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Do targeted arrests reduce crime?

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In January 1998 the New South Wales Police Service introduced a new crime fighting strategy, modelled on the New York 'Compstat' process. The strategy involves a series of 'Operation and Crime Review Panels' (OCRs) in which senior police provide Local Area and Regional Commanders with information on crime trends and patterns in their local area and ask them to devise various tactics and strategies to reduce crime. At a later point in time the same commanders return to the OCR panels and their performance in reducing crime is reviewed by senior management. This paper examines the impact of OCR panels on the rate of recorded incidents for four offence categories in New South Wales. The results suggest that OCR panels have been effective in reducing the incidence of break and enter, motor vehicle theft and armed robbery.

BACKGROUND

In the mid-1990s New South Wales (NSW) began to experience a rapid growth in most major categories of recorded crime. Between 1995 and 1997, assaults rose 39 per cent, robberies rose 65 per cent, household break-ins rose 30 per cent and motor vehicle thefts rose 18 per cent (Doak, 2000). These increases generated considerable public concern, especially as they were much more pronounced in NSW than in any other Australian State (Australian Bureau of Statistics, 1998; 1996). Public concern about crime in NSW was further exacerbated by the fact that a Royal Commission of Inquiry during the second half of the 1990s had revealed evidence of police corruption in NSW (Wood, 1997).

In January 1998, under a new Police Commissioner appointed from Britain, the NSW Police Service introduced a local version of the well known New York 'Compstat' process, known as Operation and Crime Review (OCR) panels. These panels involved periodic meetings between senior police management and Local Area (LA) commanders. At these meetings senior police confront commanders with data on the latest crime trends in their patrols and highlight crime hotspots. Commanders are asked to provide an account of the strategies they are employing to reduce crime and, where necessary, enjoined to develop more effective strategies. At subsequent meetings, the strategies they employed to reduce crime are reviewed in the light of fresh evidence about trends in, and the spatial distribution of, crime in their area.

While the OCR management process was modelled on the New York Compstat process, NSW police were not encouraged to pursue 'zero tolerance' policing.[1] Three strategies were strongly emphasised by senior police management. Firstly, police were urged to focus their resources and operations on 'hot times and hot places'. Secondly, they were encouraged to conduct frequent searches for illegal weapons among those suspected of carrying them in public places. Finally, they were urged to employ all available legal avenues to effect the arrest of known repeat offenders. To facilitate this last strategy, LA commanders were given lists of residents in their area who had three or more convictions or an outstanding first instance warrant and/or who were thought by police intelligence analysts to be criminally active. These people then became the focus of local criminal investigation teams.

Perhaps because of the large number of outstanding warrants and the fact that arresting people on outstanding warrants comes naturally to police, the strategy of targeting repeat offenders proved particularly popular. Complete information is not available but in the two years following introduction of the OCR process, the number of offenders appearing in the NSW Local Courts who had some kind of prior criminal record increased by almost 30 per cent per annum (New South Wales Bureau of Crime Statistics and Research, 2000). This change produced a substantial increase in the prison population. In the 12 months June 1998 to June 1999 the NSW prison population rose 13 per cent, following a five-year period during which it had been quite stable (Lind *et al*. 2001).

In the two years following the introduction of OCR panels police recorded no increase in any category of crime. However, several major categories of crime showed substantial decreases. Reports of robbery with a firearm fell by 24 per cent, robbery with a weapon other than a firearm fell by 20 per cent, home break-ins fell by 10 per cent, motor vehicle theft fell by 11 per cent, indecent assault fell by 16 per cent and sexual assault fell by 10 per cent (Doak, 2001). The changes were not uniformly reflected in other States (Australian Bureau of Statistics, 2000). Not surprisingly, therefore, NSW police argued that they were responsible for producing the dramatic turnaround in crime (Darcy, 1999).

For obvious reasons the coincidence of OCR panels and falling crime rates cannot be taken as unequivocal evidence of their success. A number of studies have found evidence that property crime rates are strongly influenced by economic factors such as gross domestic product and unemployment (Field, 1999; Belknap, 1989; Chiricos, 1987; Deadman and Pyle, 1997; Fagan and Freeman, 1999; Kapuscinski *et al*. 1998; Pyle and Deadman, 1994). During the second half of the 1990s Australia experienced a combination of strong economic growth and falling unemployment. It is possible, then, that the shift in crime trends observed to occur with the introduction of OCR panels was the result of these conditions rather than the result of a change in policing.

The present study was designed to provide a more rigorous assessment of the effect of the introduction of OCR panels on NSW property crime. Specifically, we sought to test the effect of OCRs on crime, controlling for a range of economic and social variables which might have otherwise explained the downward trend in crime observed after their introduction. Before describing the study in detail, however, it will be useful to conduct a brief review of the research literature on targeted arrest policies and crime.

PREVIOUS RESEARCH

Most studies of the effect of arrest on crime have examined the general relationship between arrest and crime rates, working on the assumption that the higher the arrest rate the greater the perceived risk of apprehension. Early studies overwhelmingly favoured the view that higher arrest rates produce lower crime rates (Logan 1975; Blumstein *et al*. 1978) but the results of more recent and more rigorous studies, however, have generally been mixed (see Nagin, 1998 for a full review). Some show evidence that arrest has a suppression effect on crime (Wilson and Borland, 1978; Marvell and Moody, 1996; Sampson and Cohen, 1988) but others show no effect at all (e.g., Chamblin, 1988).

As Farrell, Chenery and Pease (1998) point out, there are good reasons for expecting arrest to be more effective in controlling crime when it is targeted at certain locations or individuals. Firstly, a small number of places have been found to account for a disproportionate amount of crime (e.g., Sherman *et al*. 1989). Secondly, a small number of offenders have been found to account for a disproportionate number of offences (e.g., Farrington, 1992). Thirdly, frequent offenders are often the most persistent offenders (Wolfgang and Collins, 1979). Fourthly, repeat offenders often commit a wide variety of different crimes (Farrington, 1992). The last three considerations suggest that the incapacitation of repeat offenders could exert a substantial (even if only transient) suppression effect on many different kinds of crime.

Randomised experiments have shown targeted arrest policies to be effective, at least in some circumstances, in reducing the incidence of domestic violence (Sherman and Berk, 1992) and in controlling illicit drug markets (Weisburd and Green, 1995; Sherman and Rogan, 1995). There is also some evidence that police patrols targeted at crime 'hotspots' can be effective in reducing crime (Koper, 1995; Sherman and Weisburd, 1995). These interventions, however, do not necessarily involve the deliberate use of arrest to reduce crime or the deliberate targeting of repeat offenders for arrest. Indeed, despite the theoretical promise of targeted arrest policies directed at repeat offenders, only one study appears to have examined the effect of targeting repeat offenders on crime. Most studies have examined more intermediate outcomes.

