



The effect of police on crime and arrests: Are police deterring or incapacitating criminals?

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Aim: To estimate the causal effect of police numbers on rates of crime and arrests.

Method: The data used in the present study consists of monthly Local Area Command (LAC) level counts of police officers and selected violent and property crimes for the period July 2000 – April 2003. These crimes include: break and enter, theft, motor vehicle theft, robbery and homicide. Using these data I exploit variation in police numbers driven by a massive recruitment campaign in the lead up to the 2003 New South Wales (NSW) State election to estimate the causal effect of police numbers on rates of crime and arrests.

Results: I find that a one per cent increase in the size of the police force generates a 0.8 per cent reduction in theft and a 1.1 per cent reduction in motor vehicle theft. This roughly equates to one additional police officer preventing 17 thefts and four motor vehicle thefts each year. My estimates are too imprecise to draw any definitive conclusions with respect to other types of crime. I do not find evidence that an increase in police numbers generates any significant change to the arrest rate. This indicates that police reduce theft and motor vehicle theft through deterrence rather than incapacitation.

Conclusion: The implications of the present study are threefold. First, an increase in police numbers generates a substantial reduction in property crime. Second, an increase in police numbers has no significant effect on the arrest rate for property crime. Finally, the cost of an additional police officer is almost definitely offset by the benefit she provides to society in the form of crime reduction.

Keywords: police numbers, arrests, violent crime, property crime, two-stage least squares, instrumental variables, election spending.

INTRODUCTION

The question of whether or not police reduce crime is of first order importance for policy makers. The seminal work of Becker (1968) predicts that an increase in police numbers should decrease crime through at least one of two channels. The first is a deterrence effect; an increase in police numbers raises the perceived likelihood of apprehension and thus lowers the proclivity to offend. The second is an incapacitation effect; an increase in police numbers results in more arrests and thus fewer offenders amongst the general population. Deterrence is generally considered favourable to incapacitation given the social and economic costs associated with incarcerating an individual.

A question of second order importance for policy makers is whether or not an increase in police numbers generates an increase in arrests. For a given increase in police numbers, Owens (2013) characterises the change in the arrest rate as a function of the deterrence effect (weighted by the fraction of the population that offends), and the incapacitation effect (weighted by the fraction of crimes that are cleared by arrest). While both channels work to reduce crime, they move in opposite directions when it comes to arrests. This is because an increase in deterrence lowers the fraction of the population that chooses to offend thus also weakly lowering the arrest rate.¹

Despite the obvious importance of these two questions, there is surprisingly little empirical evidence demonstrating the link

between police and crime and even less evidence demonstrating the link between police and arrests. This is because empirically linking police to crime and arrests is confounded by the following three factors:

1. **Detection Bias:** Holding the level of actual crime constant, an increased number of police on patrol are able to detect more crime.
2. **Reporting Bias:** Holding the level of actual crime constant, an increased number of (presumably visible) police sends a signal to the public that reporting crime is now more likely to result in effective action.
3. **Simultaneity:** This source of bias comes in two interrelated flavours: static and dynamic. The static argument is that at any given point in time, police jurisdictions with high crime rates are also likely to have a high number of police. The dynamic argument is that an increase in crime in one period will, as a response, generate an increase in police in the following period.

With respect to identifying the effect of police on crime, these three forces move in the same direction and have caused many empirical researchers to find a positive and/or insignificant relationship between police and crime. With respect to identifying the effect of police on arrests, the direction of these forces is ambiguous and depends on whether the deterrence or incapacitation effect dominates. The following section provides an overview of the limited number of studies that have managed to identify these causal effects.

Literature

Studies attempting to estimate the causal effect of police on crime generally focus on specific types of violent and property crime to avoid the detection and reporting bias issues. These crimes generally include: murder, robbery, theft, motor vehicle theft, and break and enter. Where these studies differ is in terms of how they address the simultaneity problem. Studies within this literature can be divided into four groups. The first group addresses the simultaneity problem using time series methods. These methods aim to determine whether or not an increase in police numbers in one period lead to a reduction in crime in the following period, after controlling for seasonality and pre-existing trends. For example, Marvell and Moody (1996) use annual U.S. state and city level crime data to demonstrate that past police levels are significant predictors of future crime and vice-versa. Corman and Mocan (2000) address the simultaneity problem by leveraging high-frequency (monthly) crime data for New York City, arguing that they are able to recover the causal effect as there is a lag between increases in crime and police recruitment. Corman and Mocan (2000) find police significantly reduce the rate of burglaries in New York City.

