

AN EVALUATION OF THE
EFFECTIVENESS OF OVERT AND
COVERT SPEED ENFORCEMENT
ACHIEVED THROUGH
MOBILE RADAR OPERATIONS

by

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Abstract:

The effect of mobile radar enforcement and supporting publicity on road trauma during July 1995-June 1997 was examined in terms of the number of casualty crashes that occurred on undivided roads in 100 km/h speed zones in rural Victoria. The crash-based analysis compared crash frequencies for the period in which up to 73 mobile radar devices were operational (July 1995-June 1997) with corresponding two-year period before their introduction (July 1992-June 1994) when there was no mobile radar enforcement. The crash effects were examined according to the type of Police vehicle used during each session of mobile radar operation. The type of vehicle used was either a marked patrol car – signifying the overt operation, or an unmarked patrol car signifying the covert operation. Interactions of the enforcement with varying levels of mobile radar publicity awareness were also considered.

The analysis found evidence of casualty crash reductions in rural regions of Victoria, when the speed enforcement operations were either i) covert (unmarked patrol cars) or ii) a mix of overt and covert (marked and unmarked patrol cars). The strongest effects on casualty crashes occurred when a mix of overt and covert mobile radar enforcement was accompanied by high awareness levels of mobile radar publicity during July 1996-June 1997. Under these circumstances, a marginally statistically significant ($p=0.0641$) net 71.3% reduction was found for crashes occurring on the same day or up to four days after the enforcement was present. This effect was strongest on the day when there was a mix of overt/covert mobile radar enforcement in operation. A net 73.9% casualty crash reduction was found that was statistically significant ($p=0.0450$).

Crash reductions were also evident when interactions with the levels of mobile radar publicity were *not* considered. However the effects were smaller and weaker than those that were found when high awareness levels of mobile radar publicity accompanied the overt/covert mix of mobile radar enforcement. There was little evidence of statistically significant crash reductions during times when only marked cars (overt mobile radar enforcement) were in operation.

Key Words: (IRRD except when marked*)

covert and overt operations, Police vehicle, casualty crash, mobile radar speed enforcement, mobile radar publicity, rural areas, undivided highway

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1. EXECUTIVE SUMMARY

During 1999, the Victoria Police suggested that Monash University Accident Research Centre (MUARC) undertake a project to investigate the most appropriate balance of **covert** and **overt** traffic enforcement activity. The Police indicated that they were particularly concerned with the efficiency of the two alternative methods of enforcement, the effect of each on unsafe driver behaviour, the relative effect of each on the perceived risk of detection, and the most appropriate balance of these enforcement methods. However, due to changes in enforcement practices, the project's focus has shifted to an examination of the potential benefits of increasing covert speed enforcement activities.

The study was conducted in two parts:

1. A statistical analysis of mobile radar speed enforcement data in which the type of patrol car (marked or unmarked) used in the Police operations was available.
2. A telephone survey examining public perceptions of the Police enforcement and perceived risk of detection in general, in relation to speed enforcement, and more specifically in relation to speed camera enforcement.

This report presents the research findings of Part 1 of the study, i.e. a statistical analysis of the mobile radar (also sometimes referred to as moving mode radar, MMR) enforcement data examined by the type of Police vehicle used during each Police session of mobile radar operation. The type of vehicle used was either a *marked* police car – this signifies the *overt* operation, or an *unmarked* police car – this signifies the *covert* operation.

The findings of Part 2 of the study are given in Senserrick (2000 & 2001).

1.1 BACKGROUND AND AIMS

MUARC has previously completed a project that evaluated the effects of mobile radar speed enforcement and supporting publicity on road trauma for the period July 1995-June 1997. A documentation of the mobile radar enforcement and publicity awareness levels achieved, together with the estimated effects of the enforcement on road trauma can be found in Diamantopoulou, Cameron and Shtifelman (1998a & 1998b).

Whilst the above evaluation did not discriminate between the type of patrol car used in the mobile radar operations, the project reported here has considered the enforcement activity levels achieved when marked cars and when unmarked cars were used. In addition, the effects on road trauma of the marked car and unmarked car enforcement were estimated separately. Interactions with the levels of mobile radar publicity awareness were also considered.

1.2 DOCUMENTATION OF THE OVERT AND COVERT MOBILE RADAR ENFORCEMENT

The mobile radar activity that occurred in rural¹ Victoria during July 1995-June 1997 was documented and assessed in terms of the following deterrence factors:

- The number of mobile radar hours of operation conducted by Police;
- The number of speeding offences detected through mobile radar;
- The number of speeding offences detected per 100 hours of mobile radar operation.

For each of these deterrence factors, the variation between the overt (marked patrol car) and covert (unmarked patrol car) operations was examined. Overt and covert enforcement was documented separately for the following periods of increased mobile radar enforcement:

- Period A (July 1995 to June 1996) – when there were 48 mobile radar devices in operation;
- Period B (July 1996 to June 1997) – when there were 73 mobile radar devices in operation.
- Periods A & B (July 1995 to June 1997) – when *up to* 73 mobile radar devices were in operation.

1.2.1 Police Hours of Mobile Radar Operations

In rural Victoria during the *combined* periods of increased mobile radar enforcement more Police hours of *overt* mobile radar operations were achieved than *covert* hours (77% compared with 23%). However during July 1996-June 1997 when there were 73 mobile radar devices in operation, the proportion of the mobile radar hours conducted via *unmarked cars* increased to 28% compared with 18% during July 1995-June 1996 when there were 48 mobile radar devices in operation. In terms of actual number of hours of enforcement, in rural Victoria there was an increase in the number of hours of *covert* mobile radar enforcement during the second period of increased mobile radar enforcement, increasing from 7,391 hours in July 1995-June 1996 to 11,587 hours in July 1996-June 1997.

1.2.2 Speeding Offences Detected

For the combined periods of increased mobile radar enforcement (i.e. July 1995-June 1997) when there were *up to* 73 mobile radar devices in operation in rural Victoria, the majority of speeding offences (79%) were detected via *overt* mobile radar

¹ Mobile radar operations occurred predominantly in rural Victoria Police districts during the evaluation period, July 1995-June 1997. There was also some enforcement in outer Melbourne Police Districts (i.e. Districts E, F, H, J & K). However, because the Melbourne operations constituted only about 10% of the total mobile radar activity, the focus of the documentation and the crash evaluation was primarily for rural Victoria.

operations, i.e. 49,120 offences compared with 13,261 offences detected through covert mobile radar operations.

When considering the two periods of increased mobile radar enforcement separately, the proportion of speeding offences detected via *covert* mobile radar operations (i.e. *unmarked* police cars) increased considerably to 29% during July 1996-June 1997 when there were 73 devices in operation. The corresponding proportion during July 1995-June 1996 when there were only 48 mobile radar devices in operation was 12%.

1.2.3 Speeding Offences detected per 100 Hours of Mobile Radar Operation

During the first period of mobile radar enforcement, July 1995-June 1996, an average of 73 speeding offences was detected for every 100 hours of *overt* mobile radar enforcement conducted in rural Victoria. In comparison, for the same period, 45 speeding offences were detected for every 100 hours of *covert* mobile radar enforcement. However, during July 1996-June 1997 there were increases in both of these detection rates. For every 100 hours of *overt* mobile radar enforcement, 82 speeding offences were detected. The corresponding rate for *covert* mobile radar operations was 86 speeding offences detected per 100 hours of enforcement.

Hence when there were 73 mobile radar devices in operation the rate of detection of speeding drivers was more effective/greater via *covert (unmarked car)* mobile radar operations than *overt (marked car)* operations compared to the period when there were only 48 mobile radar units in operation in rural Victoria.

Similar trends in the above deterrence factors were found for mobile radar operations in *all* of Victoria (i.e., including the mobile operations that occurred in the outer Melbourne Police Districts).

1.3 EFFECTS ON ROAD TRAUMA

The findings in Diamantopoulou, Cameron and Shtifelman (1998a & 1998b) indicated evidence of a *four-day residual* enforcement effect on casualty crashes for mobile radar operations in rural areas of Victoria, with the effect diminishing on the fifth, sixth or seventh day after the enforcement's presence. Assuming a four-day residual effect, Diamantopoulou, Cameron and Shtifelman (1998a & 1998b) also found that the strongest effects on casualty crashes in rural Victoria, occurred when the mobile radar enforcement was accompanied by *high² levels of specific mobile radar publicity* awareness during November 1996-June 1997. The effects were strongest one to four

² Achieving weekly advertising awareness levels of at least 250 Adstock (a function of television Target Audience Rating Points) units.

days after the enforcement was present in each Traffic Operations Group (TOG) region³ of rural Victoria.

In view of these findings, the examination of crash effects in this study assumed a residual enforcement effect of *up to four days prior* to a crash.

The crash effects were examined at times when there was:

- i. only OVERT mobile radar enforcement occurring in a particular TOG region on a particular day (i.e. only marked car operations);
- ii. only COVERT mobile radar enforcement occurring in a particular TOG region on a particular day (i.e. only unmarked car operations);
- iii. both OVERT and COVERT mobile radar enforcement occurring in a particular TOG region on a particular day (i.e. both marked and unmarked car operations).

The effects of the mobile radar enforcement (covert, overt or both) on casualty crashes were examined for:

- a. The combined period of increased mobile radar enforcement (July 1995-June 1997);
- b. The first period of increased mobile radar enforcement, PERIOD A (July 1995-June 1996);
- c. The second period of increased mobile radar enforcement, PERIOD B (July 1996-June 1997);
- d. Period B considering interactions with mobile radar publicity⁴.

1.3.1 Crash effects during July 1995-June 1997

During the combined periods of increased mobile radar enforcement (i.e. July 1995-June 1997), reductions in casualty crashes were more evident when the mobile radar enforcement was *covert* (i.e. unmarked cars) than overt. This was particularly the case 1 to 4 days after the enforcement was present in each TOG region of rural Victoria. Under these circumstances, when *up to 73* mobile radar devices were in operation, a net 22% reduction in casualty crashes was found. Reductions were also evident when a *mix* of both overt and covert mobile radar enforcement was in operation. However, overt (marked cars) mobile radar enforcement on its own was not as effective.

³ The locations of the mobile radar operations were limited to the Police Traffic Operations Group (TOG) stations that conducted the operations. Estimates of the likely areas of a Police Division thought to be covered by each TOG station were made in terms of groupings of Local Government Areas, LGAs. It was these estimated groups of LGAs considered to be covered by their respective TOG stations that defined a TOG region for the crash analysis.

⁴ Interactions with mobile radar publicity awareness were only considered during Period B (July 1996-June 1997) because a television advertisement specific to the mobile radar technology was first launched by the TAC in November 1996. There was no mobile radar advertising during Period A.

1.3.2 Crash effects during July 1995-June 1996

A similar result was found during the first period of increased mobile radar enforcement, July 1995-June 1996, when there were 48 mobile radar units operating in patrol cars. Casualty crash reductions for this enforcement period were more evident during times and in rural regions where the mobile radar enforcement was covert (i.e. conducted via unmarked Police cars). A net 20.7% reduction for crashes occurring 1-4 days after the presence of the covert enforcement was found.

1.3.3 Crash effects during July 1996-June 1997

During the second period of increased mobile radar enforcement (i.e. July 1996-June 1997) when 73 units were in operation, crash reductions were most evident 1-4 days after the mobile radar enforcement was present in rural Victoria. This was the case when *only overt* or *only covert* enforcement was operating (i.e. net 6.6% and 17.5% reductions, respectively, were found).

The largest casualty crash reductions, however, were found during times when *both marked and unmarked* Police cars were in operation in rural TOG regions, especially *on the day* of mobile radar enforcement, i.e. a net 40% reduction in casualty crashes was found.

