EVALUATION OF THE RED LIGHT CAMERA PROGRAM AND THE OWNER ONUS LEGISLATION

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Abstract

Red light cameras were introduced in Victoria in August 1983, with the intention of reducing the number of accidents that result from motorists disobeying red traffic signals at signalised intersections. Accident data from 46 treated and 46 control sites from 1981 to 1986 were analysed. The analysis indicated that red light camera use resulted in a reduction in the incidence of right angle accidents, and in the number of accident casualties. Legislation was introduced in March 1986 to place the onus for red light camera offences onto the vehicle owner. This legislation was intended to improve Police efficiency and therefore increase the number of red light cameras in operation. Data supplied by the Police indicated that these aims have been met, and that the owner onus legislation has had beneficial road safety effects.

Key Words

Enforcement, Police, Accident Prevention, Photography, Junction, Red Light, Behaviour.

CONTENTS

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1.0 INTRODUCTION

Accidents at signalised intersections present a considerable road safety problem. In the period from 1979 to 1986, an average of 34 fatal accidents and 752 hospital-admission accidents occurred at signalised intersections each year. 10% of fatal accidents and 18% of accidents resulting in at least one admission to hospital in Melbourne occurred at signalised intersections.

It has been estimated (Hulscher, Walden, Croft, Hallam, and Saffron, 1980) that 18% of reported casualty accidents at signalised intersections involve a driver running a red light. Thus, it is likely that at least 6 fatal accidents and 135 hospital-admission accidents in the Melbourne area each year involve someone disobeying a red traffic signal.

Engineering treatments of intersections may provide a partial solution to the problem of running-the-red through, for example, the improvement of signal visibility. However, there is likely also to be a group of motorists who for various reasons disregard traffic signals. By increasing enforcement it may be possible to deter would-be offenders and so reduce the number of intersection accidents.

It is difficult for normal Police operations to be very effective in deterring red light running. The detection process must involve one policeman at the stop line to judge when an offence has been committed, and a second policeman in a vehicle on the other side of the intersection in radio contact. The second policeman has to chase and apprehend offenders. In most cases the visible police presence would be sufficient threat to deter potential offenders, but limitations on police resources would not permit this

sort of operation for extended periods or at many intersections.

An alternative approach would be to place some symbol of police presence at intersections and to ensure that the symbol is perceived as a threat by motorists. This approach was adopted in Melbourne with the introduction of red light cameras in August 1983.

1.1 Red Light Cameras

Red light cameras are devices that photograph automatically cars that go through a red light at a signalised intersection. They are triggered by a wire induction loop embedded at the intersection and photograph vehicles entering the intersection after the signal has changed to red. The photographs show the date, time of day, and the time elapsed since the beginning of the red signal. They also allow the registration number of the vehicle to be read. To ensure accurate exposure, a flash is operated automatically.

In order to maximise the visibility of the red light cameras, all intersections where cameras are used have had warning signs installed. While the use of automatic detection devices in Europe is often surreptitious, it was clear that the maximum deterrent effect would only occur if the presence of the devices was signalled in some way.

The use of warning signs provided another advantage. The warning signs, as visible symbols of enforcement, were likely to provide most of the deterrent effect on red light running. Thus, a large number of intersections had signs and camera housings installed, and a smaller number of cameras were rotated among them. This method of use was expected to maximise the

deterrent effect of a relatively small number of camera units and limited police resources for processing of offence photographs.

Prior to the large trial of red light cameras discussed here, cameras had previously been used to deter red light violations in Western Australia and in Victoria. Maisey (1981) reported the results of the installation of one camera and warning signs at a Perth intersection for one year from July 1979. The data he reported suggest that red light cameras may result in a decrease in right angle accidents and an increase in rear end accidents. In view of the small number of accidents reported by Maisey, and the possibility that the chosen intersection was atypical, it was not possible to regard this study as conclusive.

In Victoria, a red light camera was installed at a high-volume intersection of two arterial roads in Melbourne for three months from November 1981. While the public were not aware of the presence of the camera, about 300 offenders were photographed each week. After some media publicity this dropped to about 20 offenders per week.

1.2 Owner Onus

The red light camera trial in Melbourne commenced in August 1983. The original program was implemented in such a manner as to allow the effect of the cameras to be monitored and fully evaluated. It became clear quickly that the full utilization of the red light cameras was being hindered by relatively inefficient practices required before the issue of Traffic Infringement Notices (TINs) to offending drivers. It was necessary for Police to identify the driver of the photographed vehicle before issuing a TIN, and this often necessitated a number of telephone calls to

the owner to identify the driver and then an interview with the driver. The staff-time involved in this process resulted in limitations on the number of offenders that could be processed, and therefore the use of red light cameras was curtailed in order to detect only that number of offenders that could be processed. It is likely that one result of this was that the deterrent effect of the cameras was also limited.

In March 1986 legislation was proclaimed that was intended to increase the efficiency of Police operations in relation to red light cameras and, subsequently, speed cameras. This legislation, the Motor Car (Photographic Detection Devices) Act (1986) or "owner-onus legislation", placed the responsibility for certain offences detected by cameras onto the owner of the vehicle rather than the driver. The result of this was that the Police were able to send TINs to the registered owner of the vehicle rather than to the driver, reducing the amount of time needed to process each offence.

By increasing Police efficiency, it was expected that increased use of red light cameras would result. This, in turn, would increase any road safety benefits provided by the cameras. It needs to be stressed that the owner-onus legislation was not intended to have a direct effect on road safety, but rather an indirect effect. It would only have an effect to the extent that red light cameras themselves are effective road safety measures.

The purpose of this report is to present data bearing on the road safety consequences of red light camera use in Melbourne. It is also intended to discuss the effects of the owner-onus legislation here, as this should be regarded as part of the red light camera program.

2.0 EVALUATION PLAN

2.1 Aims and Logic

The questions to be addressed in this report were:

- Do red light cameras affect the number of accidents at signalised intersections that result from run-the-red offences?

- Has owner-onus legislation had any effects on police efficiency that would be expected to affect the amount of red light camera use?

Thus the criterion measure for the effect of red light cameras was the change in the number of run-the-red accidents at camera sites.

Owner onus was evaluated by examining police efficiency. As discussed above, an increase in camera use brought about by increased efficiency was expected to increase any effects of camera use. Thus the analysis of the accident-effects of red light cameras was fundamental to the evaluation of owner-onus. If red light cameras had a beneficial effect on accident patterns, and if owner-onus resulted in improved efficiency, then it could be concluded that owner-onus had indirect safety benefits.

2.2 Red Light Camera Research Design

Because modifications to signalised intersections are made progressively, the accident rate at such intersections would be expected to decline in the absence of cameras. It was not possible, therefore, simply to compare the accident rate before camera installation with that after to provide a measure of the effect of red light cameras. Furthermore the

relatively small number of accidents in each sub-group described below was too low to warrant the use of time-series analysis.