The second group employ Instrumental Variables (IV) strategies to address the simultaneity problem. These methods recover the causal effect of police on crime by utilising a third variable, referred to as an instrument, that is correlated with police numbers but otherwise unrelated to crime rates. A seminal paper in this literature is that of Levitt (1997), who uses election cycles as an instrument for police recruitment. Levitt (1997) argues that election cycles (at least partially) drive police recruitment and that after controlling for other forms of government spending (on welfare and employment programs for example), election cycles are otherwise unrelated to crime. Despite concerns regarding computational errors in his computer program, the Levitt strategy nevertheless represented a leap forward in convincingly recovering the causal effect of police on crime.² Evans and Owens (2007) follow a similar approach and use police hiring grants (allocated by the U.S. congress) as an instrument for police numbers finding that police reduce rates of motor vehicle theft, burglary and robbery.

The third group exploit difference-in-differences setups, where researchers compare crime in areas exposed to some policy intervention to control areas unexposed to the intervention, before and after the intervention. For example, Di Tella and Schargrodsky (2004) recover the effect of police on crime by exploiting variation in police numbers surrounding religious sites in Buenos Aires following a terrorist attack. Di Tella and Schargrodsky (2004) compare motor vehicle theft rates in areas near religious sites assigned additional police before and after the attack, with non-religious sites experiencing no change in police before and after. They find a large deterrent effect of police on motor vehicle thefts. Machin and Marie (2011) estimate the effect of police on robbery rates in England and Wales by comparing robbery rates in jurisdictions subject to increased police resources from the street crime initiative with jurisdictions not receiving additional resources (before and after), finding police to significantly reduce robberies.

The final group employ unconventional approaches toward identifying the effect of police on crime. Klick and Tabarrok (2005) exploit variation in police numbers driven by daily changes to the terror alert level in Washington D.C. to infer the effect of police on crime.³ Using this strategy they infer large deterrent effects of police on street crime. Chalfin and McCrary (2018) argue that measurement error in how (U.S. city level) police jurisdictions record the size of their police force is responsible for the positive and/or insignificant relationship between police and crime. Chalfin and McCrary (2018) leverage high frequency data and after correcting for measurement error, find police significantly reduce rates of property crime.

As far as I am aware, there exists only one previous study that focuses on directly estimating the effect of police on arrests.⁴ Owens (2013) follows an identical IV strategy to Evans and

Owens (2007), finding no evidence to indicate that an increase in police numbers generates any change in the arrest rate. Taken together with the findings from Evans and Owens (2007), this implies that the crime reducing effect of police in the U.S. flows predominately through the deterrence channel.

The contribution of the present study is threefold. First, to determine whether or not the effect sizes found by Levitt (1997, 2002) and Evans and Owens (2007) in the U.S.; Di Tella and Schargrodsky (2004) in Argentina; and Machin and Marie (2011) in England and Wales are generalisable to an Australian setting. The second contribution is to extend the limited body of knowledge available with respect to the effect of police on arrests. The final contribution is to determine whether the deterrence or incapacitation effect dominates in an Australian setting. This is of particular importance for policy makers as the benefit police provide to society in the form of crime reduction must be weighed against not only the (wage) cost of an additional officer, but also the cost of an additional arrest (weighted by the probability and duration of incarceration).

A brief history of the 1999 and 2003 NSW State elections

Law and order was a major election issue during both the 1999 and 2003 NSW election campaigns. During the 1999 campaign, the then Premier, Bob Carr, pledged to increase the number of police officers from 13,313 in 1998 to 14,407 by December 2003 if re-elected.⁵ After winning the 1999 election, the Carr government proceeded to take no action in this regard until about one year out from the next election. In November 2001 Michael Costa replaced Paul Whelan as Minister for Police. One month later a major restructure of the police force began. The objectives of the restructure were twofold; first, to decentralise the police force in order to provide each Local Area Command (LAC) with increased autonomy and accountability; and second, to increase police visibility within the community. The restructure had three stages; the first stage focused on top level command personnel and involved the appointment of two deputy commissioners; the second stage involved reducing the number of police region commands from 11 to five; and the final stage involved a massive recruitment campaign.⁶

Part of the recruitment campaign involved opening a training facility in Richmond. As far as I can tell, this facility was opened with the explicit purpose of meeting the Carr government's election commitment. An extract from (page 8 of) the 2001-02 Annual NSW Police Commissioner's report to the Minister for Police reads:

"establishment of the additional campus will enable police numbers to reach 14,407 by December 2003."

Indeed the recruitment campaign was successful in generating the intended increase in the police force. An extract from

(page 7 of) the 2002-03 Annual NSW Police Commissioner's report to the Minister for Police reads:

"In the last 12 months we have taken on a record number of new recruits, with more than 1800 probationary constables sworn in at NSW Police College."

The sharp increase in police numbers, beginning in April 2002, allowed the Carr government to meet their election commitment almost an entire year early. The Carr government was subsequently re-elected in March 2003 and then about nine months later police numbers began to fall toward pre-election levels. I intend to exploit this seemingly exogenous increase in the number of police using the identification strategy outlined in the following section.

