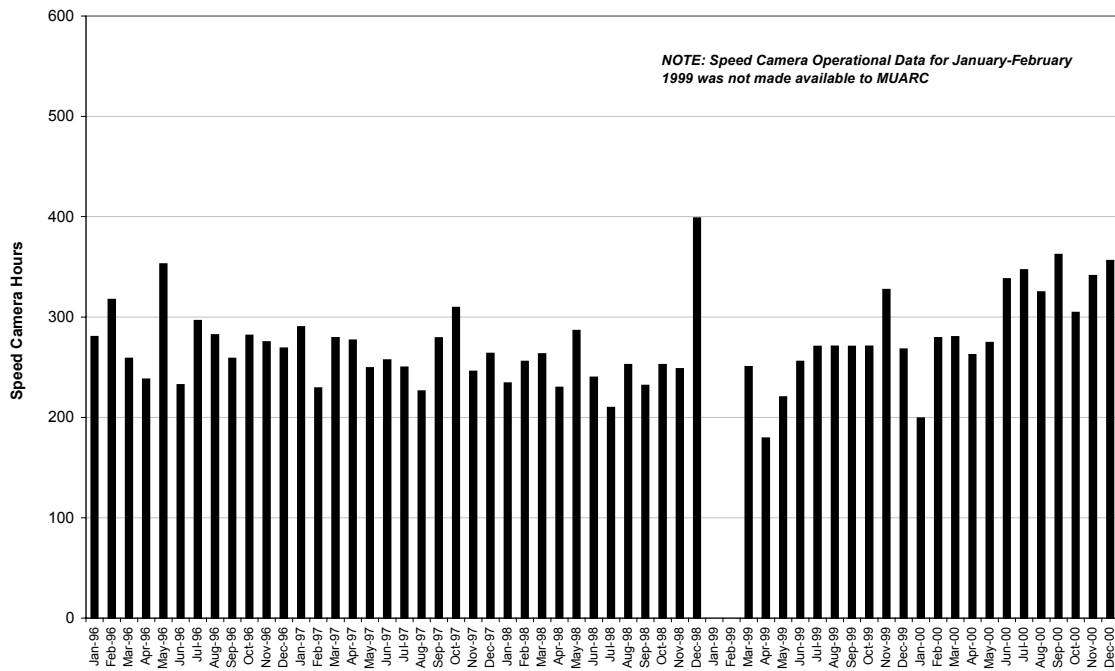


Figure 11.3 Number of hours of speed camera operations per month for District F during 1996-2000

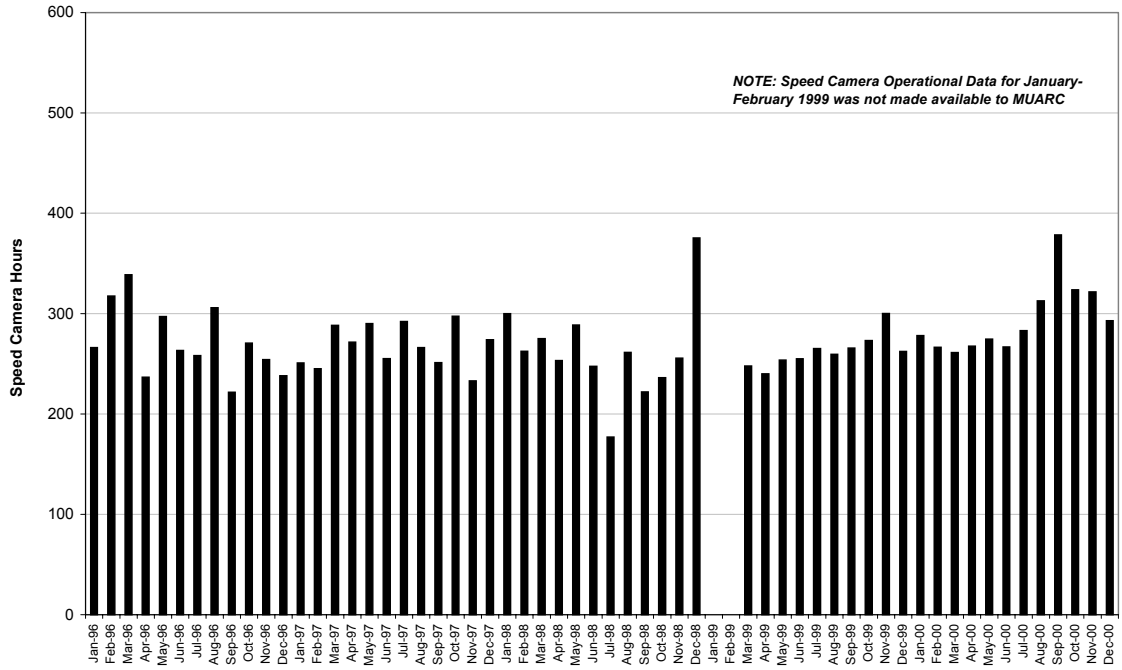


Figure 11.4 Number of hours of speed camera operations per month for District G during 1996-2000

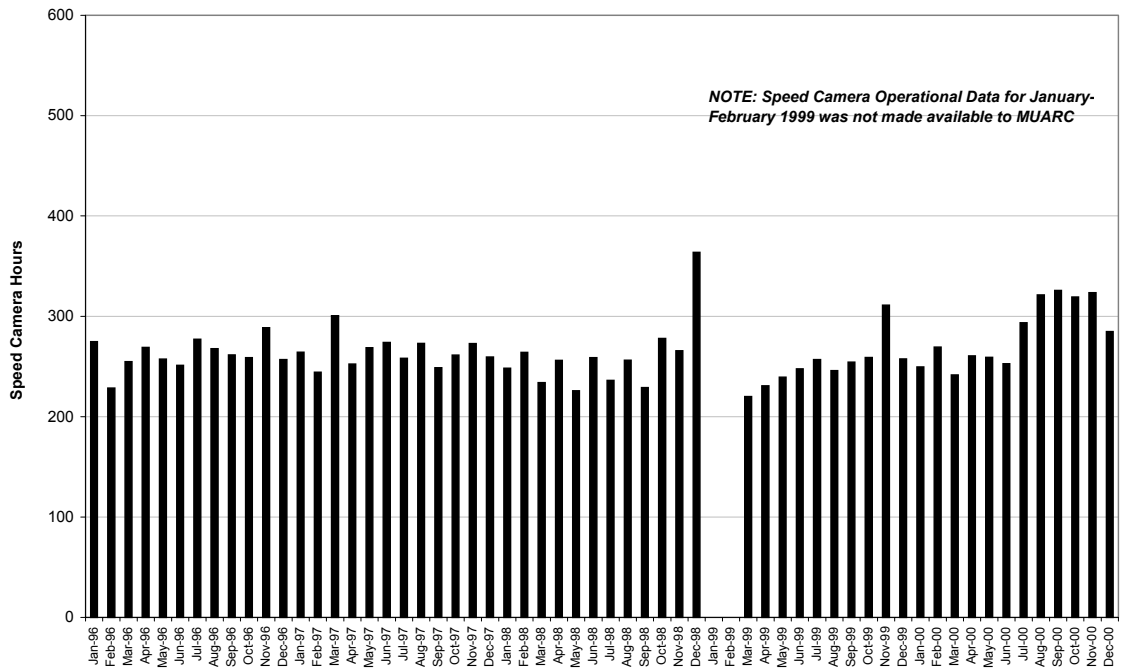


Figure 11.5 Number of hours of speed camera operations per month for District J during 1996-2000

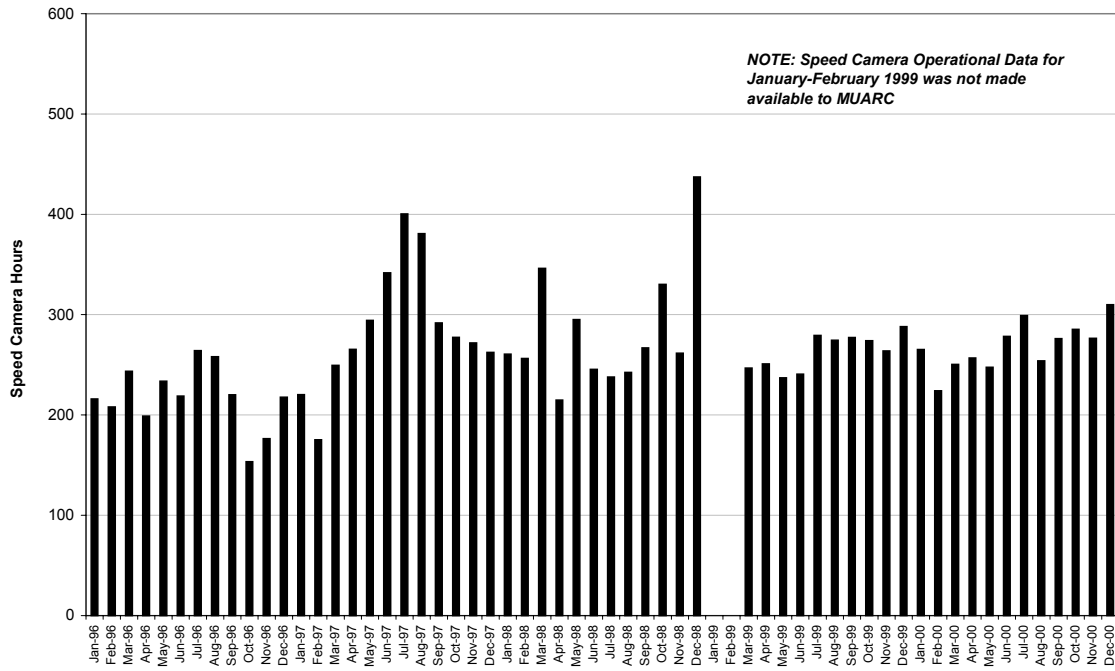
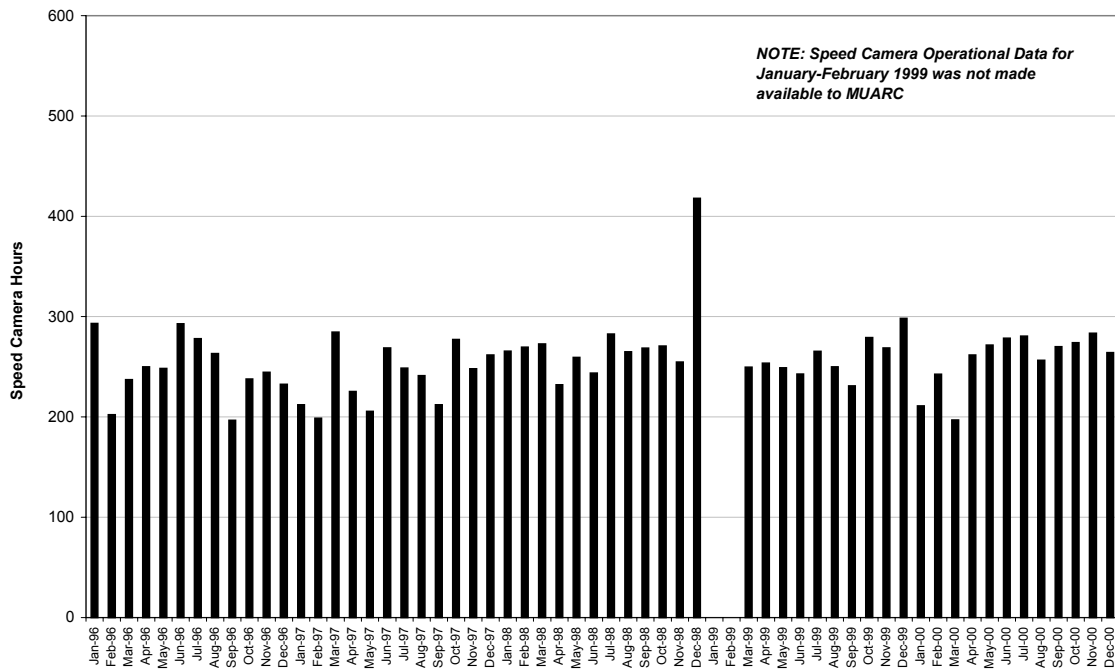