Two equivalent groups of sites were therefore selected. The treatment group was to have cameras installed and the control group would not. It was planned to collect information on all reported accidents at all sites in both groups. The logic of this research design is that the effect of the red light cameras can be measured accurately by comparing the change in accident rates before and after camera installation with any change at the control sites. Changes in accident rates at control sites would reflect any general improvements, while changes at the treatment sites would reflect general improvements plus the effects of the cameras.

This research design makes some assumptions. The most important of these are

. That apart from the installation of red light camera hardware the two groups of sites were equivalent.

. That the effect of the cameras did not spread to nearby intersections.

The first assumption was dealt with by using a systematic assignment of sites to groups, as described below. The second assumption was thought to be met as literature in the area of speed enforcement (see Armour, 1984) indicates that enforcement effects are very localised. It was thought that the effect of warning signs would be to increase the localisation of the effect of the cameras.

To select intersections for the trial, a list of signalised intersections in Melbourne was prepared, and

ranked according to the number of right-angle and right-angle casualty accidents at each intersection in the five-year period 1977 to 1981. These criteria were selected because 1977 and 1981 marked the earliest and latest suitable accident data available for use, and because it was thought that the red light cameras would reduce the number of right-angle (Maisey, 1981) and possibly right-against accidents. A total of 100 intersections was selected. Subsequent considerations of events leading to accidents indicated that right-against accidents were unlikely to be affected by the cameras as they often do not involve run-the-red offences.

Adjacent intersections were not included in the trial. This decision was taken to minimise the possibility of the effect spreading from treatment intersections to nearby intersections which may have been in the control group.

The 100 intersections were then divided into treatment and control intersections. On major roads selection was made so that treatment and control sites alternated. Other sites were then allocated so that, as far as possible, a site in one group was closer to sites in the other group than to those in its own group. Sites still not allocated after this were then allocated so that the two groups had an equal or almost-equal distribution of sites with single-lane approaches, double lane approaches, medians at the intersection, tram lines, different speed limits, and combinations of these. These assignment procedures were intended to equate the two groups as far as possible.

Arrangements were then made for the installation of camera hardware and signs at the 50 treatment sites. One camera housing and flash housing was installed at

each treatment site, and warning signs ("RED LIGHT CAMERA AHEAD") were erected on each arm of the intersection. The camera housing was installed, where possible, on the arm where running-the-red was most implicated in accidents. Only 46 sites had hardware installed in time to be included in the trial.

The first site was officially switched on by the Minister for Transport on 16 August 1983. The 46th site was installed in November 1984.

The Victoria Police were responsible for all aspects of red light camera operation, and were required to move cameras, collect film, view slides, and issue TINs to offenders.

There was no formal strategy for rotating the cameras among the treatment sites. In the early stages of the trial they were left at sites until the offence rate started to decline. Later the cameras were placed so as to ensure a constant workload for the police responsible for processing offenders (see section 1.2). Some sites that had relatively low offence rates at the beginning of the trial rarely had a camera present.

News-media attention was directed at the program at various times, particularly early in the program. Press/media releases were provided where appropriate, and some coverage of the program occurred in radio interviews. One television campaign was produced (a 30-second advertisement) to correct a misperception concerning appropriate behaviour when turning right at signalised intersections.

It was expected that the red light cameras would affect different types of accident in different ways. For this reason, the analysis of accident data was performed for six accident types.

. Right angle accidents. These are accidents in which vehicles coming from adjacent arms of an intersection collide at right-angles. These accidents generally involve one of the two vehicles running the red. The red light cameras were expected to reduce the incidence of this accident type.

. Right angle (turning) accidents. These are accidents in which vehicles coming from adjacent arms of an intersection collide. They differ from right-angle accidents in that one or both drivers intend turning at the intersection rather than continuing. This accident type does not necessarily involve running a red signal and therefore no firm expectations were held about the effect of the program on this accident type.

. Right-against accidents. These are accidents in which one vehicle, turning right, collides with an on-coming vehicle. These accidents do not necessarily involve running the red, so no firm expectations were held about the effect of the presence of red light cameras.

. Rear-end accidents. These involve a vehicle colliding into the rear of another. These accidents generally do not involve running-the-red, and it is generally accepted that any program that increases the number of motorists who stop at red traffic signals will increase the number of rear end accidents. Thus it was expected that there would be an increase in this accident type.

. Rear-end (Turning) accidents. These accidents are rear end accidents in which the front vehicle was intending to turn at the intersection. About 80% of these accidents involve left-turners in

slip-lanes. There were no firm expectations about the effect of red light cameras on these accidents.

. Other accidents. This category included any accidents not included in the categories discussed above. These accidents may or may not involve running-the-red, so no firm expectations were held about the effect of red light cameras.

Accidents included in the analyses were those in which one or more people were killed or injured requiring admission to hospital, or injured requiring medical treatment.

As noted earlier, analysis involved comparing the treatment and control sites, with accident data divided into before and after periods. The main analysis method was a contingency table method using group membership (treatment and control) and time period (before and after) as factors.

The most difficult aspect of this analysis method was the need to define the before and after period for the control sites. Accidents at control sites were categorised as occurring in the before or after period depending on whether they occurred before or after February 1984. As already noted the 46 treatment sites were installed progressively between August 1983 and November 1984. The 23rd site was installed in February 1984, and this marked the halfway point in the progran of installation. Thus accidents that occurred at control sites in or after February 1984 were assigned to the after period.

Assignment to the appropriate period at treatment sites was, of course, based on the actual date of camera installation.

2.3 Owner-Onus Research Design

As discussed earlier, the evaluation of the effect of owner-onus rested on first demonstrating the effectiveness of the cameras, and then on demonstrating a beneficial effect of owner-onus on Police workload and efficiency.

The evaluation of owner-onus proved relatively difficult, primarily because the Police initiated a number of other changes at the time owner-onus was proclaimed that confounded estimates of police effort related to processing red-light offences. The use of speed cameras started in March 1986, greater use was made of computers after owner-onus than before, and before owner-onus some of the work involved in contacting offenders was performed by District Police.

Further, it is likely that the effect of owner-onus may not have been limited to the group of police involved in the program (Traffic Camera Section), but may have extended into the fine-payment system. Thus it was necessary to examine the whole system concerned with processing offenders and receiving fine-payments. In particular, while owner-onus may be expected to reduce the operating costs of Traffic Camera Section, it may also increase the proportion of unpaid or late-paid TINs.

Police monthly cost figures for Traffic Camera Section were obtained for the period from January-July 1986. As owner-onus was introduced in March 1986, the periods January-February and April-July were used as before and after periods respectively. The figures supplied by the police did not allow expenditure to be categorised, so instead the average cost of processing offenders for each month was calculated.

Data from the Police Penalty Payment Office were collected to evaluate the overall effect of owner-onus on TIN payment. Files held by Traffic Camera Section were used to obtain details of a representative sample of 200 offenders from July and August 1986. Details were recorded from the TINs, and the Penalty Payments computer was then used to obtain payment details.