Martin and Sherman (1986), for example, conducted an experiment designed to evaluate a repeat offender project (named ROP) carried out by the Metropolitan Police Department of Washington D.C. The objective of ROP was to identify and apprehend active recidivists. To achieve this objective the police involved in the study created a special unit whose specific task was to draw up lists of potential targets and then attempt to gather evidence which would warrant their arrest and prosecution. The experimental design required ROP officers to randomly divide their list of potential targets into two groups, one of which became their focus of interest while the other (control) were designated off-limits to ROP officers but could be investigated, arrested and prosecuted by any other police.

Despite some difficulties with the random assignment, the results of the study provided moderately strong evidence that ROP increased the likelihood of arrest of targeted repeat offenders. More importantly, ROP-initiated arrests were shown to be more likely than control group arrests to result in prosecution and conviction as felonies. Furthermore, those convicted were found to be more likely to receive a prison sentence and, if sentenced to prison, were more likely to receive a longer prison term. Against these findings, ROP was found to significantly lower the arrest productivity of officers involved in the project, primarily because police involved in the program generally effected fewer arrests for public order offences. This last result may, of course, have been a positive outcome.

Martin and Sherman's (1986) findings were replicated by Abrahamse *et al.* (1991). As part of the study, police in Phoenix drew up lists of potential arrest targets using information on their suspected current criminal activity, prior criminal record, lifestyle and substance use. A targeting committee vetted these lists and drew up a master list of suspects each of which was then randomly allocated into a treatment or the control group. As in the Washington D.C. experiment, those targeted for arrest (i.e. ROP arrests) were limited to the ROP team. The control group, on the other hand, were off-limits to that team but able to be arrested by any other police. Unlike the Washington D.C. experiment, prosecutors and probation officers were explicitly drawn into the experiment through the close sharing of information on suspects and their backgrounds.

Abrahamse *et al.* found that ROP targets were somewhat more likely to be convicted than their control group counterparts but, if convicted, were substantially more likely to receive a prison sentence and, if sent to prison, generally received much longer prison terms. They also obtained evidence that ROP targets were less likely to be granted pre-trial release (i.e. bail) although the difference was not statistically significant.

The findings obtained by Martin and Sherman (1986) and Abrahamse *et al.* (1991) are important because they demonstrate the feasibility of significantly increasing the arrest rate of repeat offenders. They also provide evidence which would lead one to expect an incapacitation effect. The critical issue, however, is whether targeting repeat offenders can be shown to reduce crime. Only one reported study appears to have examined this issue.

Farrell *et al*. (1998) evaluated a UK program designed to reduce the incidence of burglary in an area known as Boggart Hill, part of the Killingbeck area of Leeds. In that study, as in the present one, police were provided with a list of suspects who were either known burglars (i.e. had a prior record), were thought to be prolific offenders, were currently 'at large' and were known or suspected to be currently active in undertaking burglaries. The initial phase of the intervention involved targeting this group of offenders for arrest. During a second, 'consolidation' phase in the study, various targethardening measures were introduced to reduce the risk of repeat victimisation.

The study results indicated that the burglary rate in Boggart Hill, following the initial phase of the study, dropped by 62 per cent. Burglary rates also fell across neighbouring areas but not by anywhere near as much (41 per cent in one area, 18 per cent in another). Farrell *et al*. also provide evidence that the drop in burglary in neighbouring areas might have been the result of arresting repeat offenders in Boggart Hill. They also provide evidence that the policy of targeting repeat burglary offenders in Boggart Hill did have a suppression effect on at least one other form of crime (vehicle theft) in the area but did not appear to produce any spatial displacement of crime to neighbouring areas.

THE PRESENT STUDY

AIM

The present study had two aims. The first was to assess whether the advent of OCR panels reduced crime in NSW. The second was to assess whether the policy of targeting repeat offenders exerted any effect, over and above that produced by OCR panels. Unlike the study by Farrell *et al*. (1998) we were not in a position to conduct an experimental evaluation of the intervention strategy. It was simply introduced across the State as a whole, consequent upon the introduction of OCR panels. Thus while we are also interested in the effect of targeting repeat offenders on crime, those effects could not be assessed by experimental methods. They had to be assessed by conducting an interrupted time series analysis of police crime trend data for offences which showed a significant downturn in the period immediately following the introduction of the OCR panel.

VARIABLES

The dependent variables in the analysis were the reported numbers of (a) break and enter (dwelling and non-dwelling), (b) armed robbery (firearm and non-firearm), (c) motor vehicle theft and (d) sexual assault offences in the 48 months before the introduction of OCR panels and in the 18 months afterwards. These are the four offence categories which showed a statistically significant downward monthly trend over the twenty-four months to December 1999, with annual percentage decreases between 1998 and 1999 of 9 per cent, 10 per cent, 21 per cent and 10 per cent, respectively.

Three variables were employed to measure the effect of policing on crime. Two dummy variables were employed to measure the effect of OCRs on crime, the first indicating the point at which the OCR panels were introduced and the second indicating the point at which the second round of OCR panels commenced. The importance of this second round is that it could be seen as the first occasion in which the crime control strategies employed by LAC commanders came in for significant criticism.

Ideally, we would have liked some direct measure of the rate at which repeat offenders were being arrested by police. It proved impossible to obtain these data from police and the available court data on the arrest of repeat offenders are very limited in scope in that they provide no indication of the nature or length of the criminal record of those being arrested. To tap the effect of targeting repeat offences we therefore rely on the monthly number of people against whom the police prosecuted for an offence (either by way of an arrest, a summons or a court attendance notice).

As already noted, the choice of control variables is difficult because there is no consensus among researchers or theorists on the factors which influence temporal trends in crime. Past research, however, has highlighted the importance of variables measuring both the level of economic activity (Field, 1999), and unemployment (Chiricos, 1987; Kapuscinski *et al*. 1998). Measures of economic activity are important because they tap the level of demand for goods in general and therefore the ease with which stolen goods can be sold. Measures of unemployment are important because they tap the extent to which people may be motivated to commit property crime. Given the strong role which illicit drug use plays in the commission of property crime (Blumstein *et al*. 1986) it would also seem prudent to control for its effects on aggregate crime trends.

In the light of these considerations, and given our desire to be comprehensive in our inclusion of control variables, we included four measures of the demand for consumer goods (monthly retail sales of goods in department stores, clothing, household goods and recreational goods), one general measure of economic activity (monthly numbers of new motor vehicle registrations), four measures of unemployment (monthly unemploymentrate for all males, monthly unemployment rate for males aged 15-24, average monthly unemployment duration for all males, average monthly unemployment duration for males aged 15-24) and one measure of the size of the dependent heroin population (monthly admissions to methadone maintenance treatment). Data on the economic variables were obtained from the Australian Bureau of Statistics. Data on methadone admissions were kindly supplied by the National Drug and Alcohol Research Centre.