Although none of the above findings were statistically significant, they are indicative of weak casualty crash reductions occurring during times and in rural TOG regions, particularly when there was either:

- **Covert** enforcement (i.e. unmarked mobile radar cars), or
- A **mix of covert and overt** enforcement (i.e. unmarked and marked mobile radar cars).

1.3.4 Interactions with Mobile Radar Publicity

When the enforcement was accompanied by *high* levels of mobile radar publicity awareness, the strongest (and largest) crash reductions occurred when *both* marked and unmarked Police cars were conducting mobile radar operations on a particular day and in a particular TOG region of rural Victoria during the second enforcement period, July 1996-June 1997.

Under these circumstances, a marginally statistically significant ($p=0.0641$) net 71.3% reduction⁵ was found for crashes occurring on the *same day or up to four days* after the enforcement was present. This effect was strongest on the *day* when there was a mix of overt/covert mobile radar enforcement in operation. A net 73.9% casualty crash reduction was found that was statistically significant ($p=0.0450$). However, as indicated by the 90% confidence limits placed on this estimate, this net % reduction could range from as low as a net 15% reduction to as high as a net 92% reduction.

⁵ It should be noted that with 90% confidence, the true value of the estimated net 71.3 % reduction lies in the range of a net 91.2% reduction to a net 6.9% reduction, as indicated by the confidence limits placed on this estimate.

A smaller net reduction of 50% was found for crashes occurring 1-4 days after the enforcement, however this reduction was not statistically significant.

Non-statistically significant crash reductions were also found during times when:

- *only overt* enforcement, or
- *only covert* enforcement

was accompanied by high mobile radar publicity awareness levels. This was especially evident 1-4 days after the presence of the mobile radar enforcement in rural TOG regions.

1.3.5 Limitations of the crash analysis

It should be noted that the effects on road trauma estimated in this study may be somewhat conservative in nature because of the following decisions that were made to facilitate the evaluation:

- *All* casualty crashes were examined rather than a subset that, presumably, was speed-related (assuming such crashes can be defined).
- All undivided, 100 km/h speed limit roads in the regions thought to be covered by mobile radar operations were included rather than those where the enforcement actually took place.
- The control group was restricted to crashes that occurred on the same roads and regions as the mobile radar enforcement but during days that were considered to be uninfluenced by the enforcement. Because the operations were so frequent, this limited the number of crashes that could be considered as 'control' crashes.
- Although the study compared crashes that occurred during the period of mobile radar enforcement with the period when there was no mobile radar enforcement, other types of speed enforcement (such as speed cameras or hand-held radars) may have been operating on the same roads during the pre-period that may not have been accounted for by changes in the control crashes.
- The analysis assumed that crashes were exclusively influenced by the most recent mobile radar enforcement present in a particular region. This most recent enforcement was considered to over-ride any enforcement that occurred one to four days earlier, which also may have influenced the crashes. Given that a four-day residual effect on crashes was found in the analysis, the most recent enforcement may not necessarily have been the most important in influencing crash frequencies.

1.4 CONCLUSION

The evaluation of mobile radar enforcement and supporting publicity found evidence of casualty crash reductions during July 1995-June 1997 in rural TOG regions of Victoria, particularly when the speed enforcement operations were either:

- covert (unmarked patrol cars) or
- a mix of overt and covert (marked and unmarked patrol cars).

The strongest effects on casualty crashes occurred when a mix of overt and covert mobile radar enforcement was accompanied by high awareness levels of mobile radar publicity during July 1996-June 1997. Under these circumstances, a marginally statistically significant ($p=0.0641$) net 71.3% reduction was found for crashes occurring on the *same day or up to four days* after the enforcement was present. This effect was strongest on the *day* when there was a mix of overt/covert mobile radar enforcement in operation. A net 73.9% casualty crash reduction was found that was statistically significant ($p=0.0450$).

Crash reductions were also evident when interactions with the levels of mobile radar publicity were *not* considered. However the effects were smaller and weaker than those that were found when high awareness levels of mobile radar publicity accompanied the overt/covert mix of mobile radar enforcement.

2. INTRODUCTION

The Victoria Police suggested that Monash University Accident Research Centre (MUARC) undertake a project to investigate the most appropriate balance of **covert** and **overt** traffic enforcement activity. The Police indicated that they were particularly concerned with the efficiency of the two alternative methods of enforcement, the effect of each on unsafe driver behaviour, the relative effect of each on the perceived risk of detection, and the most appropriate balance of these enforcement methods. However, due to changes in enforcement practices, the project is now focusing on the potential benefits of increasing covert speed enforcement activities.

The project was conducted in two parts:

1. A statistical analysis of mobile radar speed enforcement data in which the type of patrol car (marked or unmarked) used in the Police operations was available.
2. A telephone survey examining public perceptions of the Police enforcement and perceived risk of detection in general, in relation to speed enforcement, and more specifically in relation to speed camera enforcement.

This report presents the research findings of Part 1 of the study, i.e. a statistical analysis of the mobile radar (also sometimes referred to as moving mode radar, MMR) enforcement data examined by the type of Police vehicle used during each Police session of mobile radar operation. The type of vehicle used was either a *marked* police car – this signifies the *overt* operation, or an *unmarked* police car – this signifies the *covert* operation.

2.1 BACKGROUND TO THE MOBILE RADAR ENFORCEMENT DATA

MUARC has previously completed a project that evaluated the effects of mobile radar speed enforcement and supporting publicity on road trauma for the period July 1995-June 1997. A documentation of the mobile radar enforcement and publicity awareness levels achieved, together with the estimated effects of the enforcement on road trauma can be found in Diamantopoulou, Cameron and Shtifelman (1998a & 1998b).

2.1.1 Mobile Radar Enforcement

During 1995 the Transport Accident Commission (TAC) had purchased 30 new mobile radar units for installation in Victoria Police cars to supplement the 18 existing units operated by Police since August 1994. The new units became operational on 29th June 1995. In 1996, a further 25 mobile radar devices were purchased by the TAC. These 25 units became operational in late June 1996, bringing the total of mobile radar devices used by Police in Victoria to 73.

The mobile radar units (also known as moving mode radar or MMR units) are used on two-way, undivided, 100 km/h speed limit roads from a moving patrol car, primarily in rural areas where the approaching traffic is travelling in a near-parallel (but opposite) direction. The radar devices are mounted on the police car's driver's door window. A radar 'gun' beam fired from the police car can reach a vehicle up to one kilometre away. From the radar beam (reflected from the target vehicle back to the police car), the mobile radar unit (mounted on the car dashboard) then calculates the speed of the approaching vehicle and determines if the speed limit is broken. If the measured speed is excessive, the patrol car can intercept the vehicle when it arrives. A speeding infringement notice is issued on the spot and the combination of this process and flashing lights on the patrol car will ensure that the apprehension is visible to other passing motorists. The visibility may, therefore, achieve a general deterrent effect on the highway as well as a specific deterrent effect on the motorist who has been apprehended.

The use of marked patrol cars (or a combination of marked and unmarked cars) may enhance the general deterrent effect on some highways. As the use of mobile radar on the highway becomes known, it could be expected that the presence of marked cars would increase the deterrent effect. The general deterrent effect could also be further increased by mass media publicity advising motorists of the threat of this new form of speed enforcement.

2.1.2 Type of Patrol Car

The type of patrol car used during the mobile radar operations was either a *marked* car (a Police vehicle with red/blue emergency lights on the roof and a siren, together with POLICE decal, i.e., white background with Police lettering), or an *unmarked* car (a civilian car in appearance but fitted with covert emergency lights in the front and back windows, together with a siren). For this study mobile radar operations that use marked cars represent *overt* speed enforcement whilst those that use unmarked cars signify *covert* speed enforcement.

The evaluation of the mobile radar program of enforcement and supporting publicity covered the period July 1995-June 1997 when up to 73 mobile radar devices were in operation. The evaluation (summarised in Diamantopoulou, Cameron and Shtifelman, 1998a & 1998b), was carried out in the following two stages:

- i. Assessment of the enforcement activity levels achieved;
- ii. Estimation of reductions in road trauma on the enforced highways.

2.2 AIMS OF PART 1

Whilst the earlier evaluation (Diamantopoulou, Cameron and Shtifelman, 1998a & 1998b) did not discriminate between the type of patrol car used in the mobile radar operations, the project reported here has considered the enforcement activity levels achieved when marked cars and when unmarked cars were used. In addition, the effects on road trauma of the marked car and unmarked car enforcement were estimated separately. Interactions with mobile radar road safety advertising awareness were also considered.

3. DOCUMENTATION OF MOBILE RADAR ENFORCEMENT

The mobile radar activity that occurred in Victoria during July 1995-June 1997 was documented and assessed in terms of the following deterrence factors:

- The number of mobile radar hours of operation conducted by Police;
- The number of speeding offences detected through mobile radar;
- The number of speeding offences detected per hour of mobile radar operation.

For each of these deterrence factors, the variation between the overt (marked patrol car) and covert (unmarked patrol car) operations was examined. Overt and covert enforcement was documented separately for the following periods of increased mobile radar enforcement:

- Period A (July 1995 to June 1996) – when there were 48 mobile radar devices in operation;
- Period B (July 1996 to June 1997) – when there were 73 mobile radar devices in operation.
- Periods A & B (July 1995 to June 1997) – when *up to* 73 mobile radar devices were in operation.

For the evaluation period, July 1995-June 1997, mobile radar operations occurred predominantly in rural Victoria Police Districts (i.e. Districts L, M, N, O, P & Q). There was also some enforcement in the outer Melbourne Police Districts (i.e. Districts E, F, H, J & K). Since the Melbourne operations constituted only about 10% of the total mobile radar activity, the focus in the documentation was primarily for rural Victoria.

3.1 POLICE HOURS OF MOBILE RADAR OPERATION

Table 3.1 gives the number (and proportion) of Police hours of overt and covert mobile radar enforcement achieved in rural Victoria and in all of Victoria during July 1995-June 1997. The information presented in Table 3.1 is depicted graphically in Figure 3.1 (number of overt and covert hours achieved) and Figure 3.2 (percentage of overt and covert hours achieved) for rural Victoria.

In rural Victoria during the combined periods of increased mobile radar enforcement, more Police hours of *overt* mobile radar operations were achieved than *covert* hours (77% compared with 23%). However during July 1996-June 1997 when there were 73 mobile radar devices in operation, the proportion of the mobile radar hours conducted via *unmarked cars* increased to 28% compared with 18% during July 1995-June 1996 when there were 48 mobile radar devices in operation (Figure 3.2). Correspondingly, the marked car proportion decreased from 82% in Period A to 72% in Period B. In terms of actual number of hours of enforcement, in rural Victoria there was an increase in the number of hours of *covert* mobile radar enforcement during Period B, increasing from 7,391 hours in July 1995-June 1996 to 11,587 hours in July 1996-June 1997 (Figure 3.1).

The distribution of overt and covert hours of mobile radar enforcement achieved for all of Victoria was similar to that found in rural Victoria (Table 3.1).