Figure 11.6 Number of hours of speed camera operations per month for District K during 1996-2000



12 APPENDIX B : Results from Preliminary Crash Analysis

12.1 METHOD OF ANALYSIS

12.1.1 Casualty Crash Frequency

The number of casualty crashes that occurred in the Police Districts during the months in 1999 when there were changed speed camera enforcement conditions were compared with:

- i. the annual average number of casualty crashes that occurred in the same Districts during the same months three years earlier (1996-1998);
- ii. the number of casualty crashes that occurred in the same Districts during the same months one year later (2000), and
- iii. the annual average number of casualty crashes that occurred in the same Districts during the same months for combined four years 1996-1998 and 2000.

It was assumed that the levels of speed camera enforcement had remained essentially unchanged during the years 1996-1998 and 2000, hence these years' crashes could be combined in the analysis.

These estimates, expressed as percentage changes, represented an initial estimate of the effect of the changed levels of speed camera enforcement.

12.1.1.1 Comparison group of crashes

The possible effects of other factors affecting crashes during the same months were taken into account by analysing the changes in casualty crash frequencies that occurred in the Metropolitan Police Districts that had not had any changed speed camera enforcement conditions during the relevant months of 1999 (i.e. Districts B, D, F, G, J & K). These crashes were assumed to be relatively unaffected by the changed speed camera enforcement conditions during 1999.

Choosing these Districts to contain the comparison group of crashes may weaken the analysis somewhat because of the risk of a contamination effect of the enforcement from a treated District to an untreated District. For example, District J (part of the comparison group) borders District I (one of the Districts in which speed camera enforcement was increased). There is a chance that the effects of the changed enforcement conditions may spill over into District J, particularly on their common border. It was assumed that such spillage effects would be minimal, and that the bulk of the effect of the changed speed enforcement would occur towards the centre of the District away from the borders.

The percentage change in this 'comparison' group of crashes was estimated in a similar manner as had been estimated for the 'treated' crashes above. This percentage change was considered to measure the effects of other factors that may have affected crashes during the same months as the speed camera enforcement changes.

12.1.1.2 Net Percentage Change

To estimate the difference between the percentage change in the ‘treated’ crashes and the percentage change in the ‘comparison’ crash group, a *net percentage change* was calculated. The net percentage change was considered to estimate the effect of the speed camera enforcement, after the effects of other factors had been taken into account. It should be noted that this comparison measures the effects of the changes in the level of speed camera operations, not the absolute effects of an increase or decrease in speed camera enforcement.

To determine the statistical significance of the net percentage change in casualty crash frequency, two-dimensional contingency table analysis was used. The form of a 2 x 2 contingency table is shown in Table 12.1, where c_{ij} refers to the number of casualty crashes occurring in the i -th crash group and during the j -th time period.

This table depicts the casualty crash frequencies that occurred in the treated Districts and the comparison Districts during both time periods. The values denoted c_{11} , c_{12} , c_{21} , c_{22} refer to the number of casualty crashes (or the annual average number of casualty crashes) that occurred in each crash group during each time period. The annual average number is used if the relevant time period considers crashes over a period of two or more years.

Table 12.1 Two-dimensional contingency table to analyse relationship between crash group and time period

CRASH GROUP	TIME PERIOD		% change	Net %change
	No change in enforcement (1996-1998 & 2000)	Changed enforcement (1999)		
Treatment Districts	c_{11}	c_{12}	$\left(\frac{c_{12}}{c_{11}} - 1\right)\%$	$\left(\frac{c_{12}/c_{11} - 1}{c_{22}/c_{21}}\right)\%$
Comparison Districts	c_{21}	c_{22}	$\left(\frac{c_{22}}{c_{21}} - 1\right)\%$	

From the entries in Table 12.1, the net percentage change is calculated. Firstly the percentage change in crash frequencies for the treatment Districts is determined by calculating the change in crashes that occurred during the changed enforcement period compared the period when there was no change in enforcement for those Districts, i.e.

$$\%change(treatment) = \left(\frac{c_{12} - c_{11}}{c_{11}}\right)\% = \left(\frac{c_{12}}{c_{11}} - 1\right)\%$$

Then the percentage change in crash frequencies for the comparison Districts is calculated in a similar manner as follows:

$$\%change(comparison) = \left(\frac{c_{22} - c_{21}}{c_{21}} \right) \% = \left(\frac{c_{22}}{c_{21}} - 1 \right) \%$$

The net percentage change is then calculated using the following relationship:

$$Net \%change = \left(\frac{c_{12}/c_{11}}{c_{22}/c_{21}} - 1 \right) \% = \left(\frac{c_{12}c_{21}}{c_{11}c_{22}} - 1 \right) \%$$

The net percentage change is a measure of the change in casualty crash frequency that occurred during the period of changed speed camera enforcement conditions in the treatment Districts, *relative* to that expected from the crash experience in the same Districts when the enforcement level was unchanged, and taking into account other factors via the comparison Districts. That is, the treatment percentage change has been ‘netted’ for the comparison percentage change.

12.1.2 Crash Severity

The net percentage change in crash severity was calculated in a similar way to the net percentage change in crash frequency but with another dimension added, the severity of the crash (i.e. a serious casualty crash or a minor injury crash).

The form of the three dimensional contingency table is shown in Table 12.2, where c_{ijk} refers to the number of crashes occurring in the i -th crash group, during the j -th time period and at the k -th crash severity level.

From the entries in Table 12.2 the net percentage change in crash severity can be estimated. Firstly, the percentage change in minor injury crashes that occurred in the treated Districts and the percentage change in minor injury crashes that occurred in the comparison Districts are determined as follows:

$$\%change\ in\ minor\ injury\ crashes(\mathbf{treatment}) = \left(\frac{c_{121} - c_{111}}{c_{111}} \right) \% = \left(\frac{c_{121}}{c_{111}} - 1 \right) \%$$

$$\%change\ in\ minor\ injury\ crashes\ (\mathbf{comparison}) = \left(\frac{c_{221} - c_{211}}{c_{211}} \right) \% = \left(\frac{c_{221}}{c_{211}} - 1 \right) \%$$

Similarly, the corresponding percentage changes in serious casualty crashes are estimated as follows:

$$\%change\ in\ serious\ casualty\ crashes(\mathbf{treatment}) = \left(\frac{c_{122} - c_{112}}{c_{112}} \right) \% = \left(\frac{c_{122}}{c_{112}} - 1 \right) \%$$

$$\%change\ in\ serious\ casualty\ crashes(\mathbf{comparison}) = \left(\frac{c_{222} - c_{212}}{c_{212}} \right) \% = \left(\frac{c_{222}}{c_{212}} - 1 \right) \%$$

Then the *net percentage change* in minor injury crashes is determined by considering the percentage change in minor injury crashes in the treatment group *relative* to that in the comparison group. Similarly, the net percentage in serious casualty crashes is estimated by calculating the percentage change in serious casualty crashes for the treatment Districts relative to that which occurred in the comparison Districts. These calculations are shown below.

$$\text{Net \%change in } \mathbf{minor\ injury\ crashes} = \left(\frac{c_{121}/c_{111}}{c_{221}/c_{211}} - 1 \right) \%$$

$$\text{Net \%change in } \mathbf{serious\ casualty\ crashes} = \left(\frac{c_{122}/c_{112}}{c_{222}/c_{212}} - 1 \right) \%$$

The net percentage in crash severity is then estimated as follows:

$$\text{Net \%change in } \mathbf{crash\ severity} = \left[\left(\frac{\frac{c_{122}/c_{112}}{c_{222}/c_{212}}}{\frac{c_{121}/c_{111}}{c_{221}/c_{211}}} - 1 \right) \right] \%$$

This net percentage change gives the change in the proportion of casualty crashes that were serious which occurred during the period of changed speed camera enforcement conditions in the treatment Districts, relative to that *expected from the crash experience* in the same Districts when the enforcement level was unchanged, and taking into account other factors via the comparison Districts.