METHOD

In order to test the hypothesis that police activity had a significant downward influence on crime after the OCR process commenced, the statistical procedure of multiple regression modelling was used. The hypothesised linear relationship between crime and arrests is represented by equation (1) as follows:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \ldots + \beta_p X_{pt} + \varepsilon_t \qquad (1)$$

where

Y_t = the value of the dependent variable at time *t*

X_{it} = the value of the ith predictor variable at time *t*

ε_t = random error term

β_i = constants

The validity of the linear regression model described by equation (1) depends on a number of assumptions about the random error terms in the equation: namely, that the errors are normally distributed, exhibit no serial correlation, have zero mean, and are homoscedastic. The predictor variables in equation (1) include measures of police activity and other control variables. These control variables, as noted earlier, represent other potential sources of influence on the aggregate crime rate, such as the unemployment rate and unemployment duration measures, proxies for movements in economic activity, and retail sales turnovers. If the police activity variables are found to be statistically significant in the presence of these control variables, and the model assumptions are satisfied, then there is some evidence for attributing cause for the recent crime decrease in NSW, at least in part, to NSW police.

Figure 1: Monthly recorded incidents of break and enter, and arrests in NSW, July 1994 to December 1999

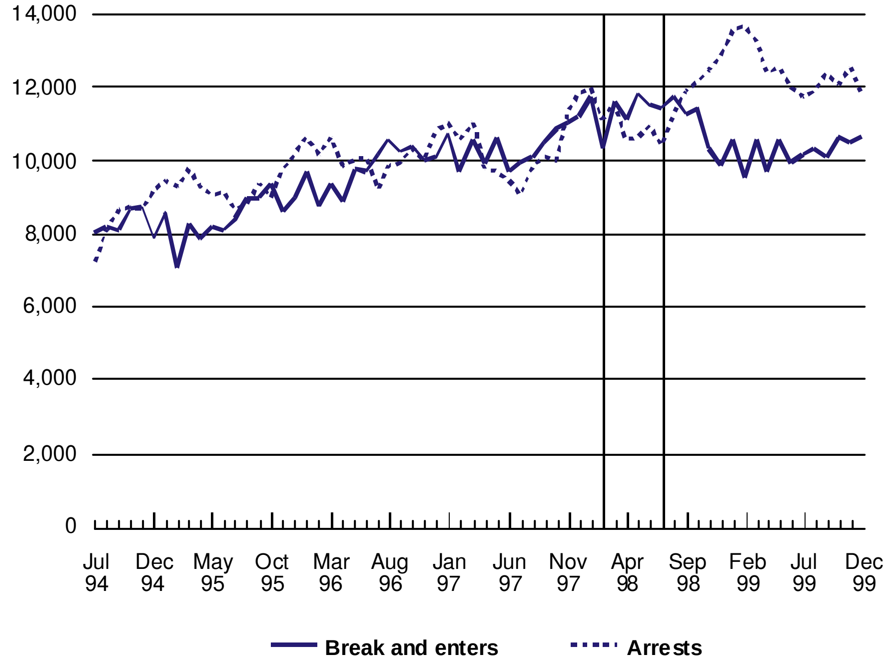


Figure 2: Monthly recorded incidents of motor vehicle theft, armed robbery, and sexual assault in NSW, July 1994 to December 1999

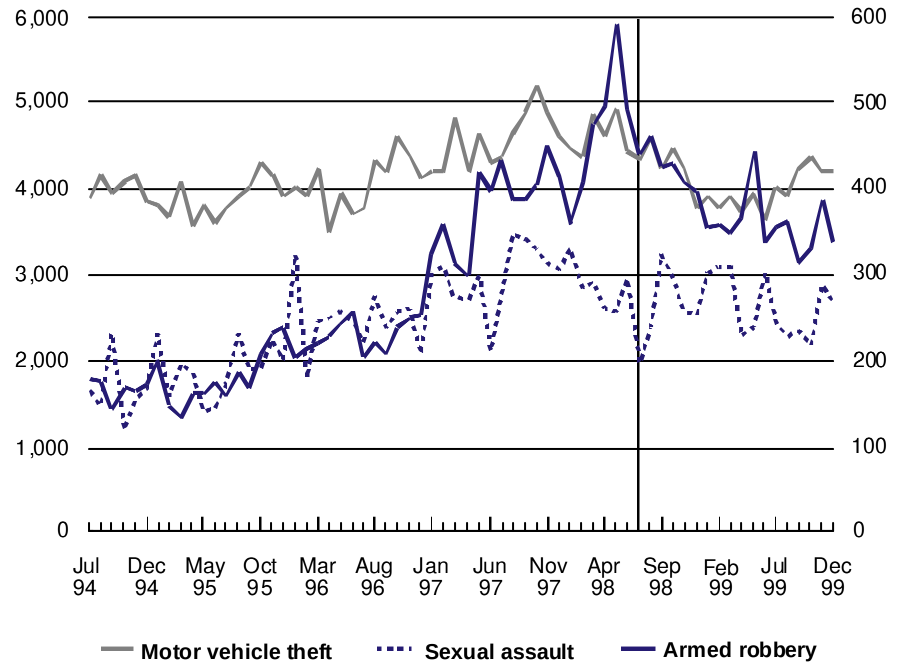
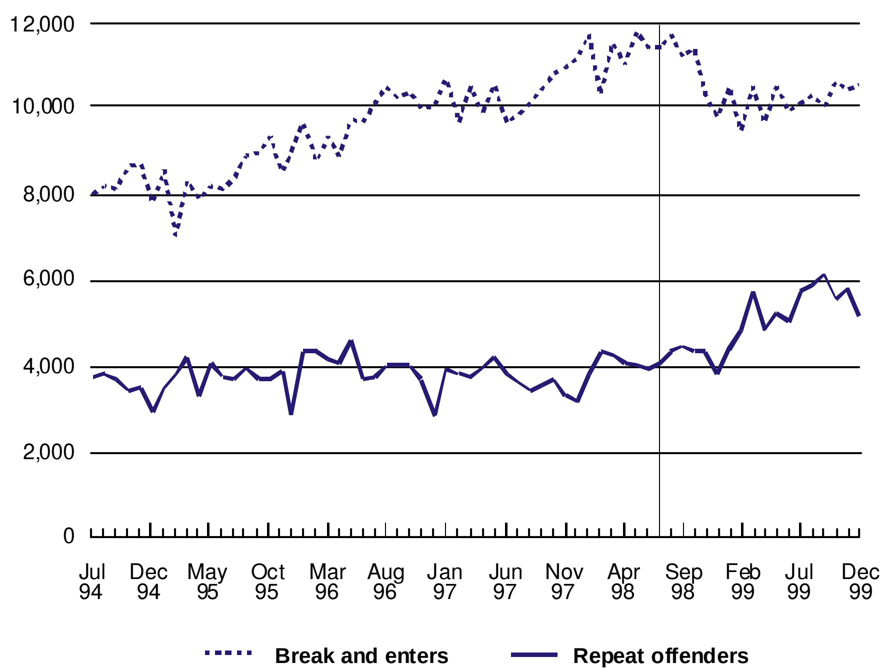