Table 3.1: HOURS of OVERT and COVERT Mobile Radar Operations, July 1995-June 1997

REGION	Type of enforcement	Period of increased mobile radar enforcement		
		Jul 95-Jun 96 (Period A)	Jul 96-Jun 97 (Period B)	Jul 95-Jun 97 (Periods A+B)
Rural Victoria	Overt (marked police car)	33,501 (81.9%)	30,102 (72.2%)	63,603 (77.0%)
	Covert (unmarked police car)	7,391 (18.1%)	11,587 (27.8%)	18,978 (23.0%)
All Victoria	Overt (marked police car)	37,253 (80.5%)	33,530 (71.7%)	70,783 (76.1%)
	Covert (unmarked police car)	9,041 (19.5%)	13,244 (28.3%)	22,285 (23.9%)

Figure 3.1 Distribution of Police HOURS of mobile radar OVERT & COVERT enforcement in RURAL VICTORIA, July 1995-June 1997

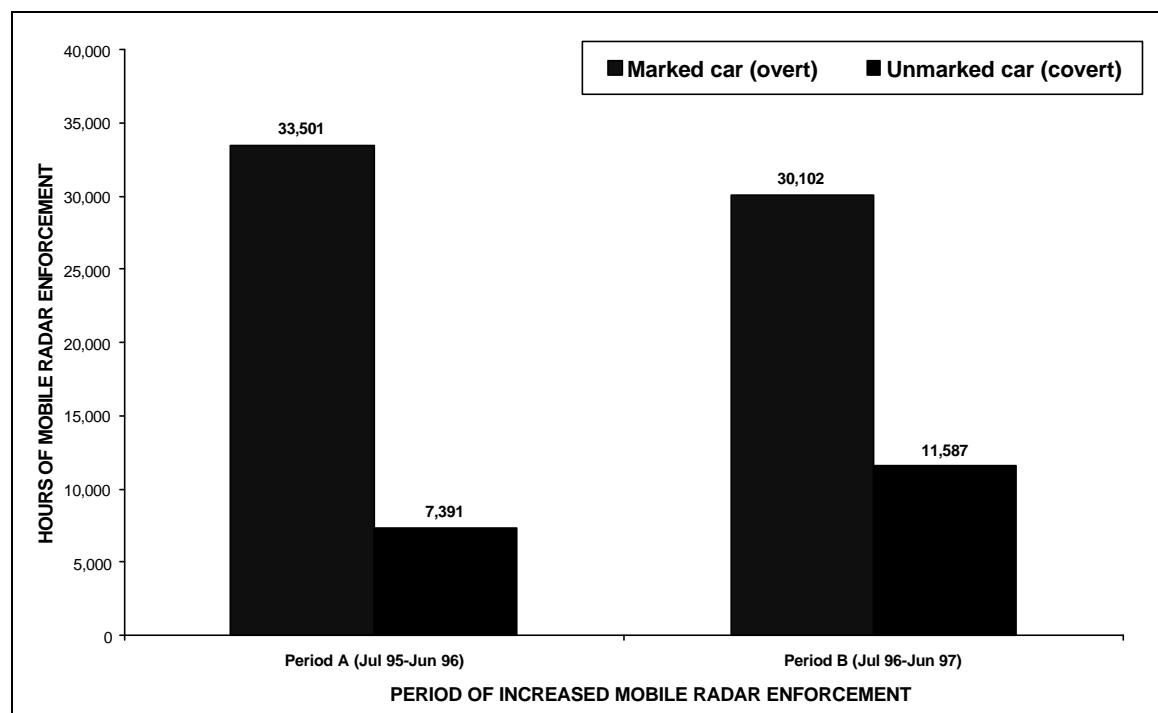
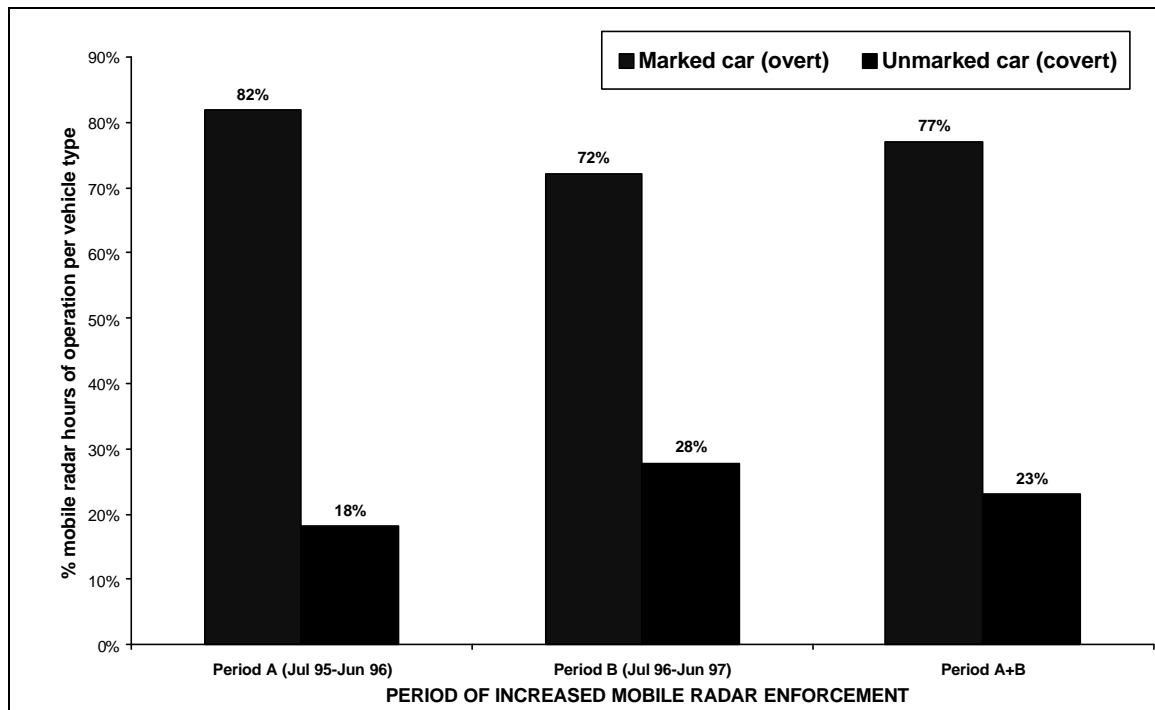


Figure 3.2 Proportion of Police HOURS of mobile radar OVERT & COVERT enforcement in RURAL VICTORIA, July 1995-June 1997



3.2 SPEEDING OFFENCES DETECTED THROUGH MOBILE RADAR ENFORCEMENT

Table 3.2 shows the number (and proportion) of speeding offences detected through overt and covert mobile radar enforcement for rural Victoria and all of Victoria. The information presented in Table 3.2 is depicted graphically in Figure 3.3 (number of offences) and Figure 3.4 (proportion of offences) for rural Victoria.

In rural Victoria, during July 1995-June 1997 when there were up to 73 mobile radar devices in operation, the majority of speeding offences (79%) were detected via *overt* mobile radar operations, i.e. 49,120 offences compared with 13,261 offences detected through covert mobile radar operations.

When considering the two periods of increased mobile radar enforcement separately, the proportion of speeding offences detected via *covert* mobile radar operations (i.e. *unmarked* police cars) increased considerably during Period B to 29% compared with Period A (12%) when there were only 48 mobile radar devices in operation.

The distribution of speeding offences detected via overt and covert mobile radar enforcement achieved in all of Victoria was similar to that found for rural areas (Table 3.2).

Table 3.2: Speeding OFFENCES detected through OVERT & COVERT mobile radar enforcement, July 1995-June 1997

REGION	Type of enforcement	Period of increased mobile radar enforcement		
		Jul 95-Jun 96 (Period A)	Jul 96-Jun 97 (Period B)	Jul 95-Jun 97 (Periods A+B)
Rural Victoria	Overt (marked police car)	24,574 (88.2%)	24,546 (71.1%)	49,120 (78.7%)
	Covert (unmarked police car)	3,302 (11.9%)	9,959 (28.9%)	13,261 (21.3%)
All Victoria	Overt (marked police car)	27,260 (86.6%)	27,547 (70.8%)	54,807 (77.8%)
	Covert (unmarked police car)	4,230 (13.4%)	11,386 (29.3%)	15,616 (22.2%)

Figure 3.3 Distribution of SPEEDING OFFENCES detected through mobile radar OVERT & COVERT enforcement in RURAL VICTORIA, July 1995-June 1997

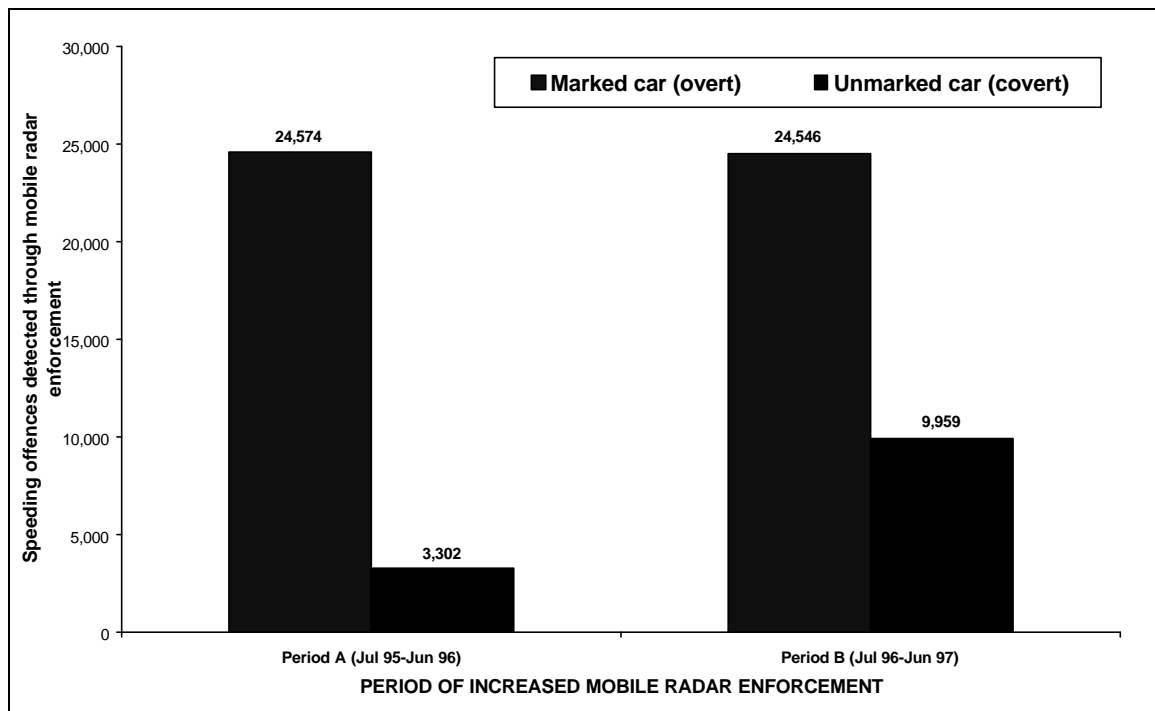
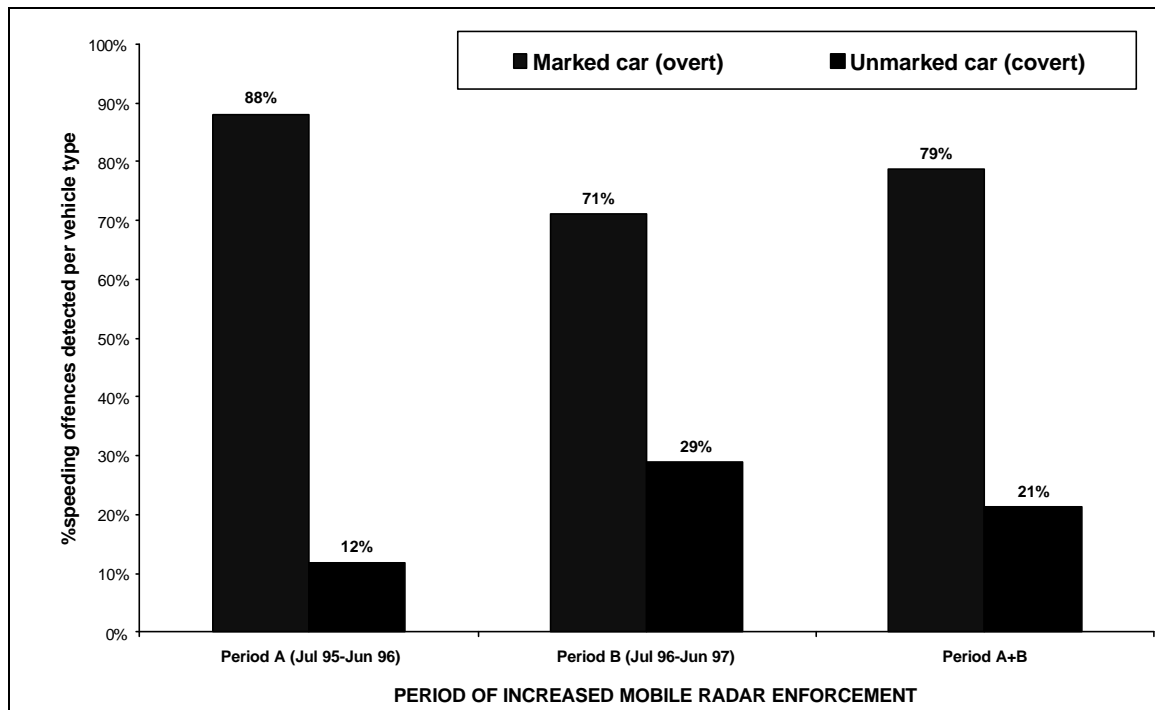


Figure 3.4 Proportion of SPEEDING OFFENCES detected through mobile radar OVERT & COVERT enforcement in RURAL VICTORIA, July 1995-June 1997



3.3 NUMBER OF SPEEDING OFFENCES DETECTED PER 100 HOURS OF MOBILE RADAR ENFORCEMENT

The operational effectiveness of mobile radar overt and covert activity was measured as the number of speeding offences detected per 100 hours of operation (Table 3.3 and Figure 3.5).