METHODS

DATA

I utilise two monthly panels, both of which run from July 2000 to December 2005 for the analysis in the present study. The first contains Local Area Command (LAC) level counts of police officers and the second contains LAC level counts of recorded/detected crimes and arrests.^{7,8}

IDENTIFICATION STRATEGY

In order to address reporting and detection bias I focus on specific violent and property crimes unlikely be affected by these biases. The violent crimes I investigate are homicide and robbery, and the property crimes I investigate are theft, motor vehicle theft and break and enter.⁹ These crimes are unlikely to be affected by reporting and detection bias because victims have a clear incentive to report these crimes to police.

In order to address the simultaneity issue I follow a similar Two Stage Least Squares (2SLS) Instrumental Variables (IV) strategy to that of Levitt (1997). In the first stage of my analysis I begin by estimating the effect of the hiring campaign on the size of the police force within each LAC. I model the change in the size of the police force by estimating an Ordinary Least Squares (OLS) regression of Equation 1 below.

$$\ln(P_{it}) = \beta^{First} D_t + \phi X'_{it} + \theta_i + \lambda_t + e_{it} \quad (1)$$

Where $\ln(P_{it})$ is the natural logarithm of the size of the police force in LAC i , during month t ; X'_{it} is a set of LAC-specific linear time trends; D_t is a binary variable equal to one during the hiring campaign, zero otherwise; θ_i is a set of LAC Fixed Effects (FEs); λ_t is a set of month and year FEs; and finally, e_{it} is the error term. In my primary specification I designate the hiring campaign as taking place between April 2002 and April 2003, discarding months after April 2003 from the analysis entirely.¹⁰ In this first stage regression, β^{First} can be interpreted as the average percentage change in the size of the police force during the hiring campaign.

After establishing that the size of the police force did sufficiently increase as a result of the campaign, I then look to see how crime and arrest rates changed during the hiring campaign by estimating an OLS regression of Equation 2 below.

$$\ln(y_{it}) = \beta^{RF} D_t + \phi X'_{it} + \theta_i + \lambda_t + \varepsilon_{it} \quad (2)$$

Where $\ln(y_{it})$ is the natural logarithm of the outcome of interest (be it crime or arrests); β^{RF} is the average percentage change in the outcome of interest during the hiring campaign; ε_{it} is the error term and all other variables have the same definition as in Equation 1.¹¹ Provided that the hiring campaign is conditionally unrelated to crime, the ratio $\beta^{RF} / \beta^{First}$ provides us with a consistent estimate of the elasticity of y_{it} with respect to police. That is, the percentage change in crime (or arrests) resulting from a one per cent increase in the size of the police force.¹²

The fact that all LACs in NSW were exposed to the hiring campaign simultaneously presents a potential problem for the analysis. That is, because the only available counterfactual for crime rates during the hiring campaign is crime rates prior to the campaign, any factor varying both over time and between LACs could bias the estimates. For example, Moffatt, Weatherburn and Donnelly (2005) find that the sharp drop in property crime from 2001 onwards (see Figure 1 in the results section) was at least in part due to an increase in the real price of heroin. The timing of the heroin shortage in conjunction with the fact that heroin availability likely varied across LAC boundaries could present a problem for the analysis. While in principle the LAC-specific linear trend in combination with the FEs should address this concern, I also remove LACs with high ex-ante rates of use/possess opiate offences from the analysis in the robustness checks with no meaningful change to the main results.¹³

Changes to police practice before and after the hiring campaign within particular jurisdictions presents another potential threat to the validity of the estimates. On 24 May 2002 the NSW Police introduced 'Operation Vikings'. Vikings was a High Visibility Policing (HVP) operation with the explicit objective of deterring street offences; anti-social behaviour; alcohol related crime; street level drug possession and traffic offences. Vikings involved the allocation of an additional 12,000 shifts over the 2002-03 financial year and was (at least in part) a result of the hiring campaign. Following the introduction of Vikings in 2002, HVP operations were embedded into standard police practice until at least 2013.¹⁴ Hence, although I cannot separate the effect of the increase in police from the deterrent effect of Vikings, I do not believe that this invalidates the policy relevance of the estimates as the additional police were used to support the on-going utilisation of HVP operations across NSW.¹⁵

The approach summarised in this section has the following four strengths. First, because the data utilised is a panel, I can directly control for static simultaneity through inclusion of the LAC FEs.

Second, like Corman and Mocan (2000) and Chalfin and McCrary (2018), I am able to leverage high frequency data and thus mitigate dynamic simultaneity concerns. Hence, in order for an increase in crime to generate an increase in police (or arrests) both increases must occur within a single month. Third, inclusion of the month and year FEs ensures that my estimates are robust to state-wide seasonal differences (in crime and unemployment rates for example) both between months and across years. Finally, inclusion of the LAC-specific linear trends renders my estimates robust to trends in crime, arrests and police recruitment at the LAC level.