Figure 3: Monthly recorded incidents of break and enter, and NSW Local Court finalisations for persons with prior record, July 1994 to December 1999



RESULTS

Figure 1 shows the monthly trend in break and enters compared with the trend in arrests over the five-and-a-half year period, from July 1994 to December 1999. The two vertical lines in Figure 1 represent the commencement of the first and second rounds of OCRs in February and July 1998. From the graph, it is apparent that these two events also coincide with a change in the relationship between the crime and the arrest series. From July 1994 to January 1998, the two series increased together. The bivariate relationship between the two series (with arrests lagged by one month) for the 48 months to June 1998, as measured by the Pearson correlation coefficient, was positive and significant ($r = +0.669$, $p < 0.001$). From February 1998 through to the end of the series shown in Figure 1, however, the relationship between monthly break and enters, and arrests changed. While arrests continued to increase until mid-1999, the monthly number of break and enters decreased sharply over the same time period. The bivariate relationship between the two series for the final 18 months of the time period shown in Figure 1 was negative and significant ($r = -0.735$, $p = 0.001$). It is this change in the relationship between arrests and break and enters, after the OCR process was underway, that is modelled.

The bivariate relationships between arrests and motor vehicle thefts, and between arrests and armed robbery incidents, are similar to that for the break and enter series. For each of these two offence categories, a significant positive relationship exists in the first four years of the series ($r = +0.345$, $p = 0.018$ for motor vehicle theft, and $r = +0.607$, $p < 0.001$ for robbery). From mid-1998 to the end of the series, however, the relationship is negative ($r = -0.723$, $p = 0.001$, and $r = -0.583$, $p = 0.011$, respectively).

The relationship between arrests and sexual assault offences, however, does not follow the same pattern. While the bivariate relationship between monthly sexual assault incidents and arrests in the first four years of the series is positive and significant ($r = +0.578$, $p < 0.001$), a significant negative relationship does not occur in the last 18 months of the time period ($r = +0.384$, $p = 0.116$). The monthly decline in sexual assault incidents commenced well before the OCR process, and a large fall in incidents in mid-1998 did not continue through the rest of the series. The monthly trends for motor vehicle theft, armed robbery and sexual assault offences are shown in Figure 2. (Note that for illustrative purposes, the monthly series for both armed robbery and for sexual assault correspond to the scale shown on the right-hand vertical axis of Figure 2. The monthly series for motor vehicle theft offences corresponds to the scale on the left-hand vertical axis of the graph.)

It was noted above that, in conjunction with the OCR process, NSW police began targeting repeat offenders. Information about the number of repeat offenders arrested is not readily available from the source of the arrests and crime data, the Computerised Operational Policing System (COPS). However, if repeat offenders were being arrested with increasing frequency, there should be an observable increase in the number of accused persons with prior records coming before the NSW Courts.

Figure 3 shows the break and enter recorded crime series graphed against the monthly numbers of repeat offenders whose cases were finalised in the NSW Local Courts (for any offence) between July 1994 and December 1999. Because the monthly counts are based on outputs from the Courts (finalisations) rather than inputs (such as registrations), there is a time lag of two to three months between when a person is arrested and when his or her case is finalised in the Local Court. Figure 3 provides evidence that there were more repeat offenders coming into the criminal justice system – in particular, through the Local Courts – from late 1998.

The model described in equation (1) above was fitted for each of the four offence categories. Using a process of backward elimination, the variables in the model were reduced from the full set of explanatory variables noted earlier, to the final models which are summarised in Table 1. Because there was a high degree of multicollinearity among the full predictor set (e.g. the unemployment variables were closely correlated), it was necessary to carefully monitor the impact of excluding variables on the parameter estimates of the variables retained in the model.

Table 1 lists each variable that was significant in the final regression model for each offence category. For each offence category, the first column of figures shows the parameter estimate (the *ß* coefficient) and its associated standard error. The second column shows the value of the test statistic and the *p*-value associated with the null hypothesis of a zero coefficient. In addition, for each model, the total number of parameters (including 11 monthly parameters to control for seasonality) is noted, as well as the model fit, the value of R-squared and the value of the Durbin-Watson statistic testing for autocorrelation in the residuals.

MODEL FOR BREAK AND ENTER

Break and enter was chosen as the base modelling offence category to determine the relevant police activity variables for inclusion in all of the models. That is, once the significant police activity variables were determined for the break and enter series (in the presence of other covariates), these same variables were tested for the other three crime series. There are a number of reasons for choosing break and enter as the primary modelling series. Firstly, break and enters are the single most prevalent form of property crime in NSW. Furthermore, although only about 80 per cent of home break-ins are reported to police, the police-recorded rate of break and enters is widely regarded as a good measure of trends in the actual incidence of the actual offence (Australian Bureau of Statistics, 1999). Finally, a recently conducted audit of police crime data for this offence provides ample basis for confidence that changes in the recorded rate of break and enters are not due to changes in police willingness to record them (Chilvers, 2000).

Firstly, it was hypothesised that arrests in one month would have an impact on the level of break and enter offences recorded by police in the next month. The lagged arrests variable shows an overall positive relationship with break and enters in the final model ($t = 6.4$, $p < 0.001$). In other words, the value of the estimated regression coefficient shows that prior to the introduction of OCRs, for every extra arrest, an extra criminal incident is recorded the following month. It appears that the two series, crime and arrests, move together. This effect, however, can be shown to be non-causal. (The issue of reciprocal causation is discussed in the Appendix.)

Secondly, it was hypothesised that the OCR process, either at first or second round commencement, would have an effect on the level of crime. The variable representing the second round was found significant ($t = 5.5$, $p < 0.001$) and retained in the model. This variable, OCR(July), is a dummy variable which takes the value zero before July 1998 and one thereafter. In terms of equation (1), the significant OCR variable represents a change in the intercept of the hypothesised linear relationship between arrests and crime.