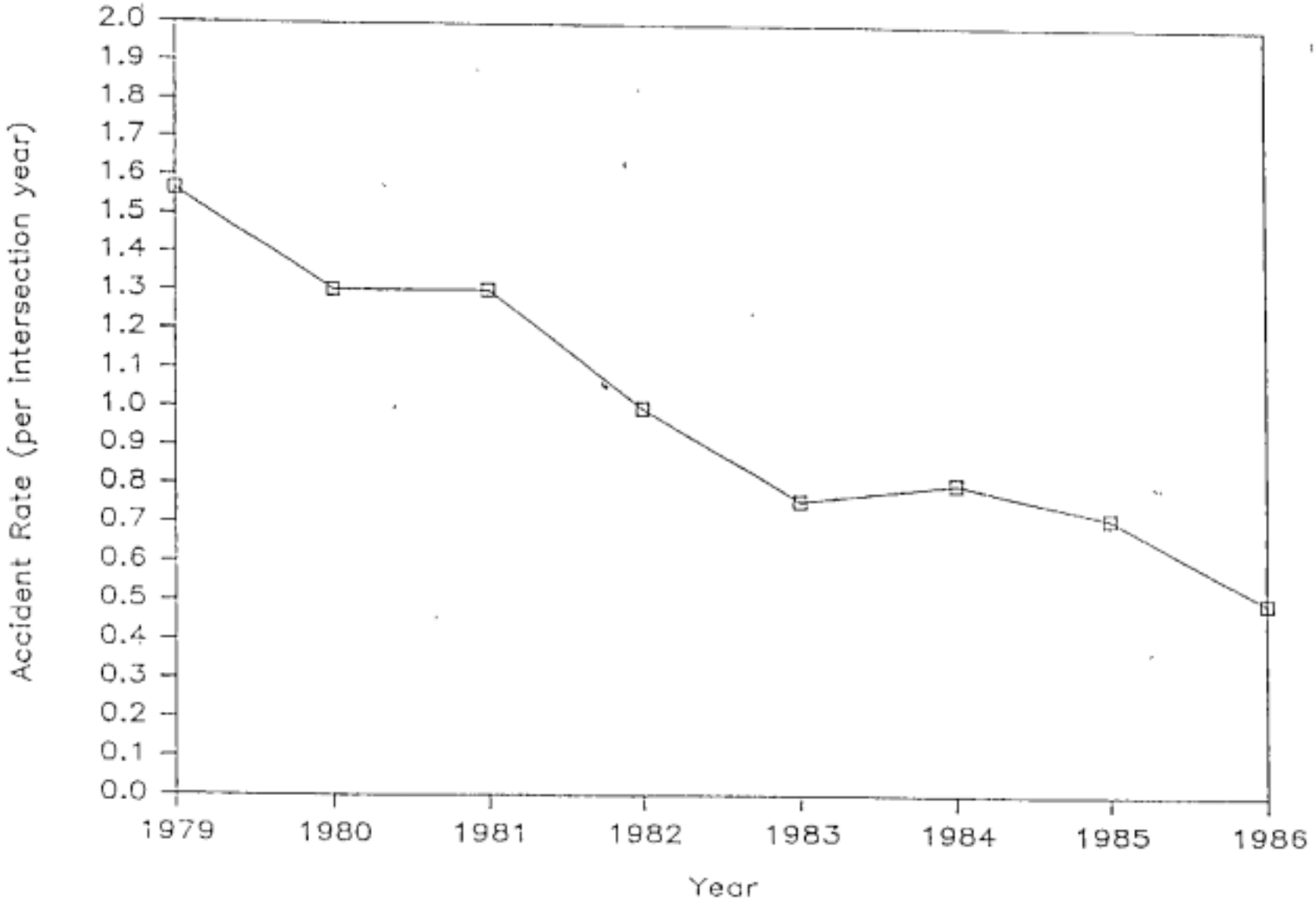
3.0 RESULTS AND DISCUSSION

For various reasons, the results of the red light camera program have proven more difficult to analyse and interpret than was expected. A number of factors contributed to these problems.

- The ongoing engineering improvements that form the RTA's Accident Black Spot program resulted in a declining accident rate at the control sites and, most likely, at the treatment sites. Any improvements in the accident rate brought about by the red light cameras had to be detected against this declining accident rate. Figure 1 shows the right-angle casualty accident rate for the control sites for the period from 1979 to 1986. In 1979 the right-angle casualty accident rate was 1.59 accidents per site per year. By 1986 it had dropped to only 0.48 accidents per site per year. It should be noted that statistical calculations that were used to plan the length of the project and the number of sites required relied on the earlier accident rates, thus resulting in underestimates of both.

- Early indications that the program was proving beneficial resulted in some pressure to expand it before the evaluation was complete. The result of this is that more sites were installed from 1985, and for various reasons fewer cameras were

Figure 1: Right angle casualty accident rate - control sites.



purchased than were needed to continue the program at the 1984 level. Figure 2 shows the number of intersections with camera hardware and warning signs installed until June 1986. Figure 3 shows the average number of red light cameras in operational use for the same period. The relative stability of the number of cameras in use, given the increasing number of sites, means that from 1985 on the amount of red light camera use at each site decreased. This would have decreased the probability of detection for offenders at treatment sites. Further, no cameras were used in February 1985, and the media gave this fairly wide coverage. There was no publicity afterwards to indicate that red light cameras were again in use.

. The research design assumed that apart from the use of red light cameras, the two groups of sites would remain equivalent throughout the program. It is possible that this was not the case. It has been suggested that red light cameras might have been viewed as a treatment for black spot sites. Thus, when deciding where to direct funds for black-spot treatment, work may have been directed less towards the treatment sites and more towards the control sites. It has not been possible to find clear evidence to indicate if this occurred and when it commenced, but it is known that red light cameras are <u>now</u> viewed as a treatment for black spot intersections with right-angle accident histories. This should be kept in mind when interpreting the data reported here.

3.1 Red Light Cameras - 1981 to 1986

The period from January 1981 to the installation of red light cameras at treatment sites or to the end of January 1984 for the control sites was used as the

Figure 2: Number of signalised intersections with camera hardware.