RESULTS

DESCRIPTIVE ANALYSIS

I begin by visually exploring the relation between police, crime and arrests in Figure 1. Figure 1 plots three quarterly time series for all LACs in NSW between 2000 Q3 and 2005 Q4. The first series, indicated by the long dashed line, corresponds to the quarterly sum of property and violent crime recorded by each LAC; the second series, indicated by the short dashed line, corresponds to the quarterly count of arrests for these crimes; and finally, the solid series, corresponds to the number of police within a given LAC. All series are indexed at 100 in 2000 Q3. The left and rightmost vertical lines indicate the beginning and end of the hiring campaign in 2002 Q2 and 2003 Q2, respectively. Four points are of note with respect to Figure 1. First, police numbers are remarkably stable prior to the hiring campaign with close to zero variation between 2000 Q3 and 2002 Q2. Second, immediately following 2002 Q2, we can see a sharp rise in the number of police across the state with this number peaking around 120 per cent of 2000 Q3 levels before flattening out and then beginning to fall in 2004. Third, just prior to the hiring campaign both crime and arrests begin a sharp and sustained decline. And finally, as one would expect, crime and arrests are closely related.

Table 1 presents descriptive statistics for the variables of interest in the present study. Columns 1, 4 and 7 provide readers with the number of observations over the entire sample, before the hiring campaign, and during the hiring campaign, respectively. Columns 2, 5 and 8 (3, 6 and 9) present the mean (standard deviation) associated with each variable in its respective part of the sample. Finally, columns 10 and 11 present the difference-in-means between periods as well as the associated standard error for each estimate, respectively. From the first row we can see that the mean size of the police force within each LAC increased from about 128 before the hiring campaign to about 142 during the campaign. This 13 officer increase is statistically significant at the one per cent level. In relative terms this implies that the hiring campaign resulted in a 10 per cent increase in the size of

Figure 1. Crime, arrests and police numbers in NSW



Table 1. Descriptive statistics for variables of interest

	Overall			Pre-hiring campaign			During the hiring campaign			Difference	
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Mean	Std. Err.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Police numbers	2,550	133.493	38.063	1,575	128.485	35.089	975	141.583	41.180	13.10***	(1.588)
Reported/detected incidents											
Break and enter	2,550	132.942	75.059	1,575	142.829	79.777	975	116.971	63.606	-25.86***	(2.862)
Theft	2,550	221.198	140.611	1,575	232.739	147.589	975	202.556	126.405	-30.18***	(5.497)
Motor vehicle theft	2,550	52.255	41.424	1,575	58.237	46.001	975	42.590	30.328	-15.65***	(1.512)
Total property crime	2,550	406.395	237.036	1,575	433.806	254.387	975	362.117	198.210	-71.69***	(9.021)
Robbery	2,550	13.289	15.348	1,575	14.411	16.749	975	11.478	12.564	-2.933***	(0.583)
Homicide	2,550	0.276	0.607	1,575	0.302	0.628	975	0.233	0.570	-0.069***	(0.024)
Total violent crime	2,550	13.565	15.469	1,575	14.713	16.889	975	11.711	12.636	-3.002***	(0.587)
Arrests											
Break and enter	2,550	10.723	8.053	1,575	11.290	7.863	975	9.806	8.273	-1.484***	(0.331)
Theft	2,550	26.281	19.492	1,575	27.051	19.970	975	25.037	18.635	-2.015***	(0.781)
Motor vehicle theft	2,550	5.014	4.805	1,575	5.652	5.120	975	3.984	4.042	-1.668***	(0.183)
Total property crime	2,550	42.018	26.905	1,575	43.994	27.499	975	38.827	25.610	-5.167***	(1.074)
Robbery	2,550	3.178	4.208	1,575	3.483	4.529	975	2.686	3.580	-0.797***	(0.162)
Homicide	2,550	0.245	0.755	1,575	0.277	0.821	975	0.194	0.631	-0.084***	(0.030)
Total violent crime	2,550	3.424	4.363	1,575	3.761	4.702	975	2.880	3.688	-0.881***	(0.167)

Note. All variables in Table 1 are monthly Local Area Command level counts. There are 75 Local Area Commands in the entire sample. Periods before the hiring campaign refer to July 2000 - March 2002 and periods during the campaign refer to April 2002 - April 2003. Robust standard errors in parentheses, $p < 0.1$ *, $p < 0.05$ **, $p < 0.01$ ***.

the police force within each LAC. Consistent with Figure 1, we can also see sharp, statistically significant reductions in crime and arrests across all rows. When comparing the relative monthly level of crime (arrests) within each LAC between periods, we can see decreases for all crime categories: break and enter decreased by about 18 per cent (13 per cent) per month; theft decreased by about 13 per cent (7 per cent) per month; motor vehicle theft decreased by about 27 per cent (30 per cent) per month; aggregate property crime decreased by about 17 per cent (12 per cent) per month; robbery decreased by 20 per cent (23 per cent) per month; homicide decreased by 23 per cent (30 per cent); and finally, aggregate violent crime decreased by 20 per cent (23 per cent).