Finally, it was hypothesised that the OCR process affected the relationship between arrests and crime. To test this, interaction variables, representing additional terms for a changed arrest effect on crime after the first and second round commencement of OCRs, were included in the model. The interaction between the OCR(July) dummy variable and arrests lagged by one month was significant in the final model ($t = -6.8$, $p < 0.001$). The significance of this variable implies that the marginal relationship between crime and arrests changed after June 1998. From July 1998, there is a significant negative

Table 1: Estimates of regression coefficients and summary statistics for four crime models

Variable	Break and enter b (SE)	Break and enter p-value (t)	Motor vehicle theft b (SE)	Motor vehicle theft p-value (t)	Armed robbery b (SE)	Armed robbery p-value (t)	Sexual assault b (SE)	Sexual assault p-value (t)
Intercept	-11,169.2 *(3,371.4)*	.002 *(-3.3)*	-1,822.2 *(559.9)*	.002 *(-3.3)*	-963.5 *(316.4)*	.004 *(-3.0)*	-146.5 *(153.2)*	.344 *(-1.0)*
OCR (July)	10,727.6 *(1,944.3)*	.000 *(5.5)*	1,626.2 *(936.2)*	.089 *(1.7)*	733.8 *(252.1)*	.006 *(2.9)*	-122.7 *(152.6)*	.426 *(-0.8)*
Lagged arrests	1.0 *(0.16)*	.000 *(6.4)*	0.10 *(0.06)*	.115 *(1.6)*	0.02 *(0.02)*	.370 *(0.9)*	0.05 *(0.01)*	.000 *(7.2)*
Lagged arrests x OCR (July)	-1.1 *(0.16)*	.000 *(-6.8)*	-0.19 *(0.08)*	.015 *(-2.5)*	-0.07 *(0.02)*	.001 *(-3.5)*	0.002 *(0.01)*	.882 *(0.1)*
Male unemployment	400.4 *(151.4)*	.011 *(2.6)*						
Youth male unemployment			53.5 *(23.8)*	.030 *(2.2)*			11.4 *(4.0)*	.006 *(2.9)*
MV registrations	0.14 *(0.06)*	.017 *(2.5)*	0.12 *(0.02)*	.000 *(5.3)*	0.03 *(0.01)*	.000 *(4.1)*		
Recreational goods sales	20.3 *(7.7)*	.011 *(2.6)*	9.2 *(4.0)*	.025 *(2.3)*	3.2 *(1.0)*	.002 *(3.3)*		
Clothing sales	17.9 *(6.8)*	.011 *(2.6)*			2.0 *(0.87)*	.024 *(2.3)*		
Household goods sales	-8.6 *(3.6)*	.020 *(-2.4)*			-1.6 *(0.46)*	.001 *(-3.5)*	-0.70 *(0.2)*	.007 *(-2.8)*
No. of predictors*	19		17		18		16	
Model fit	F=23.2	.000	F=11.5	.000	F=13.5	.000	F=6.8	.000
R-squared	.907		.806		.841		.695	
D.W. statistic	1.62		1.66		1.56		1.67	

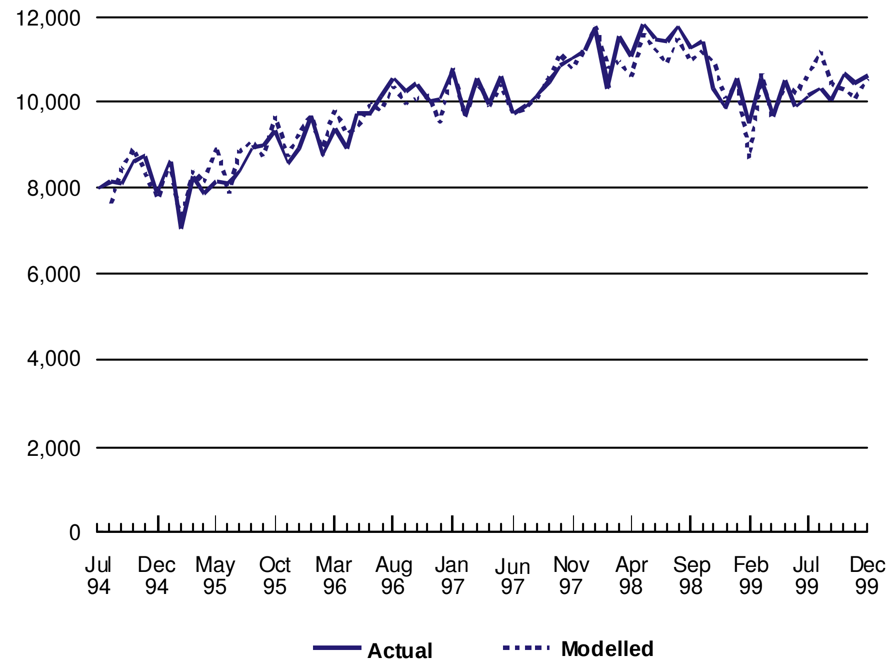
* Note that for each model, 11 dummy variables were included to take account of monthly (seasonal) variation. In each model, other than that for armed robbery, one or more months was significant. For robbery, the months were retained, despite their non-significance, because the normality assumption of the model was better met with their inclusion.

relationship between arrests and crime. In terms of equation (1), the significant interaction term represents a change in the slope of the linear relationship after June 1998.

The control variables which are significant in the final model for the break and enter series are the male unemployment rate ($t = 2.6$, $p = 0.011$), motor vehicle registrations ($t = 2.5$, $p = 0.017$), and three retail sales variables: sales of clothing goods ($t = 2.6$, $p = 0.011$), household goods ($t = -2.4$, $p = 0.020$), and recreational goods ($t = 2.6$, $p = 0.011$). There were no multicollinearity problems with these variables.

From the significant economic variables, it appears that the level of male unemployment has a positive effect on break and enters; motor vehicle registrations also have a positive effect. The effect of different types of retail sales varies – a positive effect for clothing and recreational goods, negative for household goods. Although all of these variables were significant, caution is advised in interpreting the coefficients. As evidenced by the relatively small *t*-statistics, the relationship is not particularly strong and, as with any statistical inference method in such circumstances, a different data set could

Figure 4: Monthly recorded incidents of break and enter, actual and modelled, July 1994 to December 1999



give rise to different results. The inclusion of these variables was required both to meet the model assumptions and to eliminate specification bias. Most importantly the police activity variables retain significance in the presence of these control variables.

The strength of the regression model for break and enters is shown in Table 1 (R^2=0.907, F=23.2, $p < 0.001$). The R-squared coefficient shows that, altogether, the modelled predictor variables explained more than 90 per cent of the variation in break and enters over the time period. More importantly, Figure 4 shows the close relationship between the actual and the modelled series. This graph compares the actual values of the dependent variable, break and enter, with the fitted values from the regression model. The fitted values very closely approximate the actual values. In particular, the model closely tracks the turning point in the series around mid-1998.

The reduced model for break and enter therefore shows that the overall relationship between arrests and crime is positive. Because the intervention at July 1998, and its interaction with arrests, was found to be significant, however, it can be concluded that the OCR process affected the relationship between arrests and crime. Furthermore, the model shows that the relationship between arrests and crime was negative from July 1998. Most importantly, these relationships were found while controlling for other potential confounding variables.