During July 1995-June 1996, an average of 73 speeding offences were detected for every 100 hours of *overt* mobile radar enforcement in rural Victoria. In comparison, for the same period, 45 speeding offences were detected for every 100 hours of *covert* mobile radar enforcement. However, during July 1996-June 1997 there were increases in both of these detection rates. For every 100 hours of *overt* mobile radar enforcement, 82 speeding offences were detected. The corresponding rate for *covert* mobile radar operations was 86 speeding offences detected per 100 hours of enforcement.

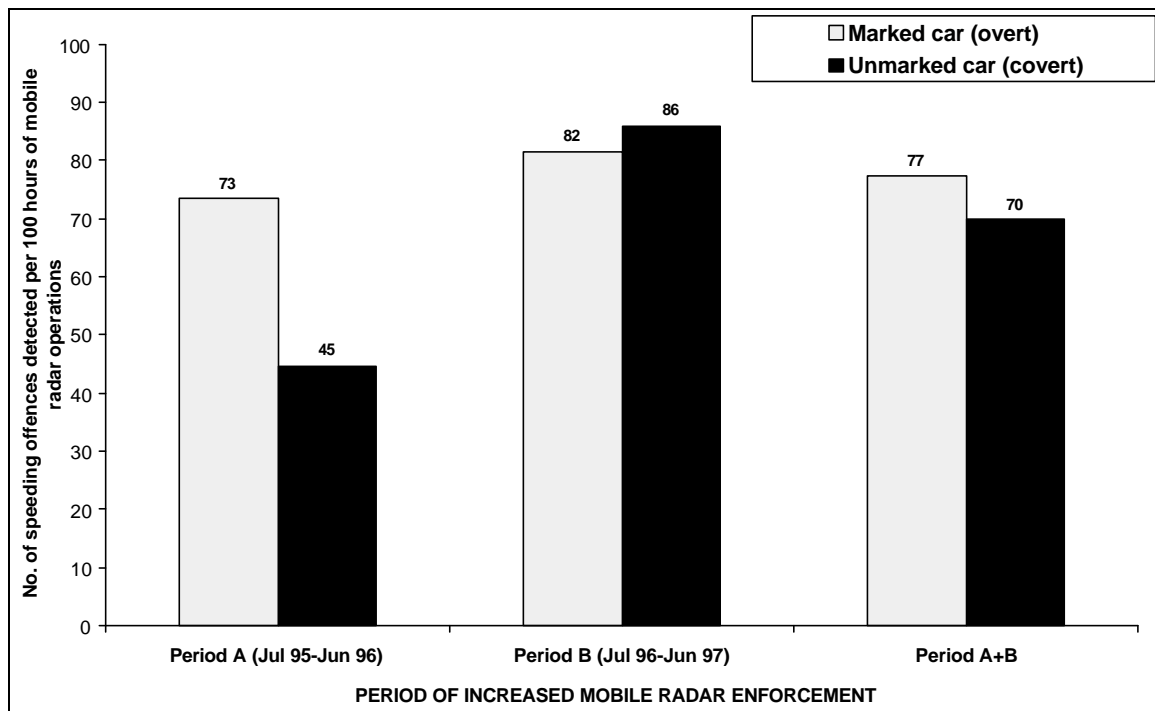
Hence during Period B when there were 73 mobile radar devices in operation the rate of detection of speeding drivers was more effective/greater via *covert (unmarked car)* mobile radar operations than *overt (marked car)* operations in rural Victoria.

A similar trend was found for mobile radar operations in all of Victoria.

Table 3.3: Distribution of the number of SPEEDING OFFENCES detected through OVERT & COVERT mobile radar enforcement per 100 HOURS of operation, July 1995-June 1997

REGION	Type of enforcement	Jul 95-Jun 96 (Period A)	Jul 96-Jun 97 (Period B)	Jul 95-Jun 97 (Periods A+B)
Rural Victoria	Overt (marked police car)	73	82	77
	Covert (unmarked police car)	45	86	70
All Victoria	Overt (marked police car)	73	82	77
	Covert (unmarked police car)	47	86	70

Figure 3.5 Number of speeding offences detected per 100 hours of mobile radar OVERT & COVERT enforcement in RURAL VICTORIA, July 1995-June 1997



3.4 SUMMARY OF MOBILE RADAR ENFORCEMENT

3.4.1 Police Hours of Mobile Radar Operations

In rural Victoria during the combined periods of increased mobile radar enforcement, July 1995-June 1997, more Police hours of *overt* mobile radar operations were achieved than *covert* hours (77% compared with 23%). However during July 1996-June 1997 when there were 73 mobile radar devices in operation, the proportion of the mobile radar hours conducted via *unmarked cars* increased to 28% compared with 18% during July 1995-June 1996 when there were 48 mobile radar devices in operation. In terms of actual number of hours of enforcement, in rural Victoria there was an increase in the number of hours of *covert* mobile radar enforcement during the second period of increased mobile radar enforcement, increasing from 7,391 hours in July 1995-June 1996 to 11,587 hours in July 1996-June 1997.

3.4.2 Speeding Offences Detected

For the combined periods of increased mobile radar enforcement (i.e. July 1995-June 1997) when there were *up to 73* mobile radar devices in operation in rural Victoria, the majority of speeding offences (79%) were detected via *overt* mobile radar operations, i.e. 49,120 offences compared with 13,261 offences detected through *covert* mobile radar operations.

When considering the two periods of increased mobile radar enforcement separately, the proportion of speeding offences detected via *covert* mobile radar operations (i.e. *unmarked* police cars) increased considerably to 29% during July 1996-June 1997 when there were 73 devices in operation. The corresponding proportion during July 1995-June 1996 when there were only 48 mobile radar devices in operation was 12%.

3.4.3 Speeding Offences detected per 100 Hours of Mobile Radar Operation

During the first period of mobile radar enforcement, July 1995-June 1996, an average of 73 speeding offences was detected for every 100 hours of *overt* mobile radar enforcement in rural Victoria. In comparison, for the same period, 45 speeding offences were detected for every 100 hours of *covert* mobile radar enforcement. However, during July 1996-June 1997 there were increases in both of these detection rates. For every 100 hours of *overt* mobile radar enforcement, 82 speeding offences were detected. The corresponding rate for *covert* mobile radar operations was 86 speeding offences detected per 100 hours of enforcement.

Hence when there were 73 mobile radar devices in operation the rate of detection of speeding drivers was more effective/greater via *covert (unmarked car)* mobile radar operations than *overt (marked car)* operations compared to the period when there were only 48 mobile radar units in operation.

Similar trends in the above deterrence factors were found for mobile radar operations in *all* of Victoria (i.e. including the mobile radar operations that occurred in the outer Melbourne Police Districts).

4. EFFECTS ON ROAD TRAUMA

The effect of the increased mobile radar enforcement on road trauma during July 1995-June 1997 was examined in terms of the number of casualty crashes that occurred on undivided roads in 100 km/h speed zones in Victoria. The crash-based analysis compared accident frequencies for the period in which the new units were operational (July 1995-June 1997) with the corresponding two-year period before their introduction (July 1992-June 1994) when there was no mobile radar enforcement.

Ideally the analysis would compare the crash frequencies for the period which the new mobile radar devices were operational (i.e. July 1995-June 1997) with the corresponding two-year period immediately before their introduction (i.e. July 1993-June 1995). However, because there already were 18 mobile radar units operational on Victorian major roads since August 1994, the *absolute effectiveness* of mobile radar operations could not be measured using this comparison, only the *change* in effectiveness due to the introduction of the new devices. This is because no information was held by Police regarding the dates and locations of mobile radar operations prior to May 1995. To overcome this problem, casualty crashes that occurred during July 1992-June 1994, when there was no mobile radar enforcement, were considered for comparison, thereby acting as a zero base for mobile radar activity.

For the crash-based evaluation, it was decided to use the amount of recorded hours of operation per shift as a measure of mobile radar activity, because hours of operation were considered to be the best measure of enforcement presence. An alternative measure could have been the number of speeding offences detected per shift, however if no offences were detected during a shift, this would be misleading in suggesting that there was no enforcement at that time in that location.

4.1 LOCATION OF MOBILE RADAR OPERATIONS

For each session of mobile radar activity, there was no record of the specific highway of Victoria on which the patrol car crew operated. Location details of mobile radar operations were limited to the Police Traffic Operations Group (TOG) stations that conducted the operations. To determine which crashes were influenced by mobile radar activity, it was necessary to use the location of the TOG station to define an area of coverage. Initial estimates of the likely areas (in terms of groupings of Local Government Areas, LGAs) of a Police Division covered by a particular TOG station were made. Each Senior Sergeant in charge of mobile radar operations in a Division of a Police District was then given the opportunity to approve the estimated group of LGAs considered to be covered by their respective TOG stations. The resulting list of 33 TOG regions is given in the Appendix.

Since major Victorian highways can cover a number of TOG regions, and since there does not appear to be any strict instructions given to operators of the mobile radar units with regard to crossing from one region to another (especially within a Police District where there are generally two Divisions), care should be taken in the interpretation of a mobile radar influenced area since it is possible for a patrol car to

travel across these newly defined boundaries. However, for the crash-based analysis to proceed this was assumed to be a minor problem, occurring infrequently.

If a TOG region had some mobile radar activity on a particular day during July 1995-June 1997 it was assumed that all 100 km/h undivided roads in that region were potentially affected by the enforcement on that day. In large TOG regions (such as those found in Gippsland, District Q), this may be a very liberal assumption, thus caution needs to be taken in interpretation of the results. Any effects on the highways actually experiencing mobile radar activity are likely to be diluted when crashes on all 100 km/h, undivided roads in the region are considered.

4.2 MOBILE RADAR DATA

During July 1995-June 1997, a total of 24,823 sessions of mobile radar activity (in which the hours of operation were recorded) were conducted in the TOG defined regions listed in the Appendix.

For a particular date and TOG region, the mobile radar session data was aggregated to produce the sum of hours of operation for that TOG region/date combination. For example, on 23 August 1995 in TOG region 33 (i.e. areas covered by Police station QSA in Sale), there were two mobile radar sessions resulting in a total of eight hours of mobile radar operations. A total of 15,548 unique TOG/date combinations were produced.

The type of Police patrol car used for each of these unique TOG/date combinations was classified as follows for the crash analysis:

- Marked car operations only (overt enforcement)
- Unmarked car operations only (covert enforcement)
- A combination of marked and unmarked car operations (a mix of overt/covert enforcement).