THE EFFECT OF THE HIRING CAMPAIGN ON POLICE

In Table 2 I quantify the link between the hiring campaign and the size of the police force by presenting the results from an OLS regression of Equation 1. Column 1 indicates that net of controls and FEs, the hiring campaign increased the size of the police force within each LAC by an average of 7.2 per cent. This roughly equates to an increase of about ten officers per LAC. Below each estimate in Table 2 are the Sanderson-Windmeijer (SW) chi-squared and F statistics.¹⁶ The results from these tests indicate the hiring campaign is sufficiently correlated with police numbers for the strategy (described in the previous section) to work.

Columns 2, 3, 4 and 5 estimate the effect of the hiring campaign on police numbers, focusing on LACs in the first, second, third and fourth quartile, respectively. These quartiles are based on the mean (pre-campaign) size of the police force within each LAC. Two points are of note with respect to these columns. First, both SW statistics are significant across all quartiles, indicating that the hiring campaign is sufficiently correlated with police numbers for the identification strategy to work. And second, the effect of the hiring campaign is positive and significant for all LACs, irrespective of their ex-ante size.¹⁷

THE EFFECT OF POLICE ON CRIME

Now that I have established that there was a strong link between police numbers and the hiring campaign, we are in a position to look at the effect of police on crime. The first row in Table 3 presents the estimated change in crime during the hiring campaign. Column 1 looks at break and enter; column 2 looks at theft; column 3 looks at motor vehicle theft; column 4 looks at the aggregate of these property crimes; column 5 looks at robberies; column 6 looks at homicide; and finally, column 7 looks at the aggregate of these violent crimes. Reading off the first row we can see statistically significant reductions in theft, motor vehicle theft and aggregate property crime in the order of 5.8, 8.2 and 4.5 per cent, respectively. The estimates from columns 1 and 5-7 are too imprecise to draw any definitive conclusions either way. However, it is worth noting that the coefficient for robbery in column 5 is positive. Given that prior studies have consistently found a negative relationship between police and rates of robbery, this would seem to indicate that robbery is subject to reporting/detection bias in the context of early 2000s NSW.

Thus far I have shown (in Table 2) that the hiring campaign generated a 7.2 per cent increase in the size of the police force. I have also shown (from the first row of Table 3) that theft, motor vehicle theft, and aggregate property crime all fell significantly during the campaign hiring. Assuming that the hiring campaign only affected crime through the resulting increase in police numbers, then the (inverse) ratio of these estimates provides us with the elasticity of crime with respect to police. The second row of Table 3 provides these elasticity estimates. From this row we can see that a one per cent increase in police generates 0.8, 1.1, and 0.63 per cent reductions in theft, motor vehicle theft, and aggregate property crime, respectively. In absolute terms, this roughly equates to the hiring of one additional officer preventing 1.4 thefts, 0.36 motor vehicle thefts, and 1.8 property crimes each month.¹⁸

Table 2. First stage estimates for the effect of the hiring campaign on police numbers

	Full sample	First quartile	Second quartile	Third quartile	Fourth quartile
	(1)	(2)	(3)	(4)	(5)
Hiring campaign	0.072*** (0.010)	0.049** (0.025)	0.104*** (0.025)	0.055*** (0.015)	0.080*** (0.014)
SW Chi-Sq Statistic	52.62***	4.58**	19.75***	15.11***	36.73***
SW F-Statistic	48.60***	3.99*	17.23***	13.18***	31.91***
Observations	2550	646	646	646	612
LAC FEs	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y
Linear trends	Y	Y	Y	Y	Y

Note. SW = Sanderson-Windmeijer, LAC = Local Area Command, FEs = Fixed Effects, cluster robust standard errors in parentheses, clusters refer to LACs of which we have 75 in each regression, p<0.1 *, p<0.05 **, p<0.01***.

The effect of police on arrests

In Table 3 I found an increase in police numbers to generate large statistically significant reductions in theft, motor vehicle theft and aggregate property crime. A natural question to ask is how are police preventing these crimes from occurring? Table 4 answers this question. Table 4 follows an identical layout to Table 3 with one exception; the dependant variable is now the natural log of each LAC’s monthly count of arrests.