MODELS FOR MOTOR VEHICLE THEFT, ROBBERY AND SEXUAL ASSAULT

The results of the previous section show a significant causal relationship between police activity and the recorded incidence of break and enter offences. The relationship between police activity and the offence categories of (1) motor vehicle theft, (2) armed robbery, and (3) sexual assault, are modelled over the same time period. As before, the dependent variable in each case is the monthly number of recorded incidents for the crime category over the five-and-a-half year period, July 1994 to December 1999. The predictor variables include measures of both police activity and economic processes. Again, the method of dynamic time series regression modelling is applied, and each full model is reduced to a minimum set of significant variables. A summary of the results for the three categories of crime noted above was presented in Table 1.

Table 1 shows that, for two of the three additional offence categories analysed, the OCR process changed the relationship between arrests and crime. Firstly, for the offence category of motor vehicle theft, the reduced model shows that, while lagged arrests did not have an effect on crime overall ($t = 1.6$, $p = 0.115$), there was a significant negative relationship between arrests and crime from July 1998, as indicated by the significant interaction term shown in Table 1 ($t = -2.5$, $p = 0.015$). Of the other predictor variables which were controlled for in the model, the monthly numbers of new motor vehicle registrations ($t = 5.3$, $p < 0.001$) and retail recreational goods sales ($t = 2.3$, $p = 0.025$) were significant. The rate of unemployment for young males (rather than all males) was also significant ($t = 2.2$, $p = 0.030$). The overall fit of the model was not as strong as that for break and enter, but was nevertheless significant ($R^2 = 0.806$, F = 11.5, $p < 0.001$).

The regression model developed for the monthly series of recorded armed robbery incidents shows similar results. While there is no overall significant relationship between total arrests and crime ($t = 0.9$, $p = 0.370$), the results in Table 1 show that there was a significant negative relationship between the two variables over the final eighteen months of the series, as shown by the significant interaction term ($t = -3.5$, $p = 0.001$).

Other predictor variables which are significant for robbery include the same set of economic activity and retail sales variables which were found significant in the model for break and enter, with the exception of male unemployment. Male unemployment does not have a significant positive relationship with the incidence of armed robbery. The fit of the model was relatively strong and significant ($R^2 = 0.841, F = 13.5, p < 0.001$).

The final offence category for which a model was fitted is that of sexual assault. Of those offences which showed a significant downward monthly trend over the two-year period to December 1999, this is the only offence category which involved violence rather than the acquisition of property. Of the four offences modelled, this is the only offence category for which there was no apparent significant downward effect exerted by arrests from July 1998, as measured by the bivariate correlation coefficient. Similar to the break and enter series, lagged arrests display a significant positive relationship with sexual assault offences overall ($t = 7.2$, $p < 0.001$), but that relationship was not interrupted by the introduction of the OCR process, as shown by the lack of a significant interaction term in the final model ($t = 0.882$, $p = 0.15$). There are only two other significant explanatory variables in the sexual assault model. Firstly, the level of youth male unemployment exerts a positive causal influence on the level of sexual assault ($t = 2.9$, $p = 0.006$); and, secondly, the level of household goods sales is negatively related to the level of crime incidence for the sexual assault offence category ($t = -2.8$, $p = 0.007$). The sexual assault model is the weakest of the four models, but displays significance ($R^2 = 0.695$, $F = 6.8$, $p < 0.001$).

In summary, then, the results in Table 1 provide evidence that police activity contributed to the drop in the level of property crime in NSW from mid-1998 to the end of 1999. While the strength of the evidence varies across crime categories, the results suggest that police arrests exerted a significant negative causal effect on crime after the OCR panels were introduced. The results from this simple, robust regression procedure therefore lend weight to the descriptive and graphical evidence already established outside the model.

MODEL DIAGNOSTICS AND RESIDUALS ANALYSIS

The validity of the regression model described above depends on the residuals from the final model meeting the assumptions about the error terms. Diagnostic tests on the residuals in the fitted model were performed for each crime series and will be discussed below. In addition, methodological problems which can arise with regression models based on time series data will be considered.

The error terms in a linear regression model are assumed to be independent. Clearly, in regression models based on time series data, there is likely to be serial correlation in the error terms. This most frequently occurs when important explanatory variables are omitted from the regression and are thus present in the error term. As any such omitted variable represents a set of observations which itself is a time series, the error terms in the final model are related across time (see, for example, Greene, 1997). In our study, in order to guard against serial correlation, a number of covariates were incorporated into the full model in addition to the police activity variables of interest for each offence.

Because the Durbin-Watson statistic for each final model shown in Table 1 was in the indeterminate range, the autocorrelation function (ACF) and partial autocorrelation function (PACF) for each set of residuals was examined. There was no model for which the set of residuals showed evidence of significant autocorrelation (checking lags 1 to 16) with the exception of a spike at lag 12 in the model for break and enter. This represents the leakage which is left over from the seasonal variation which has been modelled by the inclusion of the monthly dummy variables. The PACF of the residuals from the final model for armed robbery shows an unexplained (though non-significant) spike at lag 9 and for sexual asault at lag 8. For motor vehicle theft, though non-significant, there appears a potential association at lag 2.

In accordance with the assumptions of linear regression, the residuals from each model were checked for normality by plotting the normal scores and by examining the distribution of the standardised residuals. The homogeneity assumption was broadly met for each model with the plot of residuals against fitted values showing no pattern. The normality assumption was met well for both break and enter and sexual assault. However, for armed robbery and, to a lesser extent, motor vehicle theft, the residuals displayed some evidence of non-normality. Initially, the armed robbery model, when reduced, did not contain the seasonal variables (as none were found significant). However, the residuals from this model were heavily skewed. The addition of the dummy months improved the normality significantly. For this reason and because it conformed with the other three models, this model was reported as the final model in Table 1. As an alternative, the armed robbery variable was also converted to log scores and the regression (without seasonal variables) was repeated. This also resulted in greater conformity with the assumptions. Note that the significance and sign of the variables remained stable with each alternative model formulation.

Such stability was not found in the case of sexual assault. In fact, the original regressions were run on the combined sexual assault and indecent assault/act of indecency offence categories (for the same reason that break and enter dwelling was combined with break and enter non-dwelling for this analysis). However, the residuals from a number of models which were tested continued to show significant serial correlation. When the dependent variable was limited to sexual assault only, a reasonable model could be found and was reported.

METHODOLOGICAL ISSUES AND LIMITATIONS OF THE MODEL

There are further difficulties which arise in the modelling of time series data. It is well known that spurious regression results may arise when non-stationary time series are modelled using conventional statistical methods (Granger and Newbold, 1974; Banerjee *et al*. 1993). When non-stationary time series are modelled to investigate causal relationships between variables in the presence of covariates (which may also be non-stationary time series themselves), the procedure of first or second differencing each original series in order to achieve stationarity pre-modelling is preferred. If stationarity is achieved by this process for each time series in the regression model, and if the order of integration (or differencing) is identical for each series, then a regression analysis can be performed.