4.3 CRASH DATA

The crash database used in the analysis was the VicRoads enhanced database of Police-reported casualty crashes in Victoria. Casualty crashes were extracted for the period July 1995-June 1997 to coincide with the periods of increased mobile radar enforcement. Casualty crashes occurring during the corresponding periods in 1992-1994 were also extracted. To match the crash data with the mobile radar enforcement data, each crash was assigned to one of the 33 TOG regions according to the Local Government Area that it occurred in.

4.4 DEFINITION OF RESIDUAL ENFORCEMENT EFFECT ON CRASHES

Initially a potential residual mobile radar enforcement effect of up to seven days prior to a crash was considered because many people travel along the same road once a week and return to that same road seven days later. However, Diamantopoulou, Cameron and Shtifelman (1998a & 1998b)) established that there was little or no effect *beyond four days* after the enforcement was present. The findings showed evidence of a four-day residual enforcement effect on casualty crashes for mobile radar operations in rural areas of Victoria, but the effect diminished on the fifth, sixth and seventh day after the enforcement's presence.

Hence, for this study a *four-day residual enforcement* effect on crashes was considered.

4.5 TREATMENT GROUP OF CRASHES

In order to measure the speeds of oncoming vehicles and to have the ability to intercept an approaching offender, the mobile radar enforcement has only been used on undivided roads with a speed limit of 100 km/h. Thus, it was decided that casualty crashes occurring on *undivided, 100 km/h roads*, and occurring on the *same day or within four days* of the mobile radar operations would be defined as the 'treatment' group of crashes. Being 'treated' by the presence of mobile radar operations, either overt, covert or both, could potentially reduce crash frequencies.

4.6 CONTROL GROUP OF CRASHES

Having labelled crashes that occurred on undivided, 100 km/h roads at the time of mobile radar enforcement as treatment crashes, it was then necessary to define a suitable 'control' group of crashes from the remaining data. The use of control crashes allowed for adjustment in the analysis for the effects of other factors (apart from the increased mobile radar enforcement) which have influenced crash frequencies during the study period. These include economic, environmental and situational factors.

The type of road and speed zone were kept the same in the control group as in the treatment group of crashes. Crashes that occurred on undivided roads with a speed limit of 100 km/h at times when mobile radar was *not present within four days prior* to a crash were defined as the *control* crash group.

4.7 METHOD OF ANALYSIS

Casualty crashes that occurred on undivided roads in 100 km/h speed zones in the TOG regions where mobile radar activity took place were used in the crash analysis. These crashes were divided into 'treatment' and 'control' crashes. The 'treatment' sub-group was crashes that occurred in the same region as mobile activity and on the

same day or up to four days after the enforcement had taken place. The ‘control’ subgroup was crashes that occurred in the same region as mobile radar activity but more than four days after the enforcement had taken place.

In the analysis, four time periods were considered and are given in Table 4.1.

Table 4.1: Time periods used in the crash analysis

Period	Mobile Radar Enforcement Period	Comparison Period (no Mobile Radar enforcement)
A	July 1995-June 1996 (48 mobile radar units operating)	July 1992-June 1993
B	July 1996-June 1997 (73 mobile radar units operating)	July 1993-June 1994

4.7.1 Statistical Methodology

The number of casualty crashes occurring on undivided, 100 km/h roads during the increased mobile radar enforcement periods (July 1995-June 1997) in the defined TOG regions, was compared with crashes occurring in the same periods three years earlier (July 1992-June 1994), and the change in these numbers was then calculated. This estimate, expressed as a percentage change, represents an initial estimate of the effect of the mobile radar enforcement.

Crashes considered to be unaffected by mobile radar enforcement (i.e. those occurring more than four days after the enforcement was present), in the same TOG regions as the mobile radar operations, were compared with those occurring three years earlier. The percentage change in this ‘control’ group of crashes was considered to measure the effects of *other* factors (apart from the enforcement) that may affect crashes in the same TOG regions during the days affected by the enforcement.

To estimate the difference between the percentage change in the ‘treated’ crashes and the percentage change in crashes considered unaffected by mobile radar operations, a *net percentage change* was calculated. The net percentage change was considered to estimate the effect of mobile radar enforcement, after the effects of other factors have been taken into account. The net percentage change in crashes was estimated in each of the situations when the mobile radar enforcement was *overt (marked Police cars)*, *covert (unmarked Police cars)* or *both overt and covert*.

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

4.7.2 Hypothesis Testing

The hypothesis tests carried out in this evaluation assumed a null hypothesis in which the mobile radar enforcement had no effect on casualty crashes against an alternative hypothesis in which the mobile radar enforcement was associated with a net percentage reduction in crashes. The test is expressed as follows:

H_0 : a net %change ≥ 0 (no effect), versus

H_a : a net %change < 0 (crash reduction).

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. The significance probabilities or p-values presented in the tables are based on one-tailed tests of significance, with the following rules applying:

- i. If the p-value ≤ 0.05 , then the net %reduction is assumed to be statistically significant.
- ii. If $0.05 < \text{p-value} \leq 0.10$, then the net %reduction is labelled as ‘marginally statistically significant.’
- iii. If the p-value > 0.10 , then the net %reduction is not statistically significant, and could be due to chance.

4.7.3 Publicity Supporting Mobile Radar Enforcement

During the period of mobile radar use examined in Diamantopoulou, Cameron and Shtifelman (1998a & 1998b), July 1995-June 1997, a television advertisement specific to the new mobile radar technology was first launched by the TAC in November 1996. This advertisement was shown in both metropolitan and rural areas of Victoria. In addition, there were other advertisements relating to the general speeding theme shown in both regions during the two-year period of the evaluation.

Television exposure was measured weekly during July 1995-June 1997, using TARPs (Target Audience Rating Points), a measure of audience reach. Mobile radar advertising awareness and general speed-related advertising awareness for television viewers in Melbourne and rural Victoria were measured by a function of TARPs called “Adstock” (Broadbent, 1979). The “Adstock” function represents the audience’s retained awareness of current and past levels of advertising.

For the evaluation period, considerable variation in the awareness levels of mobile radar publicity was found. Because of this variation, potential interactions of the mobile radar enforcement with the varying levels of *specific mobile radar* publicity awareness during the one-year period July 1996-June 1997, were considered in the crash-based analysis for this study.

4.8 RESULTS

The findings in Diamantopoulou, Cameron and Shtifelman (1998a & 1998b) indicated evidence of a *four-day residual* enforcement effect on casualty crashes for mobile radar operations in rural areas of Victoria, with the effect diminishing on the fifth, sixth or seventh day after the enforcement's presence. Assuming a four-day residual effect, Diamantopoulou et al (1998a & 1998b) also found that the strongest effects on casualty crashes in rural Victoria, occurred when the mobile radar enforcement was accompanied by *high⁶ levels of specific mobile radar publicity* awareness during November 1996-June 1997. The effects were strongest one to four days after the enforcement was present in a particular TOG region of rural Victoria.

In view of these findings, the following analyses (including interactions with mobile radar publicity) assumed a residual enforcement effect of *up to four days prior* to a crash.

The crash effects were examined at times when there was:

- only OVERT mobile radar enforcement occurring in a particular TOG region on a particular day (i.e. only marked car operations);
- only COVERT mobile radar enforcement occurring in a particular TOG region on a particular day (i.e. only unmarked car operations);
- both OVERT and COVERT mobile radar enforcement occurring in a particular TOG region on a particular day (i.e. both marked and unmarked car operations).

The following sections give the results for the effects of the mobile radar enforcement (covert, overt and both) on casualty crashes during:

- The combined period of increased mobile radar enforcement (July 1995-June 1997);
- The first period of increased mobile radar enforcement, PERIOD A (July 1995-June 1996);
- The second period of increased mobile radar enforcement, PERIOD B (July 1996-June 1997);
- Period B considering interactions with mobile radar publicity.

4.8.1 Crash effects during July 1995-June 1997 (Periods A & B)

For the combined period of increased mobile radar enforcement, July 1995-June 1997, the net percentage change in casualty crash frequencies was estimated for crashes occurring on the same day as enforcement, as well as for up to four days after the enforcement was present. The type of enforcement considered was either overt (marked cars), covert (unmarked cars) or both overt and covert.

⁶ Achieving weekly mobile radar advertising awareness levels of at least 250 Adstock units.

The control group was casualty crashes occurring more than four days after mobile radar activity was present in rural regions on the same types of roads as the enforcement.

In the subsequent tables, the net percentage change was estimated for the following 'treatment' groups of crashes:

- i. Casualty crashes occurring on the same day as mobile radar enforcement
- ii. Casualty crashes occurring one to four days after mobile radar enforcement
- iii. Casualty crashes occurring on the same day or up to four days after mobile radar enforcement.

Table 4.2 gives the net percentage change in crashes for each of the above affected crash groups relative to the same group of 'uninfluenced' crashes (i.e. those occurring more than four days after the enforcement was present) during times and in TOG regions when the enforcement was either overt, covert or both. Figure 4.1 displays this information graphically.

Covert (unmarked car) operations

A net 9.1% reduction was found for crashes occurring on the same day or up to four days after the covert mobile radar enforcement was present in rural Victoria regions. This effect was stronger on the 1-4 days after the enforcement (i.e. a net 22% reduction) rather than on the same day (i.e. a net 3.7% reduction). However, none of these net % reductions were statistically significant.

Overt (marked car) operations

A net 7.8% reduction was found only for crashes occurring *1-4 days after* the overt mobile radar enforcement was present. This reduction, however, was not statistically significant. There was no evidence of a crash reduction on the day of overt mobile radar enforcement.

A mix of covert and overt operations

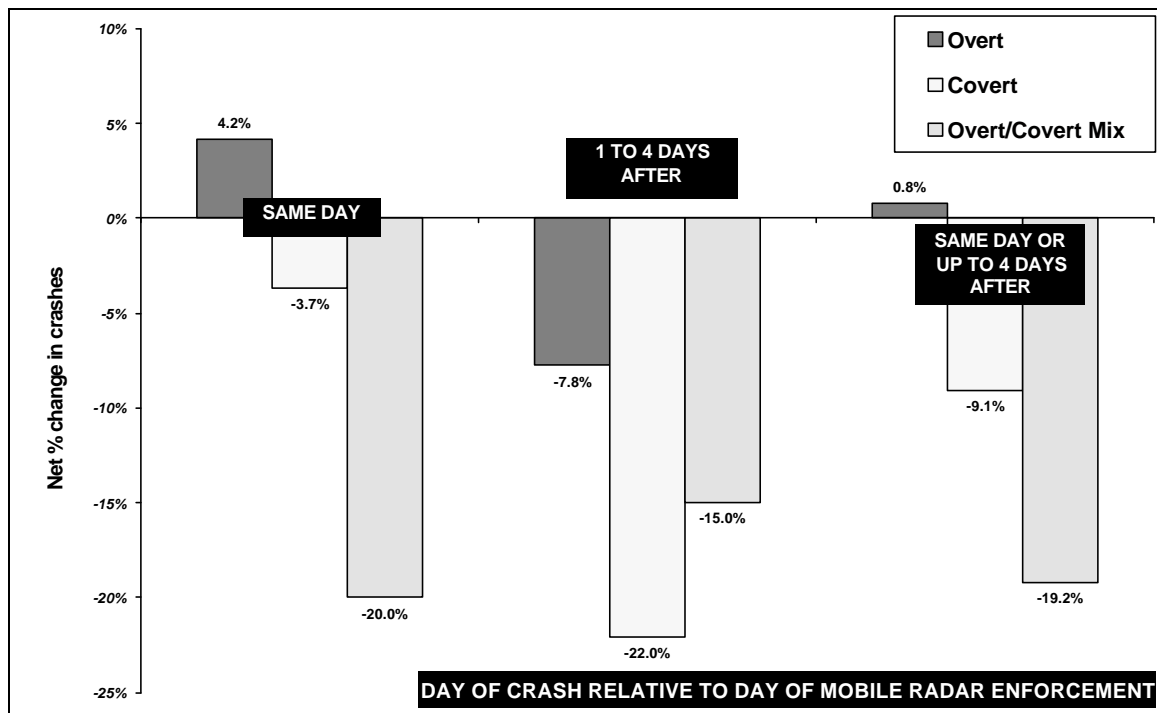
When *both* marked and unmarked Police cars were conducting mobile radar operations on a particular day and in a particular TOG region of rural Victoria, a net 19.2% reduction was found for crashes occurring on the same day or up to four days after the enforcement was present. This effect was stronger on the day of enforcement (i.e. a net 20% reduction) than 1-4 days after the enforcement (i.e. a net 15% reduction). However, none of these reductions were statistically significant.