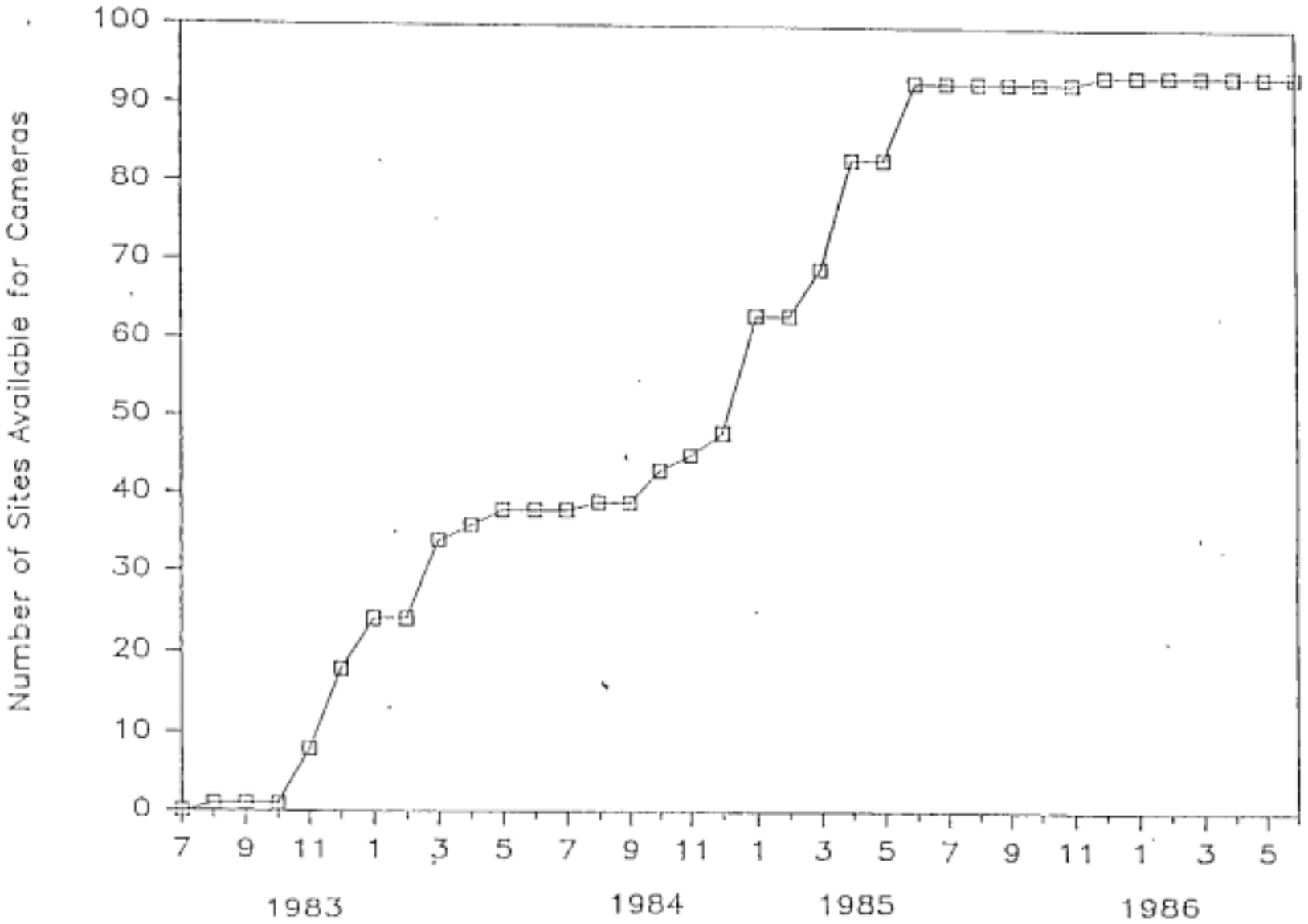
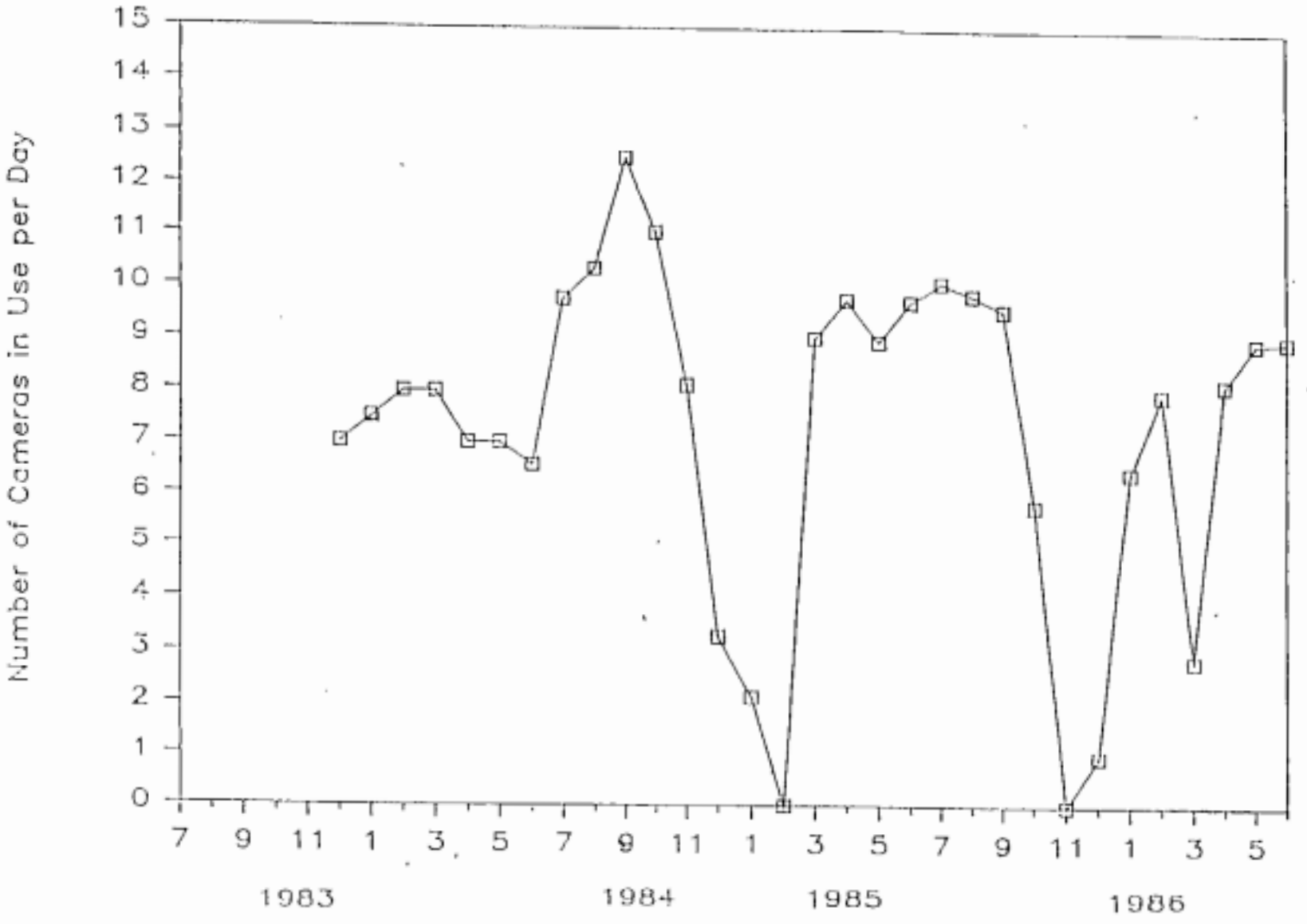


Figure 3: Average number of cameras in use per month.



before period. The after period extended to December 1986. The selection of before and after periods resulted in different before and after time periods for each group. The total number of intersection-years in each period for the two groups is shown in Table 1. These were taken into account by using them to calculate an accident rate for each accident type to facilitate analysis and discussion.