This estimate could be considered to measure the percentage change in serious casualty crashes that occurred in the treatment Districts, relative to the change in minor injury crashes and relative to the crash experience in the comparison Districts.

A numerical example of the net percentage change in crash severity is given in Section 12.2.2

Table 12.2 Three-Dimensional Contingency Table to Analyse Relationships Between Crash Group, Time Period and Crash Severity Level

		Crash Severity			
		Minor injury		Serious casualty	
Crash Group	Time Period	Before	During	Before	During
	Treatment Districts		c_{111}	c_{121}	c_{112}	$c_{122}$
Comparison Districts		c_{211}	c_{221}	c_{212}	c_{222}
%change in Treatment Districts		$\left(\frac{c_{121} - c_{111}}{c_{111}}\right)\%$ <i>minor</i>		$\left(\frac{c_{122} - c_{112}}{c_{112}}\right)\%$ <i>serious</i>	
%change in Comparison Districts		$\left(\frac{c_{221} - c_{211}}{c_{211}}\right)\%$ <i>minor</i>		$\left(\frac{c_{222} - c_{212}}{c_{212}}\right)\%$ <i>serious</i>	
Net %change for each crash severity level		$\left(\frac{c_{121}/c_{111}}{c_{221}/c_{211}} - 1\right)\%$ <i>Net %change in minor injury</i>		$\left(\frac{c_{122}/c_{112}}{c_{222}/c_{212}} - 1\right)\%$ <i>Net %change in serious casualty</i>	
Net %change in crash severity		$\left[\left(\frac{c_{122}/c_{112}}{c_{222}/c_{212}} \div \frac{c_{121}/c_{111}}{c_{221}/c_{211}} \right) - 1 \right] \%$			

12.1.3 Hypothesis Tests

The hypothesis tests carried out in this evaluation assumed a null hypothesis in which the increased levels of speed camera enforcement had no effect on crash outcomes against an alternative hypothesis in which the increased enforcement was associated with a net percentage reduction in crash outcomes. This test applies to the first four treatment conditions in which there was an increase in the level of speed camera enforcement, i.e. T1, T2, T3 and T4 (defined in section 3.5).

12.1.3.1 Casualty crash frequency

When the crash outcome measure was casualty crash frequency, the hypothesis test was expressed as follows:

H0: a net % casualty crash change = 0 (no effect), versus

Ha: a net % casualty crash change < 0 (reduction in casualty crash frequency).

A one-directional alternative hypothesis was assumed because it is expected that increased enforcement will have a positive effect on road trauma leading to crash reductions.

For the other four changed enforcement conditions, i.e. T5, T6, T7 and T8 in which the level of speed camera enforcement had been reduced, the hypothesis test was as follows:

H0: a net % casualty crash change = 0 (no effect), versus

Ha: a net % casualty crash change \neq 0 (a change in casualty crash frequency).

A two-directional alternative hypothesis was considered because recent MUARC research has found that when there had been a reduction in Police enforcement levels this reduction was not necessarily reflected in crash increases (Diamantopoulou, Cameron & Shtifelman, 2000). This evaluation found that both increases and decreases in casualty crash risk occurred when traffic enforcement levels had been reduced.

The statistical significance of the net percentage change in casualty crash frequency was measured using a two-way chi-square test (Ryan et al, 1985).

The significance probabilities or p-values presented in the results tables in the following sections were based on two-tailed tests of significance, with the following applying:

- i. If the p-value \leq 0.05, then the net % casualty crash change was assumed to be statistically significant.
- ii. If $0.05 < \text{p-value} \leq 0.10$, then the net % casualty crash change was labelled as 'marginally statistically significant'.
- iii. If the p-value $>$ 0.10, then the net % casualty crash change was not statistically significant, and so was likely due to chance.

12.1.3.2 *Crash Severity*

When the crash outcome measure considered was crash severity, the hypothesis test was expressed as follows for treatment conditions T1, T2, T3 and T4:

H0: a net % change in crash severity = 0 (no effect), versus

Ha: a net % change in crash severity $<$ 0 (reduction in the proportion of casualty crashes that were serious).

For the other four changed enforcement conditions, i.e. T5, T6, T7 and T8 in which the level of speed camera enforcement had been reduced, the hypothesis test was:

H0: a net % change in crash severity = 0 (no effect), versus

Ha: a net % change in crash severity \neq 0 (a change in the proportion of casualty crashes that were serious).

12.1.4 Statistical Methodology

The above hypothesis tests for changes in crash severity were tested by analysing the three-way interaction in contingency tables of crash frequencies categorised by crash group, time period and crash severity (Bishop et al, 1975; Christensen, 1990).

To test for the statistical significance of a three-way interaction in three-dimensional contingency tables, log-linear categorical models were fitted to the frequencies in each cell of the contingency table (Table 12.2) using the statistical computer software GLIM (Aitkin et al, 1990).

For this evaluation, log-linear models were fitted to the casualty crash frequencies in each contingency table to determine if there had been any significant net percentage reductions in crash severity, i.e. in the proportion of casualty crashes that were serious.

Assuming the crashes followed a Poisson distribution and using the notation of Christensen (1990) the log-linear model has the form:

$$\log(m_{ijk}) = \xi + \alpha_i + \beta_j + \gamma_k + (\alpha\beta)_{ij} + (\alpha\gamma)_{ik} + (\beta\gamma)_{jk} + (\alpha\beta\gamma)_{ijk}$$

where m_{ijk} are the expected number of crashes in the ijk -th cell of the contingency table and (for example),

α_i is the effect of the i -th crash group ($i=1$ refers to treated Districts; $i=2$ refers to comparison Districts);

β_j is the effect of the j -th time period ($j=1$ refers to the time period where there were unchanged levels of speed camera enforcement; $j=2$ refers to the time period of changed speed camera enforcement conditions);

γ_k is the effect of the k -th crash severity level ($k=1$ refers to a minor injury crash; $k=2$ refers to a serious casualty crash) and,

$(\alpha\beta\gamma)_{ijk}$ is the effect of the ijk -th three-way interaction of crash group, time period and crash severity level.

The results of the preliminary crash analysis, for each of the eight treatment conditions (combination of enforcement level and publicity presence during the month), are given below.

12.2 TREATMENT 2: 100% increase in speed camera enforcement with speed-related publicity present

Treatment 2 (T2) was defined as a 100% increase in speed camera enforcement with speed-related publicity present. This treatment condition occurred in District E in November 1999 and in District I in June 1999. The number of casualty crashes that occurred in these Districts during the appropriate months of increased enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during June & November. In addition comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

12.2.1 Effects on casualty crash frequency

Table 12.3 gives the net percentage change in casualty crash frequency that occurred under conditions of a 100% increase in speed camera enforcement with speed-related publicity present (i.e. June 1999 in District I and November 1999 in District E) relative to the comparison Districts (i.e. Districts B, D, F, G, J, K in June and November 1999), and to the corresponding periods when there was no change in the levels of speed camera enforcement (i.e. June & November 1996-1998 and June & November 2000). During June and November of 1996, 1997, 1998 and 2000 the levels of speed camera hours achieved in Districts I and E varied on average by about 5%-7%. Hence the comparisons were between periods of changed speed camera enforcement conditions with periods of minimal or no change in speed camera enforcement conditions, i.e.

- June & November 1999 vs. June & November 1996-1998
- June & November 1999 vs. June & November 2000

- June & November 1999 v. June & November 1996-1998, 2000.

The casualty crashes occurring in 1996-1998 were combined with those occurring in 2000 to increase crash numbers and hence statistical power in the testing process. The annual average crash frequencies for 1996-1998 are also presented in Table 12.3 in brackets. The percentage change in casualty crash frequency and the net percentage casualty crash change have been calculated using the relationships given in Table 12.1.

There was no evidence of percentage reductions in casualty crash frequency under the changed enforcement conditions of a 100% increase in speed camera enforcement accompanied by speed-related publicity relative to that expected from the crash experience in the same Districts when the enforcement levels remained unchanged.

This was also the case when the changes in casualty crash frequency that occurred in the comparison Districts had been taken into account as indicated by the net percentage change estimates. For instance, during 1999 there was an apparent net 6.5% increase in casualty crash frequency in the treated Districts compared to the combined periods when there was no change in enforcement (i.e. 1996-1998 and 2000), and relative to the changes that occurred in the comparison Districts. The net 6.5% increase in casualty crash frequency was not statistically significant, however.

Table 12.3 Casualty crashes occurring during the months & in the Police Districts where there was a 100% increase in speed camera enforcement with speed-related publicity present (Treatment 2)

Time Period Treatment Group	Jun & Nov 1996-1998 (Unchanged enforcement conditions)	Jun & Nov 1999 (Changed enforcement conditions)	Jun & Nov 2000 (Unchanged enforcement conditions)	Jun & Nov 1996-98 & 2000 (Unchanged enforcement conditions)
T2: District E in November & District I in June	710 [236.7]*	243	225	935 [233.8]
Districts B, D, F, G, J & K in June & November (Comparison Districts)	3633 [1211]	1184	1220	4853 [1213.3]
YEAR-TO-YEAR COMPARISON				
		(1996-98) vs. (1999)	(2000) vs. (1999)	(1996-98 & 2000) vs. (1999)
%change in casualty crashes in treated Districts		+2.7%	+8.0%	+3.9%
%change in casualty crashes in comparison Districts		-2.2%	-3.0%	-2.4%
Net % change in casualty crashes with significance probability (2-tailed)		+5.0 % <i>0.5492</i>	+11.3% <i>0.2901</i>	+6.5 % <i>0.4253</i>

**Annual average casualty crash frequency in brackets*

12.2.2 Effects on crash severity

Table 12.4 gives the estimated net percentage change in crash severity that occurred during the period of a 100% increase in speed camera enforcement (i.e. June & November 1999) in comparison to the combined period of no change in speed camera enforcement (i.e. June & November 1996-1998 & 2000), with speed-related publicity present.

This table also illustrates how the net percentage change in crash severity has been calculated from the net percentage changes in minor injury crashes and in serious casualty crashes using the relationships given in Table 12.2.