Hence, reductions in casualty crashes were more evident when the mobile radar enforcement was *covert* (i.e. unmarked cars) especially 1-4 days after the enforcement was present in a particular TOG region of rural Victoria during July 1995-June 1997 when there were up to 73 mobile radar devices in operation. Reductions were also evident when a *mix* of both overt and covert mobile radar enforcement was in operation. Overt (marked cars) mobile radar enforcement on its own was not as effective.

Table 4.2: Casualty crashes occurring during the combined periods July 1995-June 1997 (Periods A & B) of increased mobile radar enforcement (overt, covert or both), in rural Victoria

OVERT ENFORCEMENT (marked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1992- June 1994 (PRE- mobile radar period)	July 1995- June 1997 (DURING mobile radar period)	
Same day as MMR activity	Treatment Control	1549 283	1465 257	+4.2%
1 to 4 days after MMR activity	Treatment Control	598 283	501 257	-7.8%
Same day or up to 4 days after MMR activity	Treatment Control	2147 283	1966 257	+0.8%
COVERT ENFORCEMENT (unmarked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1992- June 1994 (PRE- mobile radar period)	July 1995- June 1997 (DURING mobile radar period)	
Same day as MMR activity	Treatment Control	344 61	315 58	-3.7%
1 to 4 days after MMR activity	Treatment Control	143 61	106 58	-22.0%
Same day or up to 4 days after MMR activity	Treatment Control	487 61	421 58	-9.1%
MIX OF OVERT & COVERT ENFORCEMENT (marked & unmarked cars)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1992- June 1994 (PRE- mobile radar period)	July 1995- June 1997 (DURING mobile radar period)	
Same day as MMR activity	Treatment Control	376 26	324 28	-20.0%
1 to 4 days after MMR activity	Treatment Control	71 26	65 28	-15.0%
Same day or up to 4 days after MMR activity	Treatment Control	447 26	389 28	-19.2%

Figure 4.1: Net % change in casualty crashes occurring during July 1995-June 1997 in rural regions of Victoria during times when the mobile radar enforcement was OVERT, COVERT or a MIX of overt/covert.



4.8.2 Crash effects during July 1995-June 1996 (Period A)

The effects of the mobile radar enforcement on casualty crashes were examined for the first period of increased mobile radar enforcement, July 1995-June 1996 (Period A). During this period, 48 mobile radar devices were operational in Police cars.

Table 4.3 and Figure 4.2 display the crash effects when *overt*, *covert* or *both* types of mobile radar enforcement were in operation.

Covert (unmarked car) operations

During July 1995-June 1996 the largest casualty crash reductions occurred during times and in locations where the mobile radar enforcement was *covert* (unmarked cars). A net 11.8% reduction was found for crashes occurring on the same day or up to 4 days after the mobile radar enforcement was *covert*. This effect was stronger 1-4 days after the enforcement (i.e. a net 20.7% reduction) rather than on the same day (i.e. a net 3.7% reduction). However, none of these reductions were statistically significant.

Overt (marked car) operations

Casualty crash reductions were also found during times and in TOG regions where marked cars were in operation for the first period of increased mobile radar enforcement (Figure 3.2). However these reductions were smaller than those found for the unmarked car analysis, and were also not statistically significant.

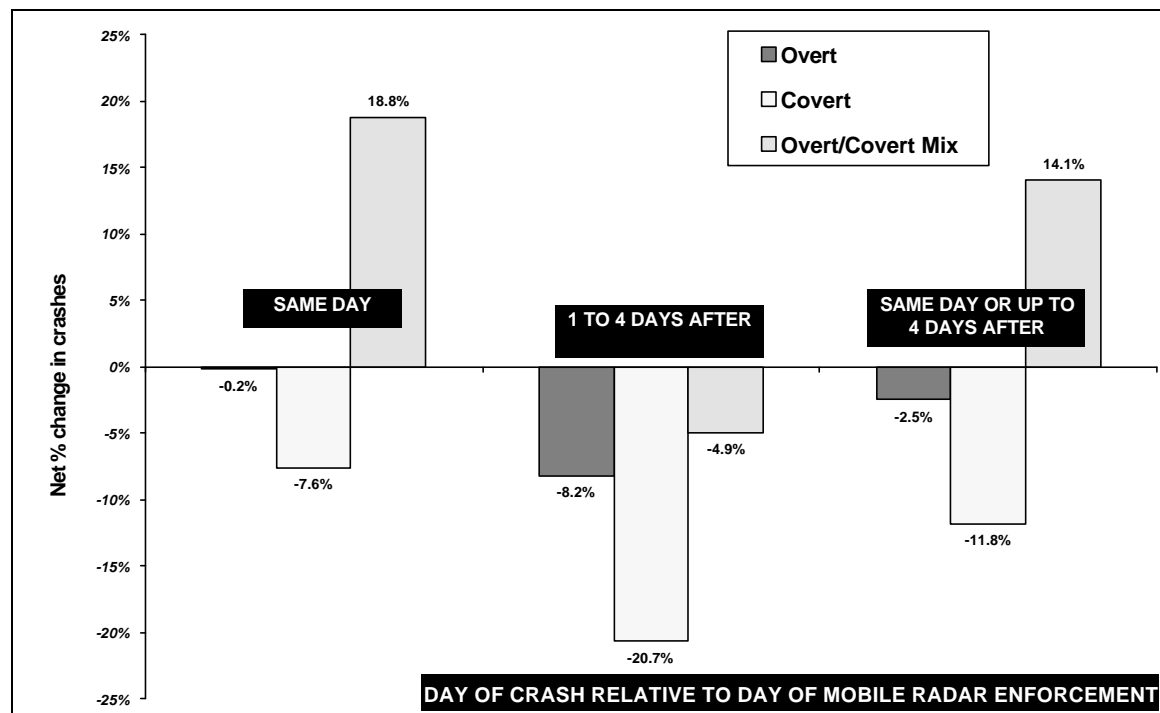
Table 4.3: Casualty crashes occurring during the July 1995-June 1996 (Period A) of increased mobile radar enforcement (overt, covert or both), in rural Victoria

OVERT ENFORCEMENT (marked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1992- June 1993 (PRE- mobile radar period)	July 1995- June 1996 (DURING mobile radar period)	
Same day as MMR activity	Treatment	892	815	-0.2%
	Control	189	173	
1 to 4 days after MMR activity	Treatment	350	294	-8.2%
	Control	189	173	
Same day or up to 4 days after MMR activity	Treatment	1242	1109	-2.5%
	Control	189	173	
COVERT ENFORCEMENT (unmarked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1992- June 1993 (PRE- mobile radar period)	July 1995- June 1996 (DURING mobile radar period)	
Same day as MMR activity	Treatment	130	127	-7.8%
	Control	35	37	
1 to 4 days after MMR activity	Treatment	62	52	-20.7%
	Control	35	37	
Same day or up to 4 days after MMR activity	Treatment	192	179	-11.8%
	Control	35	37	
MIX OF OVERT & COVERT ENFORCEMENT (marked & unmarked cars)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1992- June 1993 (PRE- mobile radar period)	July 1995- June 1996 (DURING mobile radar period)	
Same day as MMR activity	Treatment	109	111	+18.8%
	Control	14	12	
1 to 4 days after MMR activity	Treatment	27	22	-4.9%
	Control	14	12	
Same day or up to 4 days after MMR activity	Treatment	136	133	+14.1%
	Control	14	12	

A mix of covert and overt operations

A net 4.9% reduction was found only for crashes occurring 1-4 days after *both* marked and unmarked cars were conducting mobile radar operations on a particular day and in a particular TOG region of rural Victoria during July 1995-June 1996. There was no evidence of crash reductions on the day of enforcement, however.

Figure 4.2: Net % change in casualty crashes occurring during July 1995-June 1996 (PERIOD A) in rural regions of Victoria during times when the mobile radar enforcement was OVERT, COVERT or a MIX of overt/covert.



Hence, similar to the analysis that looked at the combined periods of increased mobile radar enforcement (July 1995-June 1997), casualty crash reductions during Period A (July 1995-June 1996) were more evident during times and in regions where the mobile radar enforcement was covert (i.e. conducted via unmarked Police cars).

4.8.3 Crash effects during July 1996-June 1997 (Period B)

A similar analysis was undertaken for the second period of increased mobile radar enforcement, July 1996-June 1997, when there were 73 mobile radar devices in operation. The findings of this analysis are given in Table 4.4 and Figure 4.3 in which the crash effects were estimated when *overt*, *covert* or *both* types of mobile radar enforcement were in operation during Period B.

Table 4.4: Casualty crashes occurring during the July 1996-June 1997 (Period B) of increased mobile radar enforcement (overt, covert or both), in rural Victoria

OVERT ENFORCEMENT (marked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1993- June 1994 (PRE- mobile radar period)	July 1996- June 1997 (DURING mobile radar period)	
Same day as MMR activity	Treatment Control	657 94	650 84	+10.7%
1 to 4 days after MMR activity	Treatment Control	248 94	207 84	-6.6%
Same day or up to 4 days after MMR activity	Treatment Control	905 94	857 84	+6.0%
COVERT ENFORCEMENT (unmarked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1993- June 1994 (PRE- mobile radar period)	July 1996- June 1997 (DURING mobile radar period)	
Same day as MMR activity	Treatment Control	214 26	188 21	+8.8%
1 to 4 days after MMR activity	Treatment Control	81 26	54 21	-17.5%
Same day or up to 4 days after MMR activity	Treatment Control	295 26	242 21	+1.6%
MIX OF OVERT & COVERT ENFORCEMENT (marked & unmarked cars)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change
		July 1993- June 1994 (PRE- mobile radar period)	July 1996- June 1997 (DURING mobile radar period)	
Same day as MMR activity	Treatment Control	267 12	213 16	-40.2%
1 to 4 days after MMR activity	Treatment Control	44 12	43 16	-26.7%
Same day or up to 4 days after MMR activity	Treatment Control	311 12	256 16	-38.3%

Covert (unmarked car) operations

There was evidence of a net percentage reduction only for casualty crashes occurring 1-4 days after the covert mobile radar enforcement was present during July 1996-June 1997. A net 17.5% reduction was found which, however, was not statistically significant. There was no evidence of crash reductions on the day of covert enforcement.

Overt (marked car) operations

A net 6.6% reduction was found only for crashes occurring 1-4 days after the overt mobile radar enforcement was present during July 1996-June 1997. However, there was no evidence of a crash reduction on the day of overt mobile radar enforcement.