TABLE 1:LENGTH OF BEFORE/AFTER PERIODS IN INTERSECTION-YEARS

	Camera	Control
BEFORE	146.87	141.83
AFTER	129.13	134.17

The statistical analysis method used to compare the treatment and control sites is that detailed in Cameron (1970). This method allows the incorporation of exposure estimates into a 2x2 contingency table analysis using a chi-square test for independence. A statistically reliable result indicated that the cameras had most likely affected the occurrence of accidents. This conclusion could be made because the presence or absence of cameras was the main difference between the two groups of sites other than the different time periods which was accounted for in the analysis.

The analysis method was applied to each accident type, and to the total number of accidents. One-tail tests of significance were used where the direction of an accident-effect had been predicted.

Right angle accidents: Table 2 shows the right angle accident rates per intersection per year at the two sets of sites in the two time periods. Accident numbers are provided in parentheses.

TABLE 2: RIGHT ANGLE ACCIDENTS

	Camera	Control
BEFORE	0.84 (123)	1.02 (144)
AFTER	0.37 (48)	0.66 (89)

There was a reduction in the accident rate at the treatment sites of 32% compared with the change expected on the basis of the control site data. This reduction was statistically reliable (χ^2 = 3.19, d.f.=1, $p<.05$).

Right angle (turning) accidents: Table 3 shows the rates (and number) of right angle (turning) accidents.

TABLE 3: RIGHT ANGLE (TURNING) ACCIDENTS

	Camera	Control
BEFORE	0.12 (17)	0.11 (15)
AFTER	0.09 (11)	0.11 (15)

There was a reduction in the number of right angle (turning) accidents at the treatment sites of 25% compared to the control sites. This change was not statistically reliable ($\chi^2 = 0.47$, df=1, p>.05). The 25% change may, therefore, have been a chance effect rather than the result of camera use, although the relatively low number of accidents may imply a statistical power problem where the small number of accidents in each condition may reduce the sensitivity of the statistical test. It is not possible to separate these two possibilities.

Right against accidents: Table 4 shows the rates (and number) of right against accidents.

TABLE 4: RIGHT AGAINST ACCIDENTS

	Camera	Control
BEFORE	1.53 (224)	1.71 (243)
AFTER	1.41 (182)	1.54 (206)

There was a 2% increase in the number of right against accidents at the treatment sites relative to the control sites. The change was not statistically reliable ($\chi^2 = 0.05$, df=1, p>.05).

Rear end (turning) accidents: The number of rear end turning accidents is shown in Table 5.

TABLE 5: REAR END (TURNING) ACCIDENTS

	Camera	Control
BEFORE	0.25 (37)	0.25 (36)
AFTER	0.34 (44)	0.27 (36)

There was a 28.2% increase in the rear end (turning) accident rate at the treatment sites compared to the control sites. The difference between the two groups was not statistically reliable (χ^2=0.58, df=1, p>.05). It is not possible to determine whether the lack of statistical significance of this change is due to low statistical power or not. It should be noted that it is unlikely that any changes in the rear end (turning) accident rate were due to the presence of red light cameras, as 80% of these accidents involve a vehicle using a left-turn slip lane. These accidents are unlikely to be affected by the cameras.

Rear end accidents: Table 6 shows the rear end accident rates.

TABLE 6: REAR END ACCIDENTS

	Camera	Control
BEFORE	0.48	0.42
	(68)	(59)
AFTER	0.49	0.63
	(63)	(85)

There was a 30% net reduction in the number of rear end accidents at the treatment sites compared to the control sites. The difference between control and treatment sites in the after period was not statistically reliable as it was in the opposite direction to that predicted. Had a two-tailed test been used, the difference would still not have attained significance (χ^2=2.30, df=1, p>.05).

Other accidents: Table 7 shows the rates of other accident types.

TABLE 7: OTHER ACCIDENTS

	Camera	Control
BEFORE	0.87	0.90
	(127)	(128)
AFTER	0.79	0.84
	(102)	(113)

There was a 2.2% relative reduction in other accidents. The effect of the red light cameras was not statistically reliable for this accident type (χ^2=0.01, df=1, p>.05).

. **All accidents:** Table 8 summarises the data for all casualty accidents.

TABLE 8: ALL CASUALTY ACCIDENTS

	Camera	Control
BEFORE	4.06 (596)	4.41 (625)
AFTER	3.49 (450)	4.06 (544)

The difference between the two groups was not statistically reliable (χ^2=0.65, df=1, p>.05). There were 6.6% fewer casualty accidents at the treatment site in the after period than expected.

. **Casualties:** Table 9 shows the accident casualty rates.

TABLE 9: CASUALTIES

	Camera	Control
BEFORE	6.06 (890)	6.29 (893)
AFTER	4.94 (638)	5.72 (767)

The number of casualties decreased by 10.4% at the treatment sites compared to the change expected on

the basis of the control group data. It was not possible to perform a statistical analysis on the casualty data, as the number of casualties is not a count of independent events.

The accident data reviewed above indicate that the red light cameras have reduced the number of right angle accidents (by 32%). There was no evidence of an increase in the number of rear end accidents, or of any changes in other accident types. While there was not an overall reduction in the accident rate, the number of accident casualties was reduced by 10.4%.

The reduction in the incidence of right angle accidents was expected. It is of some interest that the rear end accident rate did not increase as was expected to result from an increase in stopping behaviour of motorists. This result, and the effect of changes to the program discussed earlier, are examined in greater detail below.

Before discussing the accident effects in greater detail, some mention should be made of the effect of the camera program in monetary terms. It was noted above that there was a reduction of 6.6% in the casualty accident rate at the camera sites compared to the control sites. This change was not statistically reliable, so it is not possible to say whether the change was a result of the camera program or not. An overall accident analysis does not take into account the expectations held about different accident types, however.

As it was expected that the red light cameras would affect more severe accident types (e.g. right angle accidents), then it might be expected that there would be a larger reduction in the number of casualties. This was confirmed in Table 9, where a 10.4% reduction

in casualty numbers was noted. The change in accident severity was also expected to be reflected in a reduction in accident-costs at the treated sites. The costs of reported accidents per site-year are shown in Table 10.