In recent studies of the relationship between crime and economic variables, another common practice has been to model both the long and short term associations between the variables using a dynamic error correction mechanism. If the series are stationary in first differences, then unit root or 'weak' stationarity is said to exist. Under these circumstances, the relationship is tested for the presence of a co-integrating (equilibrium) relationship, and an error correction method is employed to model the causal relationship. Alternatively, if unit root stationarity does not exist, but if the order of integration is identical for each series, then the relationships may be modelled on the differenced series (Pyle and Deadman, 1994; Deadman and Pyle, 1997; Field, 1999). It is further acknowledged, however, that cointegration and error correction models are not easily applied to series with structural breaks (Enders, 1995; Koop, 2000).

In general, the crime and arrest series modelled in this paper are neither stationary, nor unit root stationary. Due to the modelled intervention, there is also a structural break in the series, which effectively splits the data unevenly. In effect, the nature of the intervention and the associated hypothesis that the OCR process changed the causal relationship between each dependent crime series variables and the police activity variables is at odds with the search for an equilibrium long-term relationship between the series. The shortness of the second series, and the seasonal nature of the data, precludes an approach which could, say, model cointegration for the two series separately. As such, the available data do not easily conform to the alternative econometric modelling approaches described above. In addressing the hypotheses described

Table 2: Estimates of regression coefficients and summary statistics for four crime models containing police activity variables only

	Break and enter		*Motor vehicle theft*		*Armed robbery*		*Sexual assault*	
Variable	*b* **(SE)**	***p-value (t)***	*b* **(SE)**	***p-value (t)***	*b* **(SE)**	***p-value (t)***	*b* **(SE)**	***p-value (t)***
Intercept	-3,630.1 *(1,060.0)*	.001 *(-3.43)*	955.0 *(550.2)*	.089 *(1.74)*	-738.1 *(160.4)*	.000 *(-4.6)*	-321.8 *(81.8)*	.000 *(-3.93)*
OCR (July)	11,527.4 *(2,190.9)*	.000 *(5.26)*	3,317.6 *(1,137.3)*	.005 *(2.92)*	972.4 *(331.5)*	.005 *(2.93)*	-15.6 *(169.1)*	.927 *(-0.93)*
Lagged arrests	1.4 *(0.1)*	.000 *(12.90)*	0.32 *(0.05)*	.000 *(5.84)*	0.11 *(0.02)*	.000 *(6.64)*	0.06 *(0.01)*	.000 *(6.98)*
Lagged arrests x OCR	-1.1 *(0.2)*	.000 *(-6.34)*	-0.35 *(0.09)*	.001 *(-3.70)*	-0.09 *(0.03)*	.001 *(-3.37)*	-0.01 *(0.01)*	.549 *(-0.60)*
No. of predictors*	14		14		14		14	
Model fit	F=16.9	.000	F=5.1	.000	F=5.4	.000	F=4.8	.000
R-squared	0.825		0.590		0.601		0.574	
D.W. statistic	0.78		0.75		0.48		1.36	

* Note that for each model, 11 dummy variables were included to take account of monthly (seasonal) variation.

earlier within the bounds of the data available to us, therefore, we used conventional linear regression models, but proceeded with extreme caution.

The linear regression procedure was used in our modelling exercise because of it's long-established ability to add objectivity to testing real-life (and essentially non-linear) relationships. The model is not predictive and we are not attempting to establish a long term definitive relationship between the chosen variables and crime. The main purpose of the modelling exercise is to evaluate the impact of the intervention (the OCR process) on the crime series. As we are primarily interested in the intervention point and its impact on the data, we do this by modelling the whole series, not a detrended or deseasonalised series.

The models described above suffer from a paucity of data. With only 66 data points available for modelling, and the seasonal variation inherent in crime series data, the inclusion of several explanatory variables may result in unstable parameter estimates. As we are primarily concerned with the robustness of the police activity variables, it is useful to examine the models containing only those variables (plus the seasonal dummy variables).

Table 2 shows the parameter estimates and associated model summary statistics for four parallel crime regression models which contain only the police variables. Clearly the omission of the control variables results in problems of serial correlation in the errors for each model as shown by the small Durbin-Watson statistics. The most important feature of the models in Table 2, however, is the stability of the estimated effects of arrests after the second round of OCRs (the interaction term). For each offence category modelled other than sexual assault, there is a negative causal effect of arrests on crime. The presence of the economic activity variables in the final models shown in Table 2 therefore only affects the significance of the term representing the overall impact of lagged arrests.

On the whole, therefore, despite the methodological limitations noted above, there are a number of reasons to believe that our regression results are not spurious. Firstly, the hypotheses are based on evidence outside the model and the results of the modelling analysis support this evidence. Moreover, there is no alternative explanation for the presence and timing of the intervention which has been successfully modelled. Secondly, the initial result for the break and enter offence category was broadly replicated in the models for two other offence categories. And finally, the results in these models with respect to police activity are stable.

ESTIMATING THE EFFECT OF ARRESTS

Finally, the question arises as to the scale of the impact of arrests on crime. It is difficult to quantify this effect from the model results shown in Tables 1 and 2. This is because there are two variables which model the arrest effect in these models – one over the whole series, and a second over the latter part of the series when the downturn in crime occurred. The overall arrest effect has been shown to be positive, but non-causal (see Appendix). Incorporating this parameter into the estimate of the post-OCR arrest effect would suppress the true estimated effect.

An alternative method was therefore employed to estimate the effect of arrests on each crime series from July 1998. The regression models shown in Table 1 were re-estimated for each offence category for the post-OCR series only. Because of the shortness of the series, the seasonal variables could not be included in the model. However, there was no problem with serial correlation in the error terms for any of the models. The parameter estimates for the lagged arrest coefficient in each re-estimated model are as follows: -0.55 for break and enter, -0.22 for motor vehicle theft, and -0.03 for robbery. This suggests that there is a reduction of one break and enter incident for every two arrests, a reduction of one motor vehicle theft for every five arrests and a reduction of one robbery for every 30 arrests.

These estimates should be viewed as conservative. This is because a single generic arrest variable (representing all arrests, rather than arrests for a specific offence) has been used in all of the models. The association between this arrest variable and each offence category will therefore be affected by the scale of the number of overall incidents. Because armed robbery is a relatively rare event, for example, a relatively strong arrest effect will be reflected in only a small reduction of incidents. The effects listed above should therefore be viewed only as a minimum bound for the true effect of a change in arrests on the level of crime in each crime category.

CONCLUSION

What conclusions can be drawn from the foregoing analysis? There are four pieces of evidence which, on balance, support the conclusion that police were, at least in part, responsible for the fall in crime which occurred after the introduction of the OCR process.