A 17.1% increase in minor injury crashes occurred in the treated Districts whilst a 2% reduction in minor injury crashes occurred in the comparison Districts. This resulted in a net 19.5% increase in minor injury crashes in the treated Districts after the changes in the comparison Districts had been taken into account.

When considering the changes that occurred in serious casualty crash frequencies, there was a 29.8% reduction and a 3.5% reduction in serious casualty crashes in the treated Districts and in the comparison Districts, respectively. This resulted in a net 27.2% reduction in serious casualty crashes in the treated Districts relative to those in the comparison Districts.

Hence, adjusting the net 27.2% reduction in serious casualty crashes with the 19.5% increase in minor injury crashes gives an estimated net 39.1% reduction in crash severity, or in the proportion of casualty crashes that resulted in a fatality or serious injury. This net 39.1% reduction was statistically significant (p=0.0086).

Thus, for this treatment (i.e. 100% increase in speed camera enforcement with publicity), the net percentage change in serious casualty crashes was substantially different from that of minor injury crashes. The apparent net 6.5% increase in casualty crash frequency shown in Table 12.3 was primarily due to the increase in minor injury crashes.

Table 12.4 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was a 100% increase in speed camera enforcement with speed-related publicity PRESENT (Treatment 2)

Treatment	Time Period	Crash Severity				Net % change in the proportion of crashes that were serious
		Minor injury		Serious casualty		
		Jun & Nov 1996-1998 & 2000 (Unchanged enforcement conditions)	Jun & Nov 1999 (Changed enforcement conditions)	Jun & Nov 1996-1998 & 2000 (Unchanged enforcement conditions)	Jun & Nov 1999 (Unchanged enforcement conditions)	
T2: District E in November & District I in June Comparison Districts B, D, F, G, J & K in June & November		673 [168.3]*	197	262 [65.5]	46	
		3481 [870.3]	853	1372 [343.0]	331	
	% change in Treatment Districts	+17.1% (minor)		-29.8% (serious)		
% change in Comparison Districts	-2.0 % (minor)		-3.5% (serious)			
Net % change in each crash severity level	+19.5 % (minor)		-27.2 % (serious)		-39.1% (<i>p</i> =0.0086)	

*Annual average casualty crash frequency in brackets

Table 12.5 depicts the net percentage change in crash severity that were found during the months and in the Districts where there was a 100% increase in speed camera enforcement accompanied by speed-related publicity in comparison to the three periods of unchanged enforcement conditions (1996-1998, 2000 and 1996-98/2000).

Under these conditions, the following net reductions in crash severity occurred during June 1999 in District I and during November 1999 in District E relative to the comparison Districts and to the periods when the levels of enforcement were not varied:

- A net 42.3% reduction relative to June and November 1996-1998;
- A net 28.5% reduction relative to June and November 2000;
- A net 39.1% reduction relative to June and November 1996-98 & June and November 2000.

Table 12.5 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was a 100% increase in speed camera enforcement with speed-related publicity PRESENT (Treatment 2)

Time Period Treatment	Crash Severity				Net % change in the proportion of crashes that were serious
	Minor injury		Serious casualty		
	Jun & Nov 1996-1998 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 1996-1998 (Unchanged)	Jun & Nov 1999 (Changed)	
T2: District E in November & District I in June Comparison Districts B, D, F, G, J & K in June & November	509 2635	197 853	201 998	46 331	-42.3% (p=0.0046)
Time Period Treatment	Jun & Nov 2000 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 2000 (Unchanged)	Jun & Nov 1999 (Changed)	-28.5% (p=0.1604)
T2: District E in November & District I in June Comparison Districts B, D, F, G, J & K in June & November	164 846	197 853	61 374	46 331	
Time Period Treatment	Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	-39.1% (p=0.0086)
T2: District E in November & District I in June Comparison Districts B, D, F, G, J & K in June & November	673 3481	197 853	262 1372	46 331	

*Annual average casualty crash frequency in brackets

12.3 TREATMENT 1: 100% INCREASE IN SPEED CAMERA ENFORCEMENT WITH SPEED-RELATED PUBLICITY ABSENT

Treatment 1 (T1) was defined as a treatment condition of a 100% increase in speed camera enforcement with TAC speed-related advertising or publicity absent. This treatment condition occurred in District E in April 1999 and in District I in August 1999. The number of casualty crashes that occurred in these Districts during the appropriate months of increased enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during April and August 1999. In addition comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

12.3.1 Effects on casualty crash frequencies

Table 12.6 gives the net percentage change in casualty crash frequency that occurred during the period of changed enforcement and publicity conditions, i.e. April 1999 in District E and August 1999 in District I. Comparisons were made with the corresponding months in the years before the changed enforcement/publicity conditions (i.e. 1996-1998) and in the year after the changed enforcement/publicity conditions (i.e. 2000), i.e.

- April & August 1999 vs. April & August 1996-1998
- April & August 1999 vs. April & August 2000
- April & August 1999 v. April & August 1996-1998, 2000.

The casualty crashes occurring in 1996-1998 were combined with those occurring in 2000 to increase crash numbers and hence statistical power in the testing process. Where appropriate, the percentage changes shown in Table 12.6 have been calculated using the annual average crash frequencies.

Table 12.6 Casualty crashes occurring during the months & in the Police Districts where there was a 100% increase in speed camera enforcement with speed-related publicity absent (Treatment 1)

Time Period Treatment Group	Apr & Aug 1996-1998 (Unchanged enforcement conditions)	Apr & Aug 1999 (Changed enforcement conditions)	Apr & Aug 2000 (Unchanged enforcement conditions)	Apr & Aug 1996-98 & 2000 (Unchanged enforcement conditions)
T1: District E in April & District I in August	675 [225.0]*	228	244	919 [229.8]
Comparison Districts B, D, F, G, J & K in April & August	3550 [1183.3]	1190	1207	4757 [1189.3]
YEAR-TO-YEAR COMPARISON		(1996-98) vs. (1999)	(2000) vs. (1999)	(1996-98 & 2000) vs. (1999)
%change in casualty crashes in treated Districts		+1.3%	-6.6%	-0.78%
%change in casualty crashes in comparison Districts		+0.6%	-1.4%	+0.06%
Net % change in casualty crashes with significance probability (2-tailed)		+0.8 % (<i>p</i> =0.9274)	-5.2 % (<i>p</i> =0.5944)	-0.82 % (<i>p</i> =0.9183)

*Annual average casualty crash frequency in brackets

Net percentage reductions in casualty crash frequency were estimated to have occurred in the treated Districts during the months of 1999 where there had been a 100% increase in speed camera enforcement with no publicity (i.e. a 5.2% reduction and a 0.82% reduction compared to 2000 and 1996-1998 & 2000, respectively). However, these reductions were not statistically significant.

12.3.2 Effects on crash severity

There was no evidence of net percentage reductions in crash severity (i.e. in the proportion casualty crashes that were serious) during the period when speed camera enforcement was increased by 100% in the absence of speed-related publicity (Table 12.7). The weak net 0.82% reduction in casualty crash frequency shown in Table 12.6 was primarily due to the net 3.3% reduction that occurred for minor injury crashes, although neither reduction was statistically significant.

Table 12.7 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was a 100% increase in speed camera enforcement with speed-related publicity absent (Treatment 1)

		Crash Severity				Net % change in the proportion of casualty crashes that were serious
		Minor injury		Serious casualty		
Time Period	Treatment	Apr & Aug 1996-1998 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 1996-1998 (Unchanged)	Apr & Aug 1999 (Changed)	
	T1: District E in April & District I in August	489 [163.0]*	166	186 [62.0]	62	+5.1 %
	Comparison Districts B, D, F, G, J & K in April & August	2,492 [830.7]	852	1,058 [352.7]	338	(p=0.7914)
Time Period	Treatment	Apr & Aug 2000 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 2000 (Unchanged)	Apr & Aug 1999 (Changed)	
	T1: District E in April & District I in August	186	166	58	62	+22.3%
	Comparison Districts B, D, F, G, J & K in April & August	859	852	348	338	(p=0.3812)
Time Period	Treatment	Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	
	T1: District E in April & District I in August	675 [168.8]	166	244 [61.0]	62	
	Comparison Districts B, D, F, G, J & K in April & August	3351 [837.8]	852	1406 [351.5]	338	
	%change in Treatment Districts	-1.7% (minor)		+1.6% (serious)		
	% change in Comparison Districts	+1.7% (minor)		-3.8% (serious)		
	Net % change in each crash severity level	-3.3% (minor)		+5.7 % (serious)		+9.3% (p=0.6256)

*Annual average casualty crash frequency in brackets

12.4 TREATMENT 3: 50% INCREASE IN SPEED CAMERA ENFORCEMENT WITH PUBLICITY ABSENT

Treatment 3 (T3) was defined as a 50% increase in speed camera enforcement with speed-related publicity absent. This treatment condition occurred in District E in August 1999 and in District I in April 1999. The number of casualty crashes that occurred in these Districts during the appropriate months of increased enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during April & August. In addition comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

12.4.1 Effects on casualty crash frequency

Table 12.8 gives the net percentage change in casualty crash frequency that occurred under conditions of a 50% increase in speed camera enforcement in the absence of speed-related publicity (i.e. August 1999 in District E and April 1999 in District I) relative to the control group (i.e. Districts B, D, F, G, J, K in April 1999 and August 1999), and to the corresponding periods when there was no change in the levels of speed camera enforcement (i.e. April and August 1996-1998 & 2000).

Statistically significant net % reductions were found when there was a 50% increase in speed camera enforcement in the absence of speed-related publicity during April and August 1999 relative to the control Districts. The net % reductions found were primarily due to the percentage reductions in casualty crash frequency that occurred in treated Districts. There was little change in casualty crash frequency in the comparison Districts during the period of changed speed camera enforcement conditions relative to that expected from the crash experience in the same Districts when the enforcement levels were unchanged.