With the exception of robbery and aggregate violent crime, all of the estimates are not statistically different from zero, indicating an increase in police numbers has no significant impact on the arrest rate for these crimes. The fact that the estimates for robbery and

aggregate violent crime are positive and significant lends itself to two explanations. First, that the number of arrests for robbery (and by extension aggregate violent crime) did increase during the hiring campaign. The second is that these estimates are being contaminated by reporting/detection bias. While there is no way to be sure, the evidence found in Table 3 is strongly supportive of the latter. With the exception of robbery, the estimates from Table 4 are broadly consistent with Owens (2013) who also finds an increase in police numbers to have no significant effect on arrests. This suggests that the reductions in theft and motor vehicle theft found in Table 3 are driven by deterrence rather than incapacitation.¹⁹

Table 3. Two stage least squares estimates for the effect of police numbers on crime

	Break and enter	Theft	Motor vehicle theft	Property crime	Robbery	Homicide	Violent crime
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hiring campaign	-0.008 (0.029)	-0.058*** (0.018)	-0.082** (0.036)	-0.045** (0.021)	0.056 (0.045)	-0.017 (0.036)	0.051 (0.047)
Elasticity	-0.105 (0.408)	-0.801*** (0.285)	-1.144** (0.528)	-0.628* (0.321)	0.774 (0.650)	-0.242 (0.507)	0.714 (0.673)
Observations	2,550	2,550	2,550	2,550	2,550	2,550	2,550
Estimation method	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
LAC FEs	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y
Linear trends	Y	Y	Y	Y	Y	Y	Y

Note. LAC = Local Area Command, FEs = Fixed Effects, 2SLS = Two-Stage Least Squares, cluster robust standard errors in parentheses, clusters refer to LACs of which we have 75 in each regression, p<0.1 *, p<0.05 **, p<0.01***

Table 4. Two stage least squares estimates for the effect of police numbers on arrests

	Break and enter	Theft	Motor vehicle theft	Property crime	Robbery	Homicide	Violent crime
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hiring campaign	0.042 (0.065)	0.000 (0.042)	-0.112 (0.076)	-0.001 (0.039)	0.161** (0.065)	-0.016 (0.036)	0.143** (0.070)
Elasticity	0.578 (0.892)	0.005 (0.588)	-1.560 (1.075)	-0.012 (0.550)	2.245** (0.962)	-0.229 (0.507)	1.992* (1.005)
Observations	2,550	2,550	2,550	2,550	2,550	2,550	2,550
Estimation method	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
LAC FEs	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y
Linear Trends	Y	Y	Y	Y	Y	Y	Y

Note. LAC = Local Area Command, FEs = Fixed Effects, cluster robust standard errors in parentheses, clusters refer to LACs of which we have 75 in each regression, p<0.1 *, p<0.05 **, p<0.01***

DISCUSSION

This study focused on estimating the causal effect of police on crime and arrests. In order to overcome detection and reporting bias, I focused on crimes unlikely to be affected by these issues. These crimes included: break and enter, theft, motor vehicle theft, robbery and homicide. In order to address simultaneity issues, I exploited variation in police numbers driven by a massive recruitment campaign in the lead up to the 2003 NSW State election.

The first step in my analysis was to estimate the effect of the hiring campaign on police numbers. I found that the hiring campaign increased the size of the police force by 7.2 per cent, equating to an average increase of about 10 officers in each Local Area Command (LAC). The second step in my analysis was to then see whether or not crime rates changed during the hiring campaign. I found a significant reduction in aggregate property crime, driven by large reductions in theft and motor vehicle theft, but no significant reduction in violent crime. Using these estimates I then proceeded to calculate the elasticity of crime with respect to police. I found that a one per cent increase in the size of the police force reduced incidents of theft, motor vehicle theft, and aggregate property crime by 0.8, 1.1 and 0.63 per cent, respectively. In absolute terms, this roughly equates to one additional police officer preventing 1.4 thefts, 0.36 motor vehicle thefts and 1.8 property crimes each month. The third step in my analysis was to determine whether or not the hiring campaign had any effect on the monthly arrest rate for these crimes. I found no compelling evidence to suggest that an increase in police numbers generates any change to the arrest rate. This suggests that police in NSW reduce crime predominately through deterrence rather than incapacitation, at least during the early 2000s.

At this point a natural question to ask is whether or not the (wage) cost of an additional officer is offset by the benefit she provides to society in the form of crime reduction. In general this is an extremely difficult, if not impossible, question to answer because it requires the researcher to not only estimate the cost associated with a particular crime, but also estimate the cost of an arrest (weighted by the probability and duration of imprisonment). However, the fact that I found no significant evidence indicating that an increase in police numbers generates any change to the arrest rate for motor vehicle theft, in conjunction with the fact that motor vehicle theft is both well reported and well measured (for insurance purposes), places me in a somewhat unique position to conduct such an analysis credibly. Using insurance claims data, Mayhew (2003) estimates the cost of a motor vehicle theft (in 2002) to be about \$6,000 per vehicle. Donnelly et al. (2007) estimates the salary of a NSW general duties constable (in 2005) at around \$50,000 per year. Taken together, this means that each

additional police officer is able to offset almost half of her annual salary by deterring motor vehicle thefts alone.