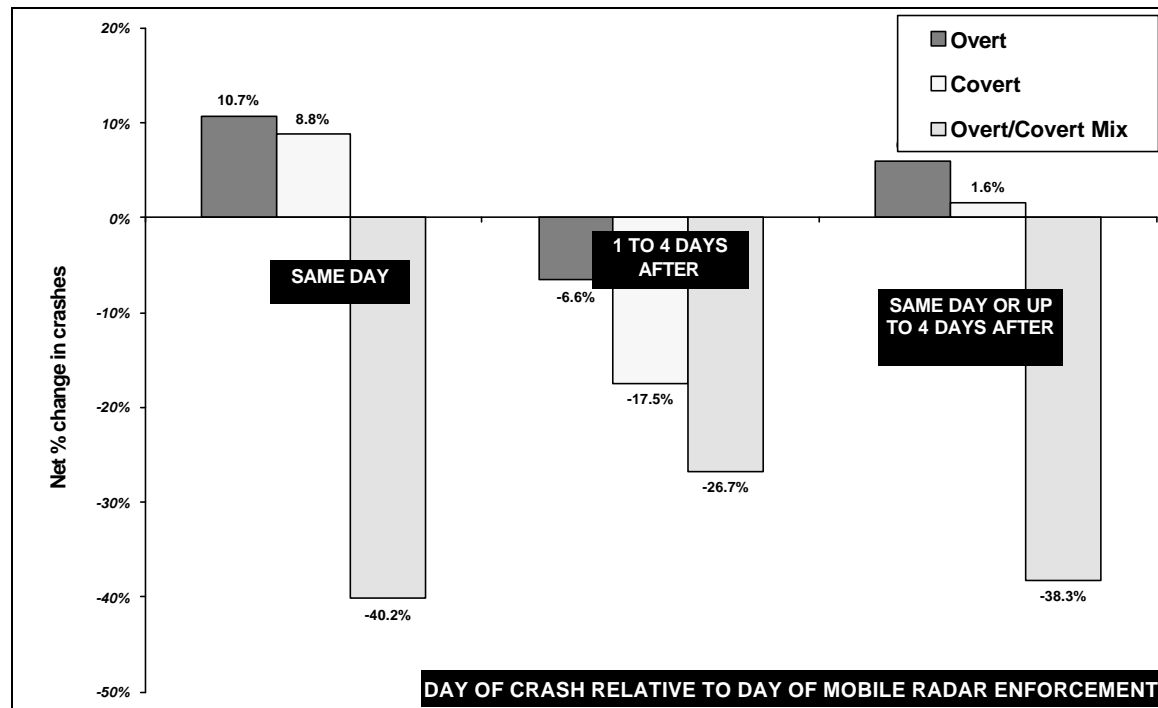
A mix of covert and overt operations

When both marked and unmarked Police cars were conducting mobile radar operations on a particular day and in a particular TOG region of rural Victoria during July 1996-June 1997, a net 38.3% reduction was found for crashes occurring on the same day or up to four days after the enforcement was present. This effect was stronger on the day of enforcement (i.e. a net 40% reduction) than 1-4 days after the enforcement (i.e. a net 26.7% reduction). However, none of these reductions were statistically significant.

These findings suggest that in Period B (July 1996-June 1997) crash reductions were most evident 1-4 days after the mobile radar enforcement was present in rural Victoria. This was the case when *only overt* or *only covert* enforcement was in operation.

The largest casualty crash reductions, however, were found during times when *both marked and unmarked* Police cars were in operation in rural TOG regions, especially on the day of mobile radar enforcement.

Figure 4.3: Net % change in casualty crashes occurring during July 1996-June 1997 (PERIOD B) in rural regions of Victoria during times when the mobile radar enforcement was OVERT, COVERT or a mix of overt/covert.



4.8.4 Interactions with Mobile Radar Publicity Awareness

In Diamantopoulou, Cameron and Shtifelman (1998a & 1998b) the strongest effects on casualty crashes occurred when the mobile radar enforcement was accompanied by high awareness levels of specific mobile radar road safety advertising during July 1996-June 1997. In view of this finding the effects of the mobile radar enforcement (overt, covert and both) were investigated during times of *high* levels of mobile radar publicity awareness.

Table 4.5 and Figure 4.4 depict the net percentage change in casualty crashes when the overt, covert or mix of overt/covert mobile radar enforcement was accompanied by *high* levels of mobile radar publicity awareness for crashes occurring on:

- i. The same day as the enforcement;
- ii. One, two, three or four days after the enforcement;
- iii. The same day or up to four days after the enforcement.

In Table 4.5 and Figure 4.4, 90% confidence limits have been placed on each net percentage change estimate, based on the assumption that the logarithm of the odds ratio⁷ is Normally distributed (Breslow and Day, 1980). The confidence interval provides an estimate of the accuracy of the estimated net percentage change.

Covert (unmarked car) operations

A net 24.8% crash reduction was found for weeks when high awareness levels of mobile radar publicity accompanied the covert mobile radar enforcement. This effect was strongest one to four days after the enforcement (i.e. a net 48.4% reduction was found) rather than on the same day (i.e. a net 16.7% reduction). However, none of these net percentage reductions were statistically significant.

Overt (marked car) operations

A net 21.2% reduction was found for crashes occurring *1-4 days after the overt* mobile radar enforcement was present during times of high mobile radar publicity awareness. This reduction, however, was not statistically significant. There was no evidence of a crash reduction on the day of overt mobile radar enforcement.

A mix of covert and overt operations

When the enforcement was accompanied by high levels of mobile radar publicity awareness, the strongest (and largest) crash reductions occurred when *both* marked and unmarked Police cars were conducting mobile radar operations on a particular day and in a particular TOG region of rural Victoria.

⁷ Odds ratio is an alternative way of expressing the net percentage change.

Under these circumstances, a marginally statistically significant ($p=0.0641$) net 71.3% reduction⁸ was found for crashes occurring on the *same day or up to four days* after the enforcement was present. This effect was strongest on the *day* when there was a mix of overt/covert mobile radar enforcement in operation. A net 73.9% casualty crash reduction was found that was statistically significant ($p=0.0450$). However, as indicated by the 90% confidence limits placed on this estimate, this net % reduction could range from as low as a net 15% reduction to as high as a net 92% reduction.

A smaller net reduction of 50% was found for crashes occurring 1-4 days after the enforcement, however this reduction was not statistically significant.

A similar analysis was undertaken for times when *low*⁹ awareness levels of mobile radar publicity accompanied the enforcement. This analysis found evidence of casualty crash reductions only when a *mix of overt and covert* mobile radar enforcement was operating in rural TOG regions of Victoria at times of low mobile radar publicity awareness. Under these circumstances, a net 23.6% reduction in casualty crashes that occurred on the same day or up to four days after the enforcement was found. This reduction however, was not statistically significant.

There was no evidence of crash reductions when *only* marked car (overt) or *only* unmarked car (covert) mobile radar enforcement was in operation during weeks when low awareness levels of mobile radar publicity accompanied the enforcement.

The statistical significance of the interaction of the effects of the enforcement with the levels of mobile radar publicity was tested using third-order contingency table analysis methods (Bishop et al, 1975 and Christensen, 1990). Log-linear categorical models were fitted to the casualty crashes to test the three-way interaction between:

- the group effect (i.e. treatment vs. control),
- the time period effect (i.e. Pre-mobile radar vs. During mobile radar) and
- the high mobile radar publicity awareness effect (i.e. present or absent).

The statistical significance of the interaction was assessed using the statistical software package GLIM (Aitkin et al, 1990).

A log-linear model fitted to the crashes to test for a three-way interaction between group, time period and mobile radar publicity awareness found marginally statistically significant interactions for casualty crashes occurring:

- on the same day as the mix of overt and covert mobile radar enforcement ($p=0.1057$),
- on the same day or up to 4 days after the mix of overt and covert mobile radar enforcement ($p=0.1229$).

⁸ It should be noted that with 90% confidence, the true value of the estimated net 71.3 % reduction lies in the range of a net 91.2% reduction to a net 6.9% reduction, as indicated by the confidence limits placed on this estimate.

⁹ Achieving weekly mobile radar advertising awareness levels of fewer than 250 Adstock units.

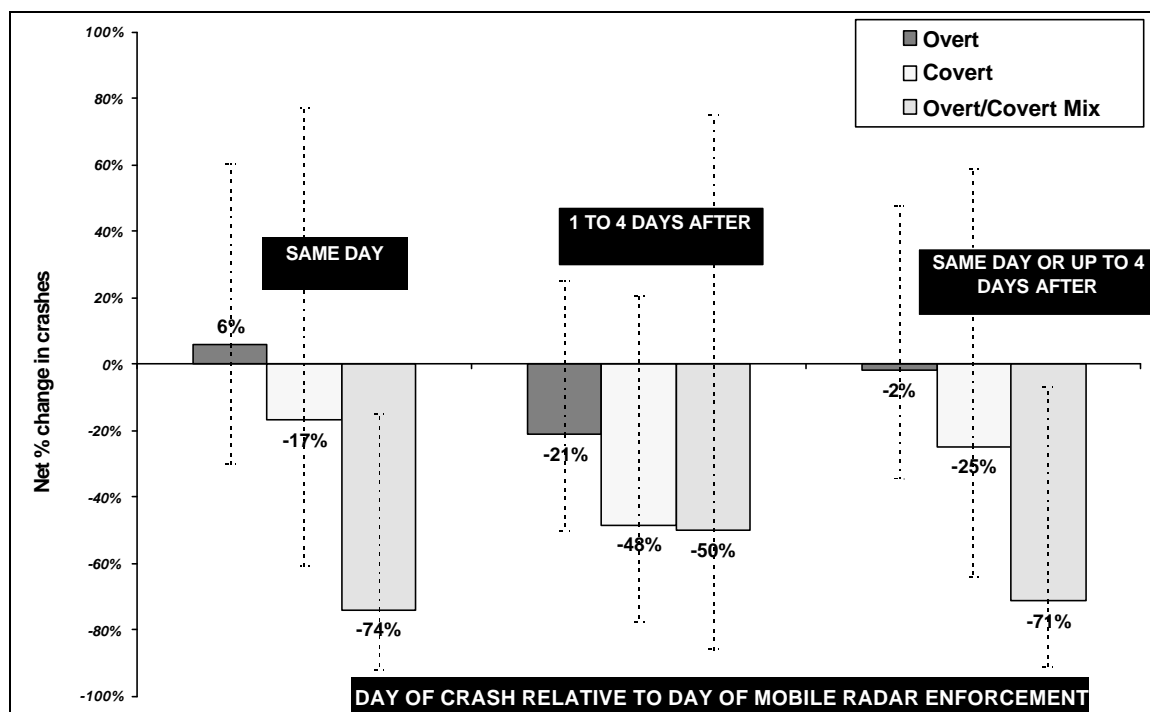
Table 4.5: Casualty crashes occurring during the second period of increased mobile radar enforcement (overt, covert or both), July 1996-June 1997 at times of HIGH MOBILE RADAR publicity awareness in rural TOG Regions of Victoria.

OVERT ENFORCEMENT (marked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change with 90% confidence limits
		July 1993- June 1994 (PRE-mobile radar period)	July 1996- June 1997 (during mobile radar period)	
Same day as MMR activity	Treatment	257	272	5.8% (-30.0%, 60.0%)
	Control	36	36	
1 to 4 days after MMR activity	Treatment	99	78	-21.2% (-50.3%, 24.9%)
	Control	36	36	
Same day or up to 4 days after MMR activity	Treatment	356	350	-1.7% (-34.6%, 47.7%)
	Control	36	36	
COVERT ENFORCEMENT (unmarked cars only)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change with 90% confidence limits
		July 1993- June 1994 (PRE-mobile radar period)	July 1996- June 1997 (during mobile radar period)	
Same day as MMR activity	Treatment	108	99	-16.7% (-60.8%, 77.2%)
	Control	10	11	
1 to 4 days after MMR activity	Treatment	37	21	-48.4% (-77.9%, 20.4%)
	Control	10	11	
Same day or up to 4 days after MMR activity	Treatment	145	120	-24.8% (-64.4%, 58.8%)
	Control	10	11	
MIX OF OVERT & COVERT ENFORCEMENT (marked & unmarked cars)				
Day of 'Treatment' Crash	Crash Group	Time Period		Net % Change with 90% confidence limits
		July 1993- June 1994 (PRE-mobile radar period)	July 1996- June 1997 (during mobile radar period)	
Same day as MMR activity	Treatment	205	107	-73.9% ** (-92.0%, -15.1%)
	Control	3	6	
1 to 4 days after MMR activity	Treatment	25	25	-50.0% (-85.7%, 75.0%)
	Control	3	6	
Same day or up to 4 days after MMR activity	Treatment	230	132	-71.3%* (-91.2%, -6.9%)
	Control	3	6	

**Statistically significant net % reduction (p=0.0450)

*Marginally statistically significant net % reduction (p=0.0641).