Table 12.8 Casualty crashes occurring during the months & in the Police Districts where there was a 50% increase in speed camera enforcement with speed-related publicity absent (Treatment 3)

Treatment Group \ Time Period	Apr & Aug 1996-1998 (Unchanged enforcement conditions)	Apr & Aug 1999 (Changed enforcement conditions)	Apr & Aug 2000 (Unchanged enforcement conditions)	Apr & Aug 1996-98 (Unchanged enforcement conditions)
T3: District E in August & District I in April	667 [222.3]*	188	240	907 [226.8]
Comparison Districts B, D, F, G, J & K in April & August	3550 [1183.3]	1190	1207	4757 [1189.3]
YEAR-TO-YEAR COMPARISON		(1996-98) vs. (1999)	(2000) vs. (1999)	(1996-98 & 2000) vs. (1999)
%change in casualty crashes in treated Districts		-15.4%	-21.7%	-17.1%
%change in casualty crashes in comparison Districts		+0.6%	-1.4%	+0.06%
Net % change in casualty crashes		-15.9 %	-20.6 %	-17.1%
Significance probability (2-tailed)		0.0491	0.0290	0.0296

*Annual average casualty crash frequency in brackets

12.4.2 Effects on crash severity

Table 12.9 presents the net % change in crash severity found during the months and in the Districts where there was a 50% increase in speed camera enforcement with speed-related publicity absent.

Weak non-significant net % reductions in crash severity were found during the months and in the Districts where there was a 50% increase in speed camera enforcement accompanied by speed-related publicity in comparison to the combined period of no change in speed camera enforcement (i.e. April & August 1996-1998 & 2000). Under these conditions a net 8.8% reduction in crash severity occurred during April 1999 in District I and during August 1999 in District E in comparison to the control group and to the periods when the levels of enforcement were not varied (i.e. April & August 1996-1998 and 2000). As can be seen from Table 12.9, net percentage reductions in both minor injury and in serious casualty crashes occurred during the changed enforcement conditions, i.e. 15.2% and 22.6% reductions, respectively. Thus the net 17.1% reduction in casualty crash frequency shown in Table 12.8 consisted of reductions in both minor and serious crashes.

Table 12.9 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was a 50% increase in speed camera enforcement with speed-related publicity ABSENT (Treatment 3)

		Crash Severity				Net % change in the proportion of casualty crashes that were serious
		Minor injury		Serious casualty		
Time Period	Treatment	Apr & Aug 1996-1998 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 1996-1998 (Unchanged)	Apr & Aug 1999 (Changed)	
T3: District E in August & District I in April		472 [157.3]*	140	195 [65.0]	48	-11.2%
Comparison Districts B, D, F, G, J & K in April & August		2492 [830.7]	852	1058 [352.7]	338	(p=0.5549)
Time Period	Treatment	Apr & Aug 2000 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 2000 (Unchanged)	Apr & Aug 1999 (Changed)	
T3: District E in August & District I in April		177	140	63	48	-1.6%
Comparison Districts B, D, F, G, J & K in April & August		859	852	348	338	(p=0.9454)
Time Period	Treatment	Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	
T3: District E in August & District I in April		649 [162.3]	140	258 [64.5]	48	
Comparison Districts B, D, F, G, J & K in April & August		3351 [837.8]	852	1406 [351.5]	338	
%change in Treatment Districts		-13.7% (minor)		-25.6% (serious)		
%change in Comparison Districts		+1.7% (minor)		-3.8% (serious)		
Net %change in each crash severity level		-15.2% (minor)		-22.6% (serious)		-8.8% (p=0.6383)

*Annual average casualty crash frequency in brackets

12.5 TREATMENT 4: 50% INCREASE IN SPEED CAMERA ENFORCEMENT WITH PUBLICITY PRESENT

Treatment 4 (T4) was defined as a 50% increase in speed camera enforcement with speed-related publicity present. This treatment condition occurred in District E in June 1999 and in District I in November 1999. The number of casualty crashes that occurred in these Districts

during the appropriate months of increased enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during June & November. In addition comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

12.5.1 Effects on casualty crash frequency

Table 12.10 gives the net percentage change in casualty crash frequency that occurred under conditions of a 50% increase in speed camera enforcement in the presence of speed-related publicity (i.e. June 1999 in District E and November 1999 in District I) relative to the control group (i.e. Districts B, D, F, G, J, K in June 199 and November 1999), and to the corresponding periods when there was no change in the levels of speed camera enforcement (i.e. June and November 1996-1998 & 2000).

There was no evidence of net % reductions in casualty crash frequency for this changed enforcement condition. (Note: Statistically significant increases were found when there was a 50% increase in speed camera enforcement and speed camera publicity was present relative to the comparison group of crashes).¹⁹

Table 12.10 Casualty crashes occurring during the months & in the Police Districts where there was a 50% increase in speed camera enforcement with speed-related publicity present (Treatment 4)

Treatment Group	Time Period	Jun & Nov 1996-1998 (Unchanged enforcement conditions)	Jun & Nov 1999 (Changed enforcement conditions)	Jun & Nov 2000 (Unchanged enforcement conditions)	Jun & Nov 1996-98 & 2000 (Unchanged enforcement conditions)
T4: District E in June & District I in November		686 [228.7]*	261	214	900 [225.0]
Comparison Districts B, D, F, G, J & K in June & November		3633 [1211.0]	1184	1220	4853 [1213.3]
YEAR-TO-YEAR COMPARISON			(1996-98) vs. (1999)	(2000) vs. (1999)	(1996-98 & 2000) vs. (1999)
%change in casualty crashes in treated Districts			+14.6%	+22.4%	+16.0%
%change in casualty crashes in comparison Districts			-2.2%	-3.0%	-2.4%
Net % change in casualty crashes With significance probability (2-tailed)			+16.7 % (p=0.0550)	+25.7 % (p=0.0234)	+18.9 % (p=0.0272)

*Annual average casualty crash frequency in brackets

¹⁹ The net percentage increases were largely comprised of the relatively large casualty crash frequencies found in District E in June 1999. When only District I in November 1999 was considered in the analysis, a net 2.7% reduction in casualty crash frequency was found. However, for District E in June 1999 a net 47% increase occurred.

12.5.2 Effects on crash severity

Table 12.11 presents the net % change in crash severity found during the months and in the Districts where there was a 50% increase in speed camera enforcement with speed-related publicity present.

There was little evidence of net % reductions in crash severity under the changed enforcement conditions of a 50% increase in speed camera enforcement with speed-related publicity present. Note: A marginally statistically significant 47.9% increase in crash severity was found when there was a 50% increase in speed camera enforcement and speed camera publicity was present compared to what was expected to have occurred in the same Districts during 2000, and relative to the comparison group of crashes.

Table 12.11 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was a 50% increase in speed camera enforcement with speed-related publicity PRESENT (Treatment 4)

		Crash Severity				Net % change in the proportion of casualty crashes that were serious
		Minor injury		Serious casualty		
Time Period	Treatment	Jun & Nov 1996-1998 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 1996-1998 (Unchanged)	Jun & Nov 1999 (Changed)	
T4: District E in June & District I in November		491 [163.7]*	187	195 [65.0]	74	-2.8%
Comparison Districts B, D, F, G, J & K in June & November		2635 [878.3]	853	998 [332.7]	331	(p=0.8755)
Time Period	Treatment	Jun & Nov 2000 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 2000 (Unchanged)	Jun & Nov 1999 (Changed)	
T4: District E in June & District I in November		164	187	50	74	+47.9%
Comparison Districts B, D, F, G, J & K in June & November		846	853	374	331	(p=0.0880)
Time Period	Treatment	Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	
T4: District E in June & District I in November		655 [163.8]	187	245 [61.3]	74	
Comparison Districts B, D, F, G, J & K in June & November		3481 [870.3]	853	1372 [343.0]	331	
%change in Treatment Districts		+14.2% (minor)		+20.7% (serious)		
%change in Comparison Districts		-2.0% (minor)		-3.5% (serious)		
Net %change in each crash severity level		+16.5% (minor)		+25.2% (serious)		+7.5% (p=0.6768)

*Annual average casualty crash frequency in brackets

12.6 TREATMENTS THAT HAD REDUCTIONS IN SPEED CAMERA ENFORCEMENT LEVELS

The changes in casualty crash frequency and crash severity that occurred in the Police Districts that were treated with *reductions* in speed camera enforcement levels are summarised in the following sections.

12.6.1 Treatment 5: No speed camera enforcement and no speed-related publicity

Treatment 5 (T5) was defined as having no speed camera enforcement and no speed-related publicity. This treatment condition occurred in District C in April 1999 and in District H in August 1999. The number of casualty crashes that occurred in these Districts during the appropriate months of decreased speed camera enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during April & August. In addition comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

The following tables compare the period of changed speed camera enforcement conditions (i.e. April and August 1999) with the *combined* periods when there was no change in speed camera enforcement (i.e. April and August 1996-1998 & 2000).

12.6.1.1 *Effects on casualty crash frequency*

Table 12.12 gives the net percentage change in casualty crash frequency that occurred under conditions of no speed camera enforcement and no speed-related publicity (i.e. April 1999 in District C and August 1999 in District H).

Although there was a net 8.9% reduction in casualty crash frequency in the Districts where there was no speed camera enforcement and no speed-related publicity, this reduction was not statistically significant so may have been due to chance.

Table 12.12 Casualty crashes occurring during the months & in the Police Districts where there was NO speed camera enforcement and NO speed-related publicity present (Treatment 5)

Treatment Group \ Time Period	Apr & Aug 1999 (Changed enforcement conditions)	Apr & Aug 1996-1998 & 2000 (Unchanged enforcement conditions)	Net % change in casualty crashes
T5: District C in April & District H in August	216	948 [237.0]*	-8.9% (<i>p</i> =0.2550)
Comparison Districts B, D, F, G, J & K in April & August	1190	4757 [1189.3]	
%change in treated Districts	-8.9%		
%change in comparison Districts	+0.06%		

*Annual average casualty crash frequency in brackets

12.6.1.2 Effects on crash severity

Table 12.13 presents the net % change in crash severity found during the months and Districts where both speed camera enforcement and speed-related publicity were absent. Although a net 14.4% reduction in crash severity was found when there was no speed camera enforcement and no speed-related publicity, this reduction was not statistically significant so may have been due to chance.