Given modern innovations in security technology it is unlikely that these estimates are generalizable to present day NSW. It is also important to bear in mind that the additional police were used to support the on-going introduction of high visibility policing operations with the explicit purpose of deterring street offences. If the additional police were instead utilised for a different purpose, to increase the number of drug related arrests for example, then we may well have found different results. That said, the present study is the first of its kind in Australia and is largely consistent with the growing body of international evidence supporting the argument that police are an underutilised resource in society.

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NOTES

1. Deterrence only weakly lowers the arrest rate as potential offenders may be deterred exclusively from crimes not cleared by arrest.
2. Interested readers are directed to McCrary (2002) who first documents the problems present in Levitt's (1997) paper. Such readers are also directed to Levitt (2002) for his response and to Kovandzic et al. (2016) for a review regarding instrument validity in these settings.
3. That is, because Klick and Tabarrok (2005) are only able to observe crime rates (and not police numbers) the best they can do is compare crime rates in densely populated areas on low and high alert days.
4. There are however, two studies that discuss the simultaneous effect of police on deterrence and incapacitation. The first is Levitt (1998) who finds increases in the arrest rate to generate both an incapacitation and deterrence effect. The second is a study by Lee and McCrary (2017) who estimate the deterrence effect associated with harsher penalties.
5. The number of police in 1998 is obtained from the Annual 1997-98 NSW Police Commissioner's report to the Minister for Police.
6. Interested readers are directed to the 2001-02 and 2002-03 Annual NSW Police Commissioner's report to the Minister for Police for further details surrounding the restructure.
7. There are two ways of linking crimes to LACs. The first is to count the number of crimes detected by or reported to each LAC. The second is to count the number of crimes detected/ reported within each LAC's jurisdiction. I use the latter of these counting methods.
8. Police jurisdictions are now referred to as Police Area Commands (PACs). The present study refers to (and utilities the geographical boundaries of) the old LACs as these were in effect during the time span of the sample.
9. Homicide refers to the sum of murder, attempted murder and manslaughter.
10. In the robustness checks I experiment with different lengths of the hiring campaign and find estimates largely consistent with the main results.
11. I inflate each LAC's monthly count of crime/arrests by one in order to prevent LAC-month combinations with zero counts of crime/arrests from being dropped from the analysis. In the robustness checks I report estimates where I do not inflate these monthly counts with no meaningful change to the main results.

12. Since there are no “always-takers” in our sample the local average treatment effect is approximately equal to the average treatment effect.
13. These LACs include; Bankstown, Blacktown, Campbelltown, Fairfield, Liverpool, Parramatta and Sydney City.
14. There are explicit references to a Vikings Unit coordinating HVP operations in the NSW Annual Police Reports for the financial years 2002-03 to 2012-13.
15. One may be tempted to argue that my estimates are inconsistent because the hiring campaign took place within the context of the restructure. However, I do not believe this to be problematic since the restructure applied to all LACs and is therefore conditioned out through the year FEs.
16. The former tests whether or not the hiring campaign is correlated with changes to the size of the police force; while the latter tests whether or not the association is strong enough for the 2SLS strategy to work.
17. This is also supportive of the monotonicity assumption required in 2SLS IV setups.
18. Interested readers are directed to column 1 in Tables A1 and A2 in the Appendix for the OLS estimates of crime and arrests on police, respectively. These estimates indicate that the high frequency nature of the data is able to control for dynamic simultaneity fairly well.
19. This is also supported by the fact that the point estimates are negative; which indicates that additional police may actually lower the arrest rate if anything.

APPENDIX

Tables A1 and A2 follow an identical structure and present the elasticity estimates from nine different robustness checks for the effect of police on crime and arrests, respectively. Each row presents estimates for a different crime category and each column corresponds to a different robustness check. Column 1 reports OLS estimates where I regress the natural logarithm of crime (or arrests) on the natural logarithm of police along with the controls and FEs from Equations 1 and 2. This is an interesting exercise as it allows us to explore the severity of the simultaneity problem when compared with the 2SLS estimates in Tables 3 and 4. In column 2 I exclude the LAC specific linear trend in order to determine whether or not the FEs are enough to control for the ex-ante drop in crime. In column 3 I regress the raw count of crimes/arrests on the raw count of police numbers in order to provide readers with a rough idea of how much crime one additional officer can prevent. In column 4 I do not inflate the dependant variable by one in order to ensure my estimates are not driven by this specification choice. In column 5 I aggregate the data from a monthly to a quarterly panel in order to determine whether or not my model is able to adequately capture the dynamics between crime/arrests and police. In column 6 I exclude LACs with high ex-ante use/possess opioid offences from the analysis in order to determine whether or not my results are driven by the heroin shortage; finally, in columns 7, 8 and 9 I shift the end of the hiring campaign (and thus the sample) to December 2002, September 2003 and December 2003, respectively, to test the sensitivity of my results to this specification choice.