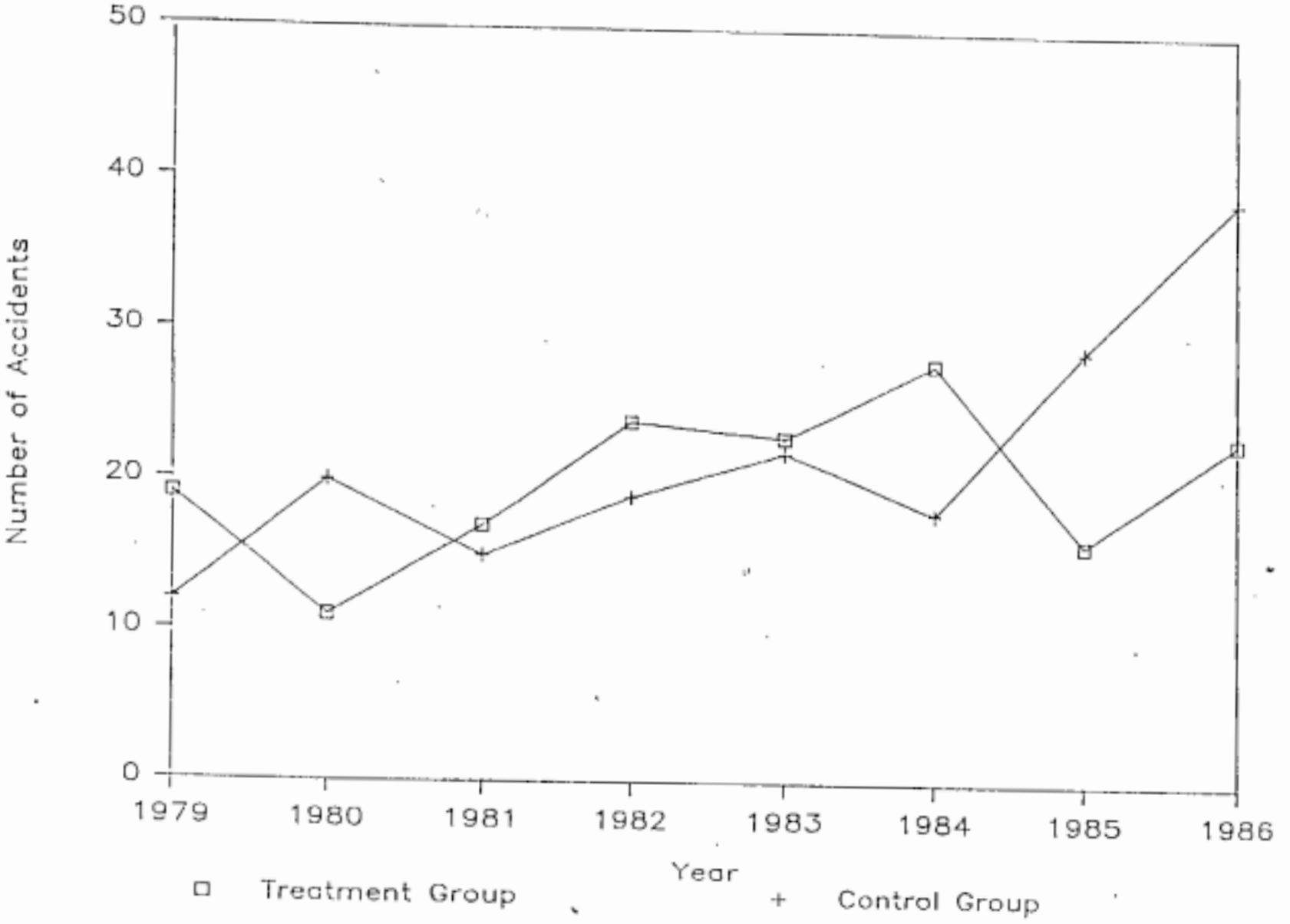
TABLE 10: ACCIDENT COSTS

	Camera ($ Thousands)	Control ($ Thousands)
BEFORE	277.55	270.02
AFTER	213.11	240.58

These costs were calculated using costs detailed in F.O.R.S. (1988), are in 1987 dollars, and include property damage accidents. The F.O.R.S. costs are provided for each person with a fatal injury, major injury, minor injury, and for each vehicle involved in property-damage only accidents. Their use here makes a number of assumptions. The first is that it is possible to equate major and minor injuries with the RTA coding of injuries requiring hospitalisation and medical treatment only, respectively. This is a sensible assumption, and as the analysis involves a comparison between groups it should not be critical. It was also assumed that property-damage accidents would on average involve two vehicles. A proportion would involve three, and some would involve a vehicle colliding with fixed object.

Another feature of the data that should be noted is that it is likely that the reporting rate for less serious accidents would be affected by the presence of the cameras. It is most likely that the reporting

Figure 4: Number of rear end casualty accidents each year by group.



rate would be highest in the camera group after camera installation. This would have the effect of reducing the accident cost benefits attributed to red light cameras.

The data in Table 10 indicate that accident costs at the red light camera intersections were 13.8% lower than expected given the change in costs at the control sites. This equates to savings of $30,253 per site year, or about $1,390,000 per year at 46 sites in 1987 dollars.

Police estimates indicate that the RLC program costs in the vicinity of $520,000 (1987 dollars) per year [1]. Thus, excluding fine revenue the benefit-cost ratio of the program is approximately 2.7 to one.

3.2 Red Light Cameras - 1983 to 1986

The analysis presented above dealt with the accident data by categorizing them into a before period and an after period. The analysis presented below provides a more detailed examination of the accident data for right angle and rear end accidents.

Figure 4 shows the number of rear end accidents each year at each group of sites. The number of accidents at the two sites remained approximately equal until the beginning of 1985 - one year after the program began. After this point, the number of rear-end accidents at the control sites continued to increase, while at the camera sites it remained relatively constant. This suggests that the red light cameras may have halted an ongoing increase in the occurrence of rear-end accidents.

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[1] This figure is made up of $190,000 for program expenses, $300,000 for salaries for public servants employed by the Police, and $300,000 for capital expenses depreciated over 10 years (i.e. $30,000 p.a.).

Figure 5: Number of right angle casualty accidents per year by group.