Table 12.13 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was NO speed camera enforcement and no speed-related publicity (Treatment 5)

Treatment Group	Time Period	Crash Severity				Net %change in proportion of casualty crashes that were serious
		Minor Injury		Serious Casualty		
		Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	
T5: District C in April & District H in August	691 [172.8]*	166	257 [64.3]	50	-14.4%	
Comparison districts B, D, F, G, J & K in April & August	3351 [837.8]	852	1406 [351.5]	338	(p=0.4146)	

12.6.2 Treatment 6: No speed camera enforcement with speed-related publicity present

Treatment 6 (T6) was defined as speed-related publicity present but no speed camera enforcement. This treatment condition occurred in District C in November 1999 and in District H in June 1999. The number of casualty crashes that occurred in these Districts during the appropriate months of decreased speed camera enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during June and November. In addition, comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

12.6.2.1 Effects on casualty crash frequency

Table 12.14 gives the net percentage change in casualty crash frequency that occurred under conditions of no speed camera enforcement but with speed-related publicity present (i.e. November 1999 in District C and June 1999 in District H). This net percentage change is in comparison to the combined periods when there was no change in speed camera enforcement (i.e. June and November 1996-1998 & 2000), and to the control group of crashes.

Although there was a net 2.4% increase in casualty crash frequency in the Districts where there was no speed camera enforcement but speed-related publicity was present, this increase was not statistically significant.

Table 12.14 Casualty crashes occurring during the months & in the Police Districts where there was NO speed camera enforcement but speed-related publicity was present (Treatment 6)

Treatment Group \ Time Period	Jun & Nov 1999 (Changed enforcement conditions)	Jun & Nov 1996-1998 & 2000 (Unchanged enforcement conditions)	Net % change in casualty crashes
T6: District C in November & District H in June	230	921 [230.3]*	+2.4 % (<i>p</i> =0.7725)
Comparison Districts B, D, F, G, J & K in June & November	1184	4853 [1213.3]	
%change in treated Districts	-0.13%		
%change in comparison Districts	-2.42%		

*Annual average casualty crash frequency in brackets

12.6.2.2 Effects on crash severity

Table 12.15 gives the net % change in crash severity that was found during the months and Districts where speed camera enforcement was absent but speed-related publicity was present. Although a net 23.4% increase in crash severity was found when there was speed-related publicity present but no speed camera enforcement, this increase was not statistically significant.

Table 12.15 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was NO speed camera enforcement but speed-related publicity was present (Treatment 6)

Treatment Group \ Time Period	Crash Severity				Net %change in proportion of casualty crashes that were serious
	Minor Injury		Serious Casualty		
	Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	
T6: District C in November & District H in June	666 [166.5]*	157	255 [63.8]	73	+23.4% (<i>p</i> =0.2334)
Comparison Districts B, D, F, G, J & K in June & November	3481 [870.3]	853	1372 [343.0]	331	

*Annual average casualty crash frequency in brackets

12.6.3 Treatment 7: 50% reduction in speed camera enforcement with speed-related publicity absent

Treatment 7 (T7) was defined as having a 50% reduction in speed camera enforcement with speed-related publicity absent. This treatment condition occurred in District C in August 1999 and in District H in April 1999. The number of casualty crashes that occurred in these Districts

during the appropriate months of decreased speed camera enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during April and August. In addition comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

12.6.3.1 Effects on casualty crash frequency

Table 12.16 gives the net percentage change in casualty crash frequency that occurred under conditions of a 50% reduction in speed camera enforcement with speed-related publicity absent (i.e. August 1999 in District C and April 1999 in District H). This net percentage change is in comparison to the combined periods when there was no change in speed camera enforcement (i.e. April and August 1996-1998 & 2000), and to the control group of crashes. Although there was a net 3.0% reduction in casualty crash frequency in the Districts where there was a 50% reduction in speed camera enforcement and no speed-related publicity, this reduction was not statistically significant.

Table 12.16 Casualty crashes occurring during the months & in the Police Districts where there was a 50% reduction in speed camera enforcement and speed-related publicity was absent (Treatment 7)

Treatment Group \ Time Period	Apr & Aug 1999 (Changed enforcement conditions)	Apr & Aug 1996-1998 & 2000 (Unchanged enforcement conditions)	Net % change in casualty crashes
T7: District C in August & District H in April	215	886 [221.5]*	-3.0% (<i>p</i> =0.7129)
Comparison Districts B, D, F, G, J & K in April & August	1190	4757 [1189.3]	
%change in treated Districts	-2.9%		
%change in comparison Districts	+0.06%		

*Annual average casualty crash frequency in brackets

12.6.3.2 Effects on crash severity

Table 12.17 gives the net percentage change in crash severity that was found during the months and in the Districts where speed camera enforcement had been reduced by 50% and speed-related publicity was absent. Although a net 16.6% reduction in crash severity was found when there was a 50% reduction in speed camera enforcement in the absence of publicity, this reduction was not statistically significant so may have been due to chance.

Table 12.17 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was a 50% reduction in speed camera enforcement and no speed-related publicity (Treatment 7)

Treatment Group	Time Period	Crash Severity				Net %change in proportion of casualty crashes that were serious
		Minor Injury		Serious Casualty		
		Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	Apr & Aug 1996-98 & 2000 (Unchanged)	Apr & Aug 1999 (Changed)	
T7: District C in August & District H in April		640 [160.0]*	165	246 [61.5]	50	-16.6%
Comparison Districts B, D, F, G, J & K in April & August		3351 [837.8]	852	1406 [351.5]	338	(p=0.3400)

*Annual average casualty crash frequency in brackets

12.6.4 Treatment 8: 50% reduction in speed camera enforcement with speed-related publicity present

Treatment 8 (T8) was defined as having a 50% reduction in speed camera enforcement with speed-related publicity present. This treatment condition occurred in District C in June 1999 and in District H in November 1999. The number of casualty crashes that occurred in these Districts during the appropriate months of decreased speed camera enforcement were compared with the crashes that occurred in the non-treated Melbourne Districts (i.e. B, D, F, G, J and K) during June and November. In addition comparisons were made with corresponding crash frequencies before and after the period of changed speed-enforcement conditions, i.e. 1996-1998 and 2000.

12.6.4.1 *Effects on casualty crash frequency*

Table 12.18 gives the net percentage change in casualty crash frequency that occurred under conditions of a 50% reduction in speed camera enforcement with speed-related publicity present (i.e. June 1999 in District C and November 1999 in District H). This net percentage change was estimated in comparison to the combined periods when there was no change in speed camera enforcement (i.e. June and November 1996-1998, 2000), and to the control group of crashes.

A very small non-significant net 0.07% reduction in casualty crash frequency was found in the Districts where there was a 50% reduction in speed camera enforcement during months when speed-related publicity was present. There was little difference between the %change found for the treated Districts and that found for the comparison Districts.

Table 12.18 Casualty crashes occurring during the months & in the Police Districts where there was a 50% reduction in speed camera enforcement and speed-related publicity was present (Treatment 8)

Treatment Group	Time Period	Jun & Nov 1999 (Changed enforcement conditions)	Jun & Nov 1996-1998 & 2000 (Unchanged enforcement conditions)	Net % change in casualty crashes (<i>p</i> =0.9929)
	T8: District C in June & District H in November	226	927 [231.8]*	
	Comparison Districts B, D, F, G, J & K in June & November	1,184	4,853 [1213.3]	
	%change in treated Districts	-2.5%		
	%change in comparison Districts	-2.4%		

*Annual average casualty crash frequency in brackets

12.6.4.2 Effects on crash severity

Table 12.19 gives the net % change in crash severity that was found during the months and Districts where speed camera enforcement was reduced by 50% and speed-related publicity was present. Although a net 18% reduction in crash severity was found when there was a 50% reduction in speed camera enforcement in the presence of speed-related publicity, this reduction was not statistically significant.

Table 12.19 Serious casualty & minor injury crashes occurring during the months & in the Police Districts where there was a 50% reduction in speed camera enforcement with speed-related publicity (Treatment 8)

Treatment Group	Time Period	Crash Severity				Net %change in proportion of serious casualty crashes (<i>p</i> =0.2833)
		Minor Injury		Serious Casualty		
		Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	Jun & Nov 1996-98 & 2000 (Unchanged)	Jun & Nov 1999 (Changed)	
	T8: District C in June & District H in November	663 [165.8]*	171	264 [66.0]	55	-18.0 %
	Comparison Districts B, D, F, G, J & K in June & November	3481 [870.3]	853	1372 [343.0]	331	

*Annual average casualty crash frequency in brackets

Overall, the net percentage changes in casualty crash frequency and in crash severity that were found for the treated conditions where there had been a reduction in the level of speed camera enforcement were not statistically significant.

A recent MUARC study found that when monthly traffic enforcement levels in Police Regions of Victoria had declined based on previous years, the effect of the reduced levels of enforcement

on crash outcomes was inconclusive (Diamantopoulou, Cameron & Shtifelman, 2001). It may be expected that reduced levels of enforcement are associated with crash increases, however this study found both increase and decreases in casualty crash risk. Perhaps the public still perceives there is some level of enforcement present and may not be aware that the enforcement has either been reduced or is absent.