Figure 4.4: Net % change (& 90% confidence limits) in casualty crashes occurring during July 1996-June 1997 (PERIOD B) in rural TOG regions of Victoria during times when the mobile radar enforcement was OVERT, COVERT or a MIX of overt/covert, and at times of HIGH MOBILE RADAR publicity awareness.



4.9 SUMMARY OF CRASH EFFECTS

4.9.1 Crash effects during July 1995-June 1997

During the combined periods of increased mobile radar enforcement (i.e. July 1995-June 1997), reductions in casualty crashes were more evident when the mobile radar enforcement was *covert* (i.e. unmarked cars) than overt. This was particularly the case 1 to 4 days after the enforcement was present in a particular TOG region of rural Victoria. Under these circumstances, when *up to 73* mobile radar devices were in operation, a net 22% reduction in casualty crashes was found. Reductions were also evident when a *mix* of both overt and covert mobile radar enforcement was in operation. However, overt (marked cars) mobile radar enforcement on its own was not as effective.

4.9.2 Crash effects during July 1995-June 1996

A similar result was found during the first period of increased mobile radar enforcement, July 1995-June 1996 when there were 48 mobile radar units operating in patrol cars. Casualty crash reductions for this enforcement period were more evident during times and in rural regions where the mobile radar enforcement was covert (i.e.

conducted via unmarked Police cars). A net 20.7% reduction for crashes occurring 1-4 days after the presence of the covert enforcement was found.

4.9.3 Crash effects during July 1996-June 1997

During the second period of increased mobile radar enforcement (i.e. July 1996-June 1997) when 73 units were in operation, crash reductions were most evident 1-4 days after the mobile radar enforcement was present in rural Victoria. This was the case when *only overt* or *only covert* enforcement was operating.

The largest casualty crash reductions, however, were found during times when *both marked and unmarked* Police cars were in operation in rural TOG regions, especially on the day of mobile radar enforcement, i.e. a net 40% reduction in casualty crashes was found.

Although none of the above findings were statistically significant, they are indicative of weak casualty crash reductions occurring during times and in rural TOG regions, particularly when there was either:

- **Covert** enforcement (i.e. unmarked mobile radar cars), or
- A **mix of covert and overt** enforcement (i.e. unmarked and marked mobile radar cars).

4.9.4 Interactions with Mobile Radar Publicity

When the enforcement was accompanied by *high* levels of mobile radar publicity awareness, the strongest (and largest) crash reductions occurred when *both* marked and unmarked Police cars were conducting mobile radar operations on a particular day and in a particular TOG region of rural Victoria during the second enforcement period, July 1996-June 1997.

Under these circumstances, a marginally statistically significant ($p=0.0641$) net 71.3% reduction¹⁰ was found for crashes occurring on the *same day or up to four days* after the enforcement was present. This effect was strongest on the *day* when there was a mix of overt/covert mobile radar enforcement in operation. A net 73.9% casualty crash reduction was found that was statistically significant ($p=0.0450$). However, as indicated by the 90% confidence limits placed on this estimate, this net % reduction could range from as low as a net 15% reduction to as high as a net 92% reduction.

A smaller net reduction of 50% was found for crashes occurring 1-4 days after the enforcement, however this reduction was not statistically significant.

Non-statistically significant crash reductions were also found during times when:

¹⁰ It should be noted that with 90% confidence, the true value of the estimated net 71.3 % reduction lies in the range of a net 91.2% reduction to a net 6.9% reduction, as indicated by the confidence limits placed on this estimate.

- *only overt* enforcement, or
- *only covert* enforcement

was accompanied by high mobile radar publicity awareness levels. This was especially evident 1-4 days after the presence of the mobile radar enforcement in rural TOG regions.

4.10 LIMITATIONS OF THE STUDY

It should be noted that the effects on road trauma estimated in this study (as in Diamantopoulou, Cameron and Shtifelman, 1998a & 1998b) may be somewhat conservative in nature because of the following decisions that were made to facilitate the evaluation:

- *All* casualty crashes were examined rather than a subset that, presumably, was speed-related (assuming such crashes can be defined).
- All undivided, 100 km/h speed limit roads in the regions thought to be covered by mobile radar operations were included rather than those where the enforcement actually took place.
- The control group was restricted to crashes that occurred on the same roads and regions as the mobile radar enforcement but during days that were considered to be uninfluenced by the enforcement. Because the operations were so frequent, this limited the number of crashes that could be considered as ‘control’ crashes.
- Although the study compared crashes that occurred during the period of mobile radar enforcement with the period when there was no mobile radar enforcement, other types of speed enforcement (such as speed cameras or hand-held radars) may have been operating on the same roads during the pre-period that may not have been accounted for by changes in the control crashes.
- The analysis assumed that crashes were exclusively influenced by the most recent mobile radar enforcement present in a particular region. This most recent enforcement was considered to over-ride any enforcement that occurred one to four days earlier, which also may have influenced the crashes. Given that a four-day residual effect on crashes was found in the analysis, the most recent enforcement may not necessarily have been the most important in influencing crash frequencies.

5. CONCLUSION

The evaluation of mobile radar enforcement and supporting publicity found evidence of casualty crash reductions during July 1995-June 1997 in rural TOG regions of Victoria, particularly when the speed enforcement operations were either:

- covert (unmarked patrol cars) or
- a mix of overt and covert (marked and unmarked patrol cars).

The strongest effects on casualty crashes occurred when a mix of overt and covert mobile radar enforcement was accompanied by high awareness levels of mobile radar publicity during July 1996-June 1997. Under these circumstances, a marginally statistically significant ($p=0.0641$) net 71.3% reduction was found for crashes occurring on the *same day or up to four days* after the enforcement was present. This effect was strongest on the *day* when there was a mix of overt/covert mobile radar enforcement in operation. A net 73.9% casualty crash reduction was found that was statistically significant ($p=0.0450$).

Crash reductions were also evident when interactions with the levels of mobile radar publicity were *not* considered. However the effects were smaller and weaker than those that were found when high awareness levels of mobile radar publicity accompanied the overt/covert mix of mobile radar enforcement.

6. REFERENCES

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APPENDIX

TOG-DEFINED REGIONS: Local Government Areas (LGAs) covered by each TOG Station with Mobile Radar Equipment

**The Local Government Areas Covered by each TOG Station
with Mobile Radar Equipment**

METROPOLITAN

POLICE DISTRICT	DIVISION	TOG Station	LGAs (pre-1995) covered by the TOG
E	1	EDG Dandenong	City of Dandenong Shire of Pakenham City of Berwick
E	2	EWI Wonthaggi	Wonthaggi Borough Phillip Island City of Cranbourne Shire of Bass
F	2	FKN Knox	Shire of Healesville Shire of Lilydale Shire of Upper Yarra Shire of Sherbrooke
H	2	HEP Epping	Shire of Whittlesea
J	2	JML Melton	Shire of Melton Shire of Werribee Shire of Bacchus Marsh
K	1	KGL Geelong	City of Geelong City of Geelong West City of Newtown Queenscliffe Borough Shire of Bannockburn Shire of Leigh Shire of Bellarine
K	1	KTY Torquay	City of South Barwon Shire of Barrabool Shire of Winchelsea
K	2	KCI Corio	Shire of Corio

**The Local Government Areas Covered by each TOG Station
with Mobile Radar Equipment**

RURAL

POLICE DISTRICT	DIVISION	TOG Station	LGAs (pre-1995) covered by the TOG
L	1	LCO Colac	Colac City Colac Shire Otway Shire Heytesbury Shire Camperdown Shire Hampden Shire
L	1	LWB Warrnambool	Warrnambool City Warrnambool Shire Mortlake Shire
L	2	LHA Hamilton	Hamilton City Dundas Shire Glenelg Shire Wannon Shire Mt. Rouse Shire
L	2	LPL Portland	Portland City Heywood Shire Belfast Shire Port Fairy Borough Minhamite Shire
M	1	MAR Ararat	Ararat City Ararat Shire Ripon Shire
M	1	MBA Ballarat	Ballarat City Ballarat Shire Sebastopol Borough Bungaree Shire Ballan Shire Buninyong Shire Grenville Shire Lexton Shire Talbot & Clunes Shire Creswick Shire Daylesford & Glenlyon Shire
M	2	MSW Stawell	Stawell City Stawell Shire Avoca Shire Kara Kara Shire St. Arnauds City Donald Shire
M	2	MHM Horsham	Horsham City Wimmera Shire Arapiles Shire Kowree Shire Kaniva Shire Lowan Shire Dimboola Shire Warracknabeal Shire Dunmunkle Shire
N	1	NMB Mildura	Mildura City Mildura Shire Walpeup Shire Karkaroc Shire
N	2	NSH Swan Hill	Swan Hill City Swan Hill Shire Kerang Borough Kerang Shire Wicheproof Shire Birchip Shire

**The Local Government Areas Covered by each TOG Station
with Mobile Radar Equipment (continued...)**

RURAL

POLICE DISTRICT	DIVISION	TOG Station	LGAs (pre-1995) covered by the TOG
O	1	OBO Bendigo	Bendigo City Eaglehawk Borough Marong Shire Strathfieldsaye Shire Korong Shire Charton Shire Huntly Shire Mclvor Shire Pyalong Shire Bet Bet Shire Newstead Shire Maldon Shire Tullaroop Shire Maryborough City
O	1	OKY Kyneton	Kyneton Shire Newham & Woodend Shire Romsey Shire Metcalf Shire Castlemaine City
O	2	OEC Echuca	Echuca City Rochester Shire Cohuna Shire Gordon Shire East Loddon Shire Deakin Shire Kyabram City
O	2	OSH Shepparton	Shepparton City Shepparton Shire Rodney Shire Nathalia Shire Numurkah Shire Cobram Shire Tungamah Shire Waranga Shire
P	1	PWA Wodonga	Wodonga City Chiltern Shire Yackandandah Shire Tallangatta Shire Upper Murray Shire
P	1	PWN Wangaratta	Wangaratta City Wangaratta Shire Oxley Shire Yarrowonga Shire Beechworth Shire Rutherglen Shire Myrtleford Shire Bright Shire
P	2	PBN Benalla	Benalla City Benalla Shire Violet Town Euroa Shire
P	2	PMF Mansfield	Mansfield Shire Yea Shire Alexandra Shire
P	2	PSY Seymour	Seymour Shire Goulbourn Shire Broadford Shire Kilmore Shire

**The Local Government Areas Covered by each TOG Station
with Mobile Radar Equipment (continued...)**

RURAL

POLICE DISTRICT	DIVISION	TOG Station	LGAs (pre-1995) covered by the TOG
Q	1	QKM Korumburra	Korumburra Shire Woorayl Shire South Gippsland Shire Mirboo Shire
Q	1	QMW Morwell	Morwell Shire Traralgon Shire Moe City Yallourn Works Taralgon City Alberton Shire
Q	1	QWG Warragul	Warragul Shire Buln Buln Shire Narracan
Q	2	QBL Bairnsdale	Bairnsdale City Bairnsdale Shire Omeo Shire Tambo Shire
Q	2	QOB Orbost	Orbost Shire
Q	2	QSA Sale	Sale City Rosedale Shire Maffra Shire Avon Shire