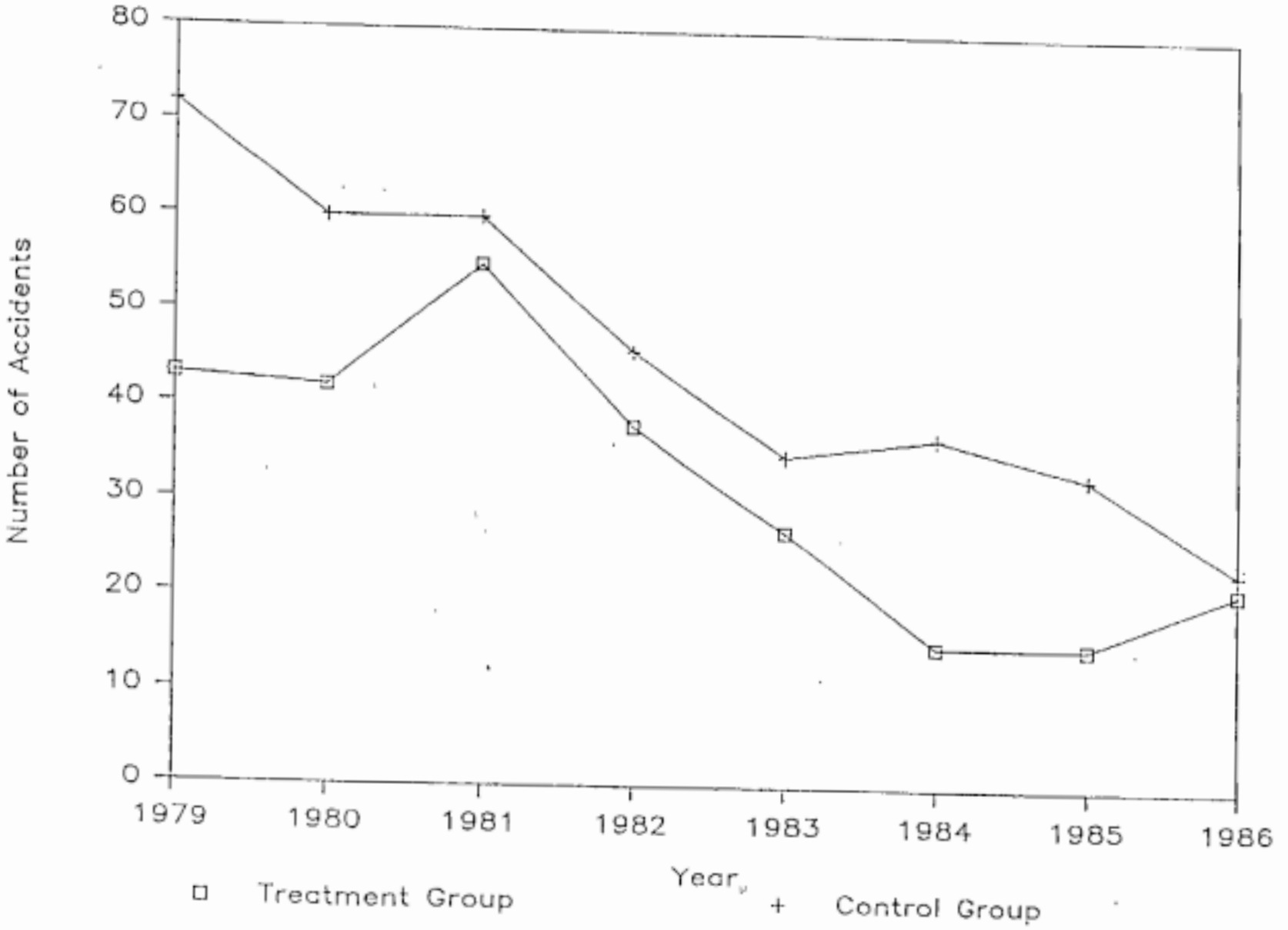

Figure 5 shows the number of right angle accidents each year at each group of sites. The number of accidents remained approximately equal until 1984. At this time the number of accidents at the treatment sites fell below the number at the control sites. By 1986, the two groups of sites were again equal. Figure 5 also shows the continuing decline in the number of right angle accidents at all signalised intersections that has resulted from engineering improvements. This graph suggests that any gains from the use of RLCs had dissipated by 1986.

The failure to find an increase in rear end accidents at the treatment sites was surprising. Figure 4 indicates that a relative decrease in rear end accidents may have occurred after one full year of the RLC program - i.e. from 1985 onwards. One possible explanation of this reduction is that drivers approached camera sites more slowly than other sites. This would be expected to result if drivers are deterred from running the amber and early red phase by the red light cameras. By slowing down at the approach to signed intersections, the likelihood of stopping when necessary would be increased, and the likelihood of rear end accidents would be reduced.

While there is no clear evidence to support this argument, Connor (Note 1) reported that 69% of a sample of motorists photographed by red light and speed cameras indicated that they did slow down when approaching sign-posted automatic enforcement sites. While it is generally accepted that increasing compliance with traffic signals will reduce right angle accidents and increase rear end accidents, by increasing deterrence at signalised intersections the cameras may have reduced the incidence of both accident types by increasing the level of care taken by drivers. The reduction in rear end accidents

resulting from this would have countered any increase resulting from increased stopping behaviour - resulting in no net change.

The pattern of right-angle accidents in Figure 5 is interesting because it suggests a weakening of the effect in 1986. The difference between the number of right angle accidents at the treatment and control sites was significantly larger in 1984 and 1985 than it was in 1986 (χ^2=4.65, df=1, p<.05). The reduction in the effectiveness of the red light camera program in 1986 may be due to a number of things:

- Increased number of sites: It will be recalled that the number of treated sites (other than those used in this report) was increased from the beginning of 1985, without any linked increase in the number of cameras for use at the sites. This is likely to have had two effects. The reduction in camera use at each site may have resulted in a weakening of the deterrent effect of the warning sign at the treatment sites. This would have reduced the effect of cameras on right angle accidents. Alternatively, the increased use of camera warning signs may have resulted in a spread, or generalisation of the effect of the cameras to the control sites. This would result in a reduction in the number of right angle accidents at the control sites - which is consistent with the data shown in Figure 5. It is not possible to test either hypothesis with the available data.

- Site Works: The possibility that more engineering treatments were performed at control sites than at treatment sites was raised earlier. It is not possible to examine this hypothesis in detail, but if this were the case, the reduction in right angle accidents in 1986 at control sites would be

expected, as would an increase in rear end accidents in 1986 at the same sites. Both are consistent with the data shown in Figures 4 and 5.

In both cases, it is not possible to determine the exact effect of these problems on the incidence of the two types of accident. It should be noted that the effect on rear end accidents may, in part, be a result of engineering treatments at the control sites, and that the dissipation of the effect on right angle accidents may be due to site works, or to the increase in the size of the red light camera program.

A replication of the Melbourne evaluation would be necessary to confirm or refute these suggestions.

3.3 Red Light Cameras - General

In light of the issues raised above, it seems appropriate to make the following conclusions concerning the effects of red light cameras on accidents.

- The cameras result in a significant decrease in right angle accidents of the order of 30% or more. Whether this effect is weakened by reducing the camera:site ratio or is generalised to other sites is unclear, but whatever the effect of increasing the program size it is clear that a beneficial effect was achieved for this accident type.

- The cameras did not result in a significant increase in rear end accidents.

- There was a reduction in the number of casualties resulting from accidents of about 10.4%. If the effect of cameras generalised to other sites as a result of the expansion of the program (see Figure 5), then the casualty-reduction may have been larger than 10.4%.

3.4 Owner-Onus

Police monthly cost figures were provided for the period January-July 1986. As owner-onus was introduced in March, the present analysis used January-February as the before period, and April-July as the after period. It was not possible, using the figures provided by the Police, to determine which expenditure related to speed cameras and which to red light cameras. The method adopted was to calculate an average cost for the detection and processing of each offender by dividing total expenditure for each month by the total number of offenders detected during that month. The results of this procedure are presented in Table 10.