13 APPENDIX C: Speed Camera TINs by Month Detected

Figure 13.1 Monthly TINs detected in Police District B

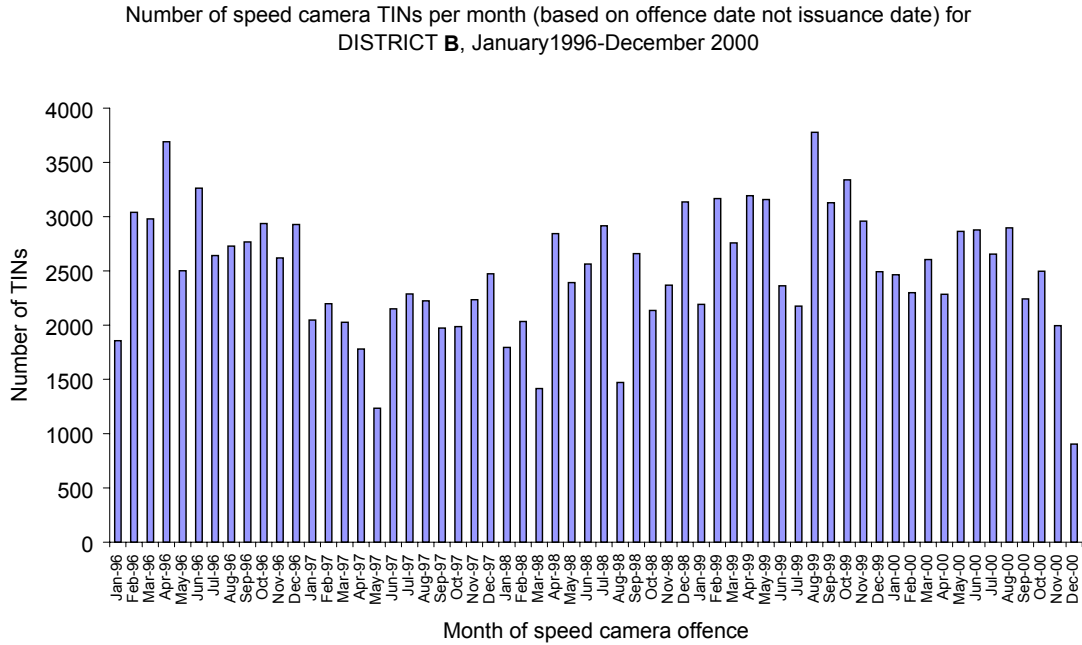


Figure 13.2 Monthly TINs detected in Police District D

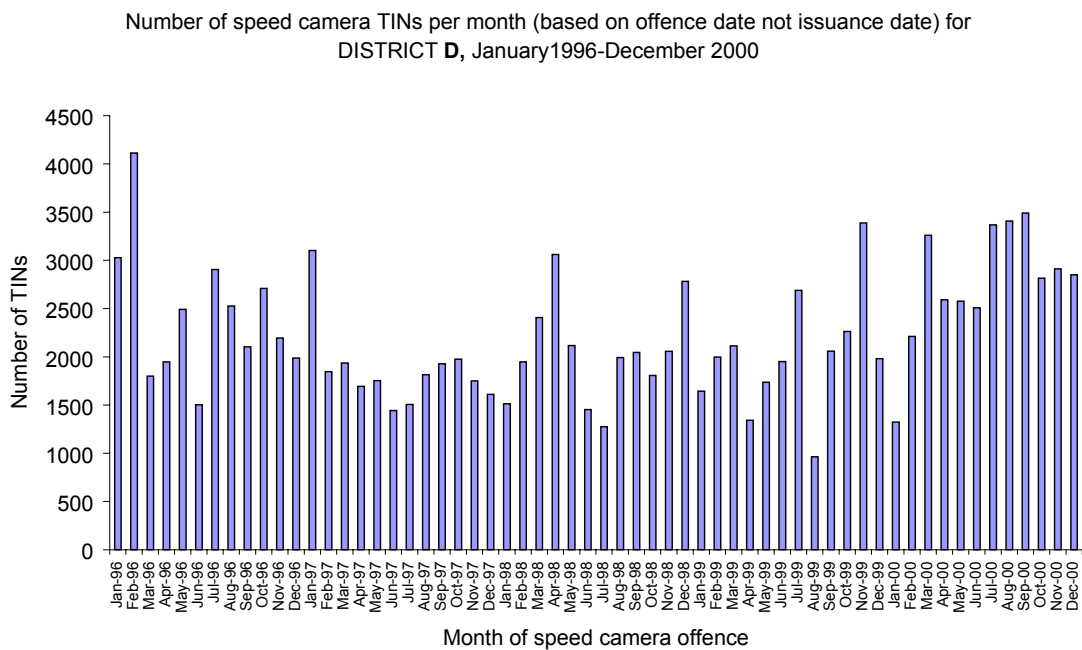


Figure 13.3 Monthly TINs detected in Police District F

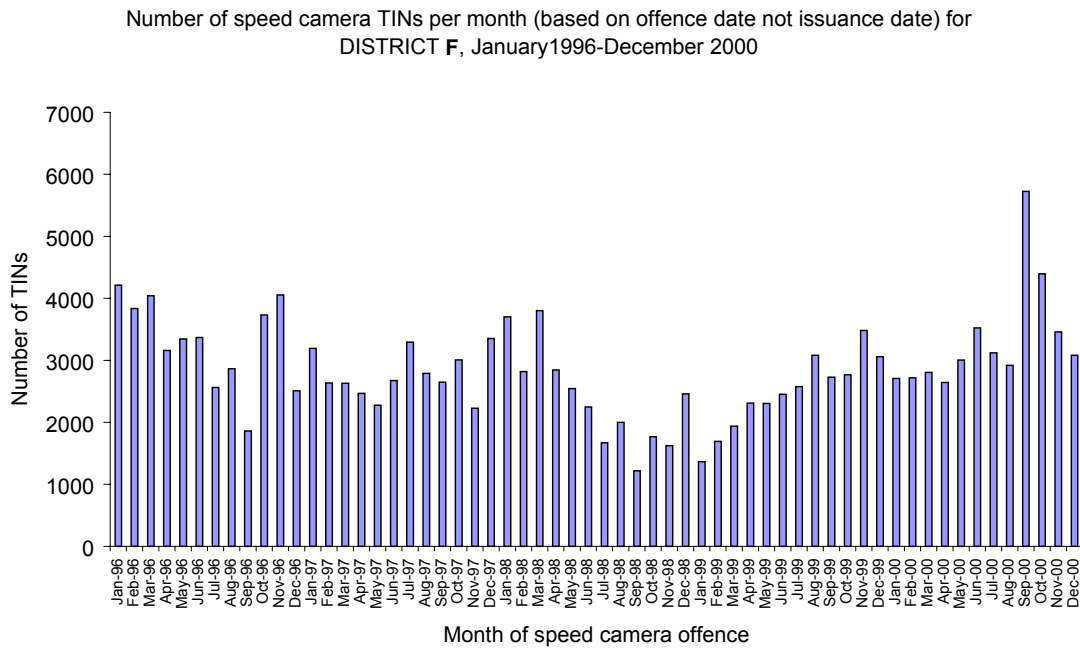


Figure 13.4 Monthly TINs detected in Police District G

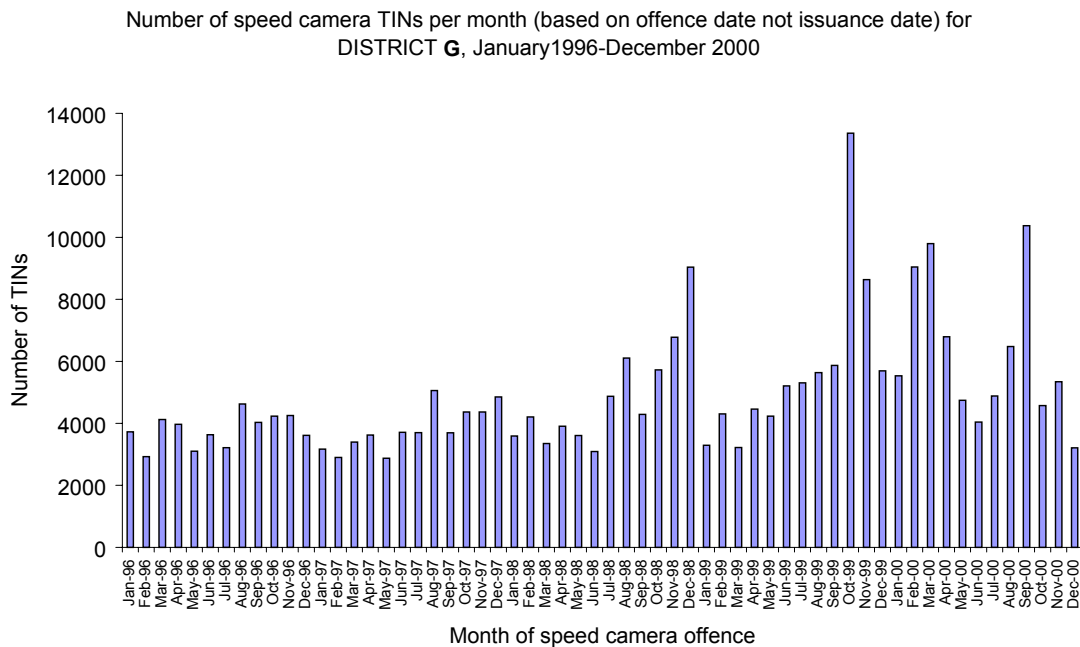


Figure 13.5 Monthly TINs detected in Police District J

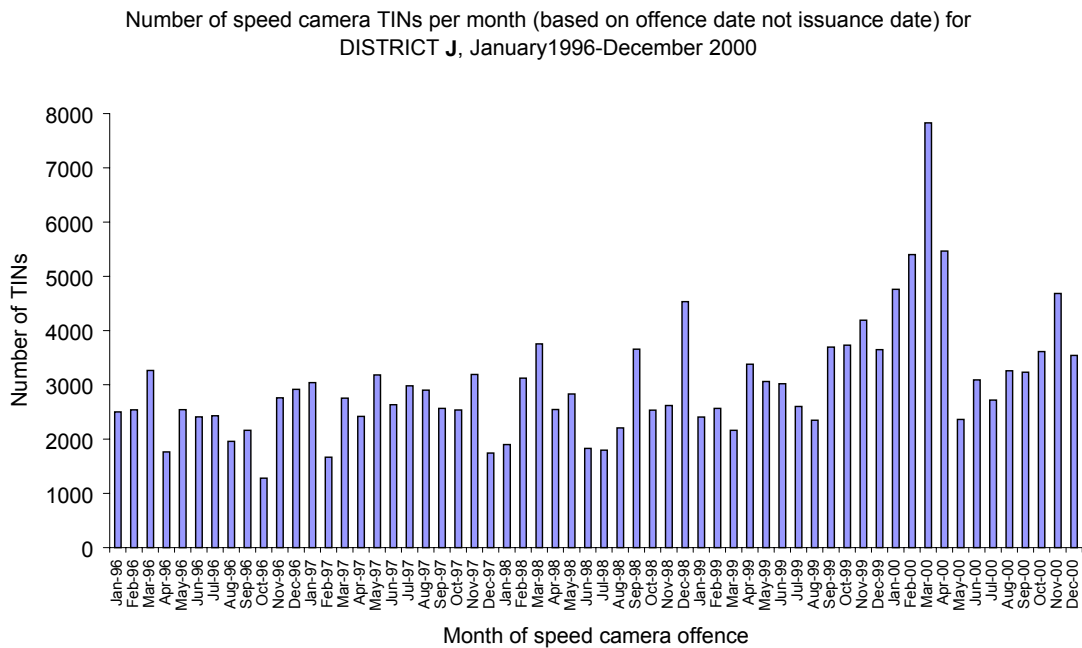
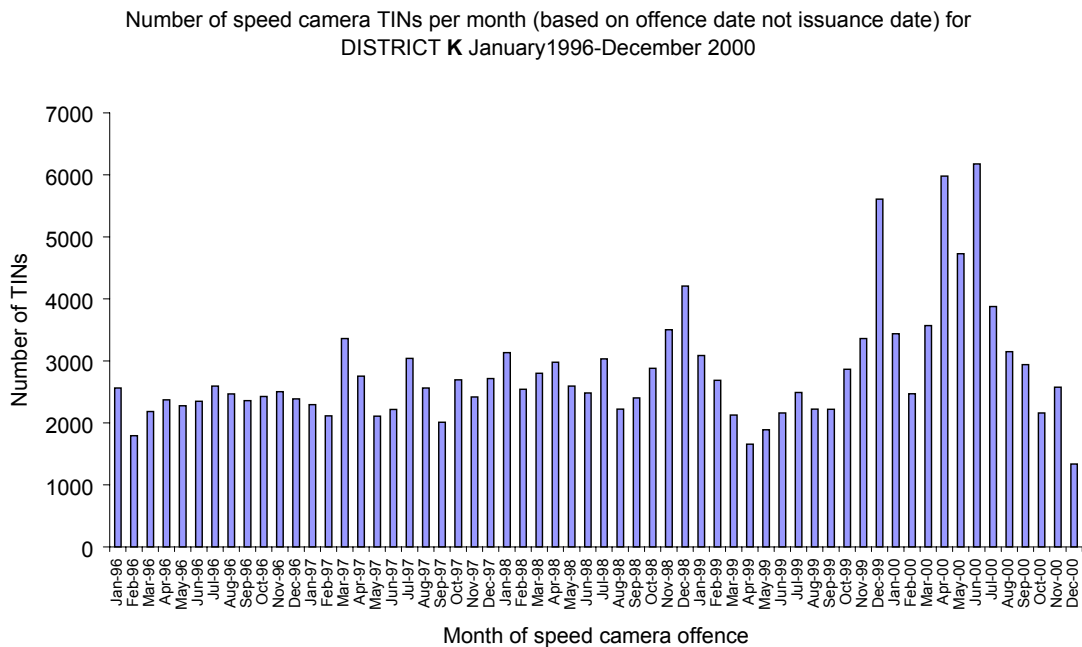


Figure 13.6 Monthly TINs detected in Police District K



14 APPENDIX D: Analysis matrix of lagged speed offence detections, by Police District and month during 1996-2000

Month	Melbourne Police District									
	B	C	D	E	F	G	H	I	J	K
Jan-96	L	LL	LL	HH	LL	H	LL	LL	LL	H
Feb-96	L	M	HH	L	HH	L	M	H	L	M
Mar-96	H	H	HH	L	HH	LL	LL	M	L	LL
Apr-96	H	M	L	M	HH	L	M	HH	H	L
May-96	HH	HH	M	H	H	L	M	H	LL	L
Jun-96	M	H	H	M	H	LL	L	L	L	L
Jul-96	H	M	L	M	H	L	L	L	L	L
Aug-96	M	M	HH	L	M	LL	L	H	L	M
Sep-96	M	LL	H	L	M	M	L	H	LL	L
Oct-96	M	M	M	L	LL	L	LL	H	L	L
Nov-96	H	H	H	L	HH	L	M	M	LL	L
Dec-96	M	L	M	M	HH	L	LL	H	M	L
Jan-97	H	M	M	L	M	L	M	M	M	L
Feb-97	L	M	HH	L	H	LL	M	H	M	L
Mar-97	L	L	L	L	M	LL	LL	L	LL	L
Apr-97	L	H	M	L	M	L	M	HH	M	H
May-97	L	L	L	LL	L	L	M	H	L	M
Jun-97	LL	LL	L	L	L	LL	L	M	M	L
Jul-97	L	L	LL	L	M	L	LL	M	L	L
Aug-97	M	LL	L	L	H	L	L	L	M	M
Sep-97	L	H	L	M	M	M	LL	M	M	M
Oct-97	L	LL	M	L	M	L	LL	LL	L	L
Nov-97	L	M	M	L	M	M	LL	L	L	M
Dec-97	L	M	L	H	L	M	L	L	M	L
Jan-98	M	HH	L	H	H	M	LL	M	LL	M
Feb-98	L	M	L	L	HH	L	LL	M	LL	H
Mar-98	L	M	M	M	M	L	L	L	M	M
Apr-98	LL	L	H	L	HH	LL	L	L	H	M
May-98	H	LL	HH	H	M	L	L	M	L	M
Jun-98	M	M	M	M	M	L	L	M	M	M
Jul-98	M	L	LL	LL	L	LL	LL	LL	LL	L
Aug-98	H	H	LL	L	LL	M	L	LL	LL	M
Sep-98	LL	HH	M	LL	L	H	H	L	L	L
Oct-98	M	HH	M	LL	LL	L	HH	M	H	L
Nov-98	L	H	L	L	LL	H	M	L	L	M
Dec-98	M	HH	M	L	LL	HH	HH	M	L	H
Jan-99	H	HH	HH	H	L	HH	HH	M	HH	HH
Feb-99	L	L	L	M	LL	LL	H	LL	L	M