Firstly, Figures 1 and 2 show clearly that, for property crimes in particular, while crime and arrests rose in tandem up until the introduction of OCRs, after their introduction, crime began to fall while arrests continued to rise. Secondly, Figure 3 is consistent with the police claim that the fall in break and enters could have resulted from the priority they began to assign to the arrest of repeat offenders. Thirdly, the significant coefficients in Tables 1 and 2 for the interaction between arrest and OCR variables suggests that the change in crime which occurred after the advent of OCRs is attributable to policing rather than to some other extraneous variable. Fourthly, Granger tests for causality (see Appendix) provide further grounds for confidence that the drop in crime was due to increased arrests rather than vice versa.

This said, the statistical analysis conducted to test the effect of the OCR process on crime is not entirely free from ambiguity. There are preferred econometric methods for the analysis of non-stationary time series data (such as error correction models which take account of the cointegration between series) which have been recently developed, but which could not be applied to our data. The structural break (interruption) in our time series precludes the use of cointegration models, while the shortness of the post-OCR series and the presence of monthly seasonality does not allow for separate modelling of the latter time period. However, as the model diagnostics have shown that the underlying regression assumptions have been met, and the model fits the data well, the use of our intervention study technique is appropriate under the circumstances. It is desirable to undertake further analyses of longer time series which could incorporate the more sophisticated modelling techniques noted above. The limitations of the statistical model are therefore acknowledged, but the analytical work is just one part of the evidence offered towards the hypotheses in this paper.

Of course, the ultimate test of a crime control strategy is not whether it is effective in reducing crime but whether it is more cost-effective than the available alternatives. In addressing this issue we need to examine the size of any effect produced by the strategy of targeting repeat offenders and determine how long that effect can be expected to last. The size of the effect observed in the present study is fairly moderate for some offence categories. Essentially, for every two arrests we get one less break and enter, for every five arrests, one less motor vehicle theft. Given the cost of crime to the community, such a result may be well worth the effort. Much depends, however, on whether the police strategy of targeting repeat offenders produces a significant but temporary suppression of crime or a durable long-term reduction.

Data on crime in NSW collected after this study indicate that the incidence of break and enter (dwelling) is now stable rather than falling. The incidence of break and enter (non-dwelling), however, has risen about eight per cent over the last two years, as has the incidence of steal from a motor vehicle and motor vehicle theft (Doak, 2001). These changes might seem to suggest that targeting repeat offenders only produced a temporary suppression of crime. Arrest rates, however, also declined during the year 2000. It is entirely possible, therefore, that the rise in property crime now being observed is due to a fall in arrest rates rather than a failure of the strategy of targeting repeat offenders.

Further research is also needed to determine whether targeting repeat offenders reduces crime by means of deterrence or incapacitation. If the mechanism is one of deterrence, past studies suggest that the maximum benefits of the strategy will be apparent soon after its implementation and then tend to fade over time (Sherman, 1992). If the mechanism is one of incapacitation, on the other hand, there is no reason to expect a fall-off in the efficacy of the strategy but its effectiveness will depend upon the seriousness of the charges police lay against those whom they arrest and the quality of the evidence they have to support those charges. Conviction on minor charges or a high rate of acquittal among those arrested would both tend to reduce the incapacitative effect of the strategy because they would both tend to reduce the number of active offenders who receive a prison term.

Finally, it is important to weigh the benefits of the strategy of targeting repeat offenders against its potential risks and costs. The arrest rate of Aboriginal and Torres Strait Islander (ATSI) people is already five times higher than one would expect, given their numbers in the population (Baker, 2001). Hunter and Borland (1999) have shown that the differences in rates of arrest between ATSI and non-ATSI people accounts for about 15 per cent of the difference in employment rates between the two groups. There is strong evidence suggesting that long-term unemployment among active offenders increases the depth of involvement in crime (Good *et al*. 1986). In some communities, then, targeting repeat offenders may have the effect of increasing crime over the longer term rather than reducing it.

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NOTES

1 Several scholars nevertheless saw the introduction of OCR panels as tantamount or akin to the adoption of 'zero-tolerance policing'. As such, they argued, it represented a threat to civil liberties, had the potential to further inflame race hatred and was potentially inimical to the restoration of public confidence in the integrity of police (see: Dixon, 1998; Cunneen, 1999; Poynting, 1999).

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APPENDIX

RECIPROCAL CAUSATION

The change in the direction of the relationship between arrests and break and enter offences, as shown by the regression model reported in this paper, may be looked at more closely. The results in Table 1 showed that, for the offence category of break and enter, there was a positive influence of lagged arrests on crime overall, and then a negative effect after the OCR process. These relationships are examined more closely by testing the causal relationships using a Granger test which helps evaluate the extent of any explanatory power of a predictor variable in the presence of lagged values of the dependent variable (Koop, 2000).

Two sets of tests are performed on the two separate time periods. The first test checks whether lagged arrests explain crime (in the presence of lagged crime), and the second test examines the effect of lagged crime on arrests in the presence of lagged arrests. The tests are performed separately for the pre and post OCR periods, due to the hypothesised changed relationship between crime and arrests as a result of the OCR process.

Table 3 show the results of Granger causality tests over the two periods. As noted earlier the bivariate correlation between break and enters and arrests was positive before July 1998. Figure 1 showed that the two series moved together. In order to test if lagged arrests exerted an influence on crime, crime is regressed on both lagged crime and lagged arrests. If lagged arrests are significant predictors in the presence of significant lagged crime, then arrests 'Granger cause' crime in this time period. In fact, in the period to June 1998, the lagged arrest variable was not significant. However, in the second test, when arrests were regressed on lagged arrests and lagged crime, the lagged crime variable was positive and significant. That is, before July 1998, crime had a positive effect on arrests - explaining the positive correlation.

After the OCR process commenced, the relationship is very different. Table 3 shows that there is an explanatory effect of arrests on crime (in the presence of lagged crime), but no corresponding explanatory effect of crime on arrests during this period. Because the *t*-statistic in this regression was negative (not shown), these results confirm the regression findings reported in the paper.

Table 3: Granger test results for break and enter incidents and arrests

July 1994 to June 1998		*July 1998 to December 1999*	
Crime = f (lagged crime, ***lagged arrests****)*		*Crime = f (lagged crime,* ***lagged arrests****)*	
Explanatory variable	***p*-value**	**Explanatory variable**	***p*-value**
Crime (lag 1)	0.026	Crime (lag 1)	0.720
Crime (lag 2)	0.000	Crime (lag 2)	0.029
Arrests (lag 1)	0.909	Arrests (lag 1)	0.038
Arrests = f (lagged arrests, ***lagged crime****)*		*Arrests = f (lagged arrests,* ***lagged crime****)*	
Explanatory variable	***p*-value**	**Explanatory variable**	***p*-value**
Arrests (lag 1)	0.000	Arrests (lag 1)	0.003
Crime (lag 1)	0.262	Crime (lag 1)	0.773
Crime (lag 2)	0.002	Crime (lag 2)	0.619

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