Table 10: COSTS/OFFENCE FOR TRAFFIC CAMERA SECTION

Month	Expenditure $	Offences	Cost/Offence $
January	38,615	741	52
February	39,876	725	55
March	35,438	905	39
April	40,198	1,184	34
May	82,707	7,491	11
June	97,809	2,906	33
July	72,246	2,343	30

Average cost per offence:

Before:	January-February:	$53
After:	April-July:	$21

The data indicate that the average cost to the Traffic Camera Section of detecting and processing each offender was greater ($53) before owner-onus than it was after owner-onus ($21).

Before owner-onus was introduced, 92% of TINs for traffic signal offences were paid. Of the 200 TINs in the "after owner-onus" sample, 180 were paid, a 90% payment rate.

In the before period, all 92% were paid within 28 days. In the "after" sample, only one hundred and twenty five (63%) of the 180 payments were within 28 days. Although 75 fines were not paid within the required time period, only 14 of them attracted the extra $8 penalty. This means 61 $90 fines were paid after 28 days. These would be cases granted extensions due to pleas and queries entered into by the TIN recipients, and would also reflect delays in entering data into the computers. The additional costs associated with these offenders are covered by Traffic Camera Section, and so would be accounted for in the cost calculations presented above.

The amount of work involved in the task of issuing TINs has decreased since the introduction of owner-onus legislation in March, 1986. This is because it is no longer necessary for police resources to be utilised in the process of identifying the driver at the time of an RLC offence. This onus is now placed on the owner of the vehicle.

Of the total sample of offenders collected for this evaluation who paid their fines, 83% paid within the required period or were granted an extension and paid within that time. There would, therefore, be a small increase in costs at the Penalties Payment Office above

that included in the cost calculations for Traffic Camera Section resulting from the need to send reminder letters to offenders. The late-payment penalty of $8 collected by the Penalties Payment Office covers this extra cost.

The results of the analysis of Police expenditure indicates that the most likely effect of owner-onus was to reduce the cost of processing offences. It is necessary, however, to note the following problems:

- The use of divisional staff to contact offenders stopped in January 1986. From this time Traffic Camera Section staff took control of all aspects of offence processing. For a proper comparison of processing costs before and after owner-onus, it was necessary to use cost figures from January to February as before figures, rather than figures from 1985 or earlier. Cost figures from January to February may slightly over estimate the true costs of processing offenders. In addition to processing recent offenders, staff at Traffic Camera Section were also clearing the backlog of files from before 1986. Estimates of the significance of this over-estimation, however, are that it is not great.

- Costing figures after owner-onus do not adequately separate expenses incurred in operating speed cameras from those incurred in operating RLCs. The costs per offence are different for the two programs, because of differences in the procedures used. However this should not have greatly affected the result. The Police estimate that costs are greater for the speed-camera program than for the red light camera program, indicating that the cost per offence calculated for the after

period may over-estimate the actual cost per offence for the red light cameras.

While these problems may have had small effects on the data, it is reasonable to conclude that owner-onus has generally improved police efficiency. Owner-onus made an increase in red light camera use possible, combined with the introduction of speed cameras.

Finally, it should be noted that these data indicated there has been an increase in workload - but that the increase resulted from the increased use of cameras rather than directly from the introduction of owner-onus.

4.0 CONCLUSIONS

4.1 The Argument Revisited

The evaluation was performed for two, interrelated reasons. In the first instance it was necessary to evaluate the effect of red light cameras on the incidence of different types of casualty accidents. The red light cameras were introduced as a road safety measure, and therefore needed to provide a road safety benefit to justify their continued use. This benefit needed to be demonstrated for the particular accidents that the cameras were planned to address.

Secondly, the Motor Car (Photographic Detection Devices) Act (1986) was proclaimed in March 1986 with the intention of improving police efficiency, thereby providing resources for increased red light camera use and road safety gains. It was necessary to determine whether the expected outcome occurred so that a recommendation could be made on whether owner-onus should continue or be allowed to lapse.

The evaluation of red light cameras was relatively straight forward and needed only to include an investigation of accident rates at treated sites and control sites.

The evaluation of the effect of the owner-onus legislation was more complicated. The success of owner-onus required that the following be demonstrated:

- That police efficiency be improved by owner-onus
- That increased camera use then occur
- That red light camera use have demonstrated road safety benefits.

Thus if cameras improve safety, and if increased camera use resulted from the use of the owner-onus provisions,

then owner-onus would have been shown to have provided indirect safety benefits.

4.2 Red Light Cameras

The effect of red light cameras is shown in Table 11. The percentages refer to the change in accident rate at the treatment site compared to the change expected given the accident rates at the control sites.

TABLE 11: RESULTS OF RED LIGHT CAMERA USE

Accident Type	Change	Significance
Right angle	-32%	*
Right angle (turn)	-25%	N.S.
Right against	+2%	N.S.
Rear end	-30.8%	N.S.
Rear end (turn)	+28.2%	N.S.
Other	-2.2%	N.S.
All accidents	-6.7%	N.S.
No. of casualties	-10.4%	Not tested

* $p<.05$
N.S. not statistically significant.

There are reasons to believe that the effect on right angle accidents may have been larger - through the spread of the effect to other sites - or may be improved by increasing the number of red light cameras in use. It should be recalled that red light cameras deter red light offences, and so their success needs to be measured in terms of those accidents that are likely

to be affected by such deterrence - namely right angle accidents. In light of this, the final conclusion must be that the red light cameras have thus far been beneficial in road safety terms, and that there is scope for improvement to the program in future.

4.3 Owner-Onus

The best available estimates of the effect of owner-onus on Police efficiency within Traffic Camera Section is that it reduced the costs of processing each offence by about 50%. There was no evidence that this reduction was accompanied by an increase in workload, per offence, in the penalty payment system.

The reduction in processing costs - an indication of improved efficiency - resulted in increased camera use after owner-onus. The use of red light cameras increased, and speed cameras were introduced. These two factors are confounded, and had speed cameras not been used from March 1986, the use of red light cameras would have increased by considerably more than it did.

Both the small increase in red light cameras and the start of speed camera use would have brought about safety benefits. The effectiveness of red light cameras has already been discussed, and it is clear that an increase in red light camera use would improve the benefits already provided by the program.

The introduction of speed cameras has been shown to reduce vehicle speeds at black-spot locations (Harrison, 1987), and is therefore likely to have had a beneficial effect on safety. It has not been possible to evaluate the effect of speed cameras on accidents as too few cameras are in use at present.

Thus owner-onus has had beneficial effects on police costs and efficiency, and as a result has most likely had a beneficial effect on safety by allowing increased levels of operation of programs that have safety benefits.

5.0 REFERENCES

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5.1 Notes

1 Connor, E.J. (1987) Technical Enforcement of Traffic Offences Unpublished Manuscript. This report was prepared as part of the requirements for a Bachelor of Arts degree. The data analysed in the report came from a survey given to offenders detected by red light and speed cameras.