Mar-99	H	M	M	LL	LL	L	L	LL	L	M
Apr-99	M	M	M	M	L	LL	HH	L	L	L
May-99	H	L	LL	HH	L	M	L	HH	H	LL
Jun-99	H	L	L	L	L	L	H	LL	M	LL

	Melbourne Police District									
Month	B	C	D	E	F	G	H	I	J	K
Jul-99	M	LL	M	HH	L	M	L	HH	M	L
Aug-99	L	H	H	HH	M	H	HH	M	L	L
Sep-99	HH	L	LL	HH	H	H	L	HH	L	L
Oct-99	H	H	M	H	M	H	HH	M	H	L
Nov-99	HH	M	M	H	M	HH	HH	L	H	M
Dec-99	H	L	HH	HH	H	HH	M	HH	HH	H
Jan-00	M	M	M	M	H	H	HH	M	H	HH
Feb-00	M	M	LL	M	M	H	HH	L	HH	H
Mar-00	M	M	M	M	M	HH	HH	M	HH	L
Apr-00	M	HH	HH	H	M	HH	HH	H	HH	H
May-00	M	M	H	M	M	HH	HH	M	HH	HH
Jun-00	H	M	H	HH	M	M	HH	L	L	HH
Jul-00	H	M	H	M	H	L	H	L	M	HH
Aug-00	M	LL	HH	H	H	M	H	M	M	HH
Sep-00	H	L	HH	H	M	HH	M	L	H	H
Oct-00	L	L	HH	H	HH	HH	H	L	M	M
Nov-00	M	LL	HH	HH	HH	M	M	LL	H	L
Dec-00	L	LL	HH	M	H	H	HH	L	HH	M

15 APPENDIX E: Analysis matrix of TAC speed-related publicity Adstock, by style of advertising and month during 1996-2000

Month	Speed-related publicity Adstock (all styles)	Enforcement-style speed-related publicity Adstock	Emotive-style speed-related publicity Adstock
Jan-96	H	L	H
Feb-96	H	L	H
Mar-96	H	L	H
Apr-96	H	L	H
May-96	L	L	H
Jun-96	L	L	L
Jul-96	H	L	H
Aug-96	H	L	H
Sep-96	H	L	H
Oct-96	H	L	H
Nov-96	H	H	H
Dec-96	H	H	H
Jan-97	H	H	H
Feb-97	H	H	H
Mar-97	H	H	L
Apr-97	H	H	L
May-97	L	L	L
Jun-97	H	H	H
Jul-97	H	H	H
Aug-97	H	H	H
Sep-97	H	L	H
Oct-97	H	L	H
Nov-97	H	L	L
Dec-97	L	L	L
Jan-98	H	H	L
Feb-98	H	H	H
Mar-98	H	L	H
Apr-98	H	L	H
May-98	H	L	H
Jun-98	H	H	H
Jul-98	H	H	H
Aug-98	H	H	H
Sep-98	H	H	H
Oct-98	H	L	H
Nov-98	H	L	H
Dec-98	L	L	H
Jan-99	H	H	L
Feb-99	H	H	L
Mar-99	H	H	H
Apr-99	H	H	H
May-99	L	L	L
Jun-99	H	L	H

Month	Speed-related publicity Adstock (all styles)	Enforcement-style speed-related publicity Adstock	Emotive-style speed-related publicity Adstock
Jul-99	H	L	H
Aug-99	L	L	L
Sep-99	H	H	H
Oct-99	L	H	L
Nov-99	H	L	H
Dec-99	H	L	H
Jan-00	L	L	L
Feb-00	L	L	L
Mar-00	L	L	L
Apr-00	L	L	L
May-00	L	H	L
Jun-00	L	L	L
Jul-00	H	L	H
Aug-00	H	L	H
Sep-00	H	L	H
Oct-00	H	L	H
Nov-00	H	L	H
Dec-00	L	L	L