The estimates reported in Tables A1 and A2 are largely consistent with the main results. There is however, one noteworthy exception in Table A2. Specifically, when I aggregate the data to a quarterly panel I find that a one per cent increase in police numbers actually lowers the arrest rate for motor vehicle theft by about two per cent. I can think of two plausible explanations for this. The first is that my primary specification is unable to adequately capture the dynamics of motor vehicle theft. That is, it may take more than a single month for motor vehicle theft arrest rates to respond an increase in police numbers. The second is that aggregation to a quarterly panel has confounded the model’s capacity to address dynamic simultaneity concerns. In any event, the conflict between the estimates in Tables 4 and A2 does not change the qualitative conclusion of the study. In fact, if an increase in police numbers really does lower the arrest rate for motor vehicle theft, then the claim made in the discussion concerning the benefit of an additional officer exceeding the cost is grossly understated.

Table A1. Robustness checks for police on crime

	OLS	No linear trend	Counts	No inflation	Quarters	Heroin shortage	Dec-02	Sep-03	Dec-03
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Break and enter	0.078 (0.105)	-0.105 (0.402)	-0.011 (0.385)	-0.108 (0.413)	-0.329 (0.492)	-0.358 (0.495)	-0.107 (0.392)	-0.487 (0.748)	-0.057 (0.674)
Theft	-0.127* (0.076)	-0.801*** (0.280)	-1.418*** (0.417)	-0.807*** (0.287)	-0.960*** (0.350)	-1.017*** (0.339)	-0.759*** (0.269)	-0.033 (0.440)	0.398 (0.428)
Motor vehicle theft	-0.138 (0.119)	-1.144** (0.520)	-0.359** (0.176)	-1.183** (0.564)	-1.558** (0.652)	-1.360** (0.638)	-1.161** (0.491)	-2.315* (1.182)	-2.233** (1.119)
Property crime	0.057 (0.078)	-0.628* (0.316)	-1.788** (0.826)	-0.631* (0.322)	-0.845** (0.395)	-0.849** (0.385)	-0.606* (0.305)	-0.494 (0.534)	-0.114 (0.467)
Robbery	0.005 (0.160)	0.774 (0.640)	0.174** (0.072)	0.449 (0.764)	0.644 (0.808)	0.583 (0.770)	0.843 (0.632)	0.644 (1.280)	0.764 (1.178)
Homicide	0.039 (0.154)	-0.242 (0.500)	-0.002 (0.006)	0.750 (1.217)	-0.204 (0.724)	0.0136 (0.523)	-0.172 (0.490)	-0.706 (0.891)	-0.504 (0.758)
Violent crime	0.002 (0.165)	0.714 (0.663)	0.172** (0.071)	0.220 (0.777)	0.576 (0.828)	0.513 (0.802)	0.789 (0.653)	0.384 (1.257)	0.526 (1.151)
Estimation method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
LAC FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y
Linear trends	Y	N	Y	Y	Y	Y	Y	Y	Y

Note. LAC = Local Area Command, FEs = Fixed Effects, cluster robust standard errors in parentheses, clusters refer to LACs of which we have 75 in each regression, p<0.1 *, p<0.05 **, p<0.01***

Table A2. Robustness checks for police on arrests

	OLS	No linear trend	Counts	No inflation	Quarters	Heroin shortage	Dec-02	Sep-03	Dec-03
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Break and enter	0.313 (0.197)	0.578 (0.879)	0.016 (0.075)	0.739 (1.041)	0.556 (1.056)	0.043 (1.047)	0.629 (0.855)	0.552 (1.548)	-0.865 (1.355)
Theft	0.535* (0.270)	0.005 (0.579)	0.099 (0.096)	-0.153 (0.671)	-0.011 (0.666)	-0.142 (0.714)	0.161 (0.561)	0.348 (1.025)	0.547 (0.975)
Motor vehicle theft	-0.206 (0.300)	-1.560 (1.059)	-0.041 (0.046)	-0.793 (1.147)	-2.014* (1.191)	-1.842 (1.279)	-1.583* (0.900)	-5.084** (2.050)	-5.045** (2.002)
Property crime	0.442** (0.195)	-0.012 (0.541)	0.075 (0.156)	-0.011 (0.576)	-0.077 (0.664)	-0.252 (0.666)	0.118 (0.517)	-0.709 (0.966)	-0.888 (0.881)
Robbery	0.120 (0.250)	2.245** (0.948)	0.086*** (0.032)	2.966*** (1.094)	1.977 (1.227)	2.115* (1.112)	2.021** (0.931)	0.325 (1.663)	0.303 (1.575)
Homicide	0.185 (0.142)	-0.229 (0.499)	-0.004 (0.008)	0.200 (3.410)	-0.401 (0.866)	0.029 (0.527)	-0.160 (0.514)	-1.068 (1.022)	-0.917 (0.917)
Violent crime	0.218 (0.260)	1.992** (0.990)	0.083** (0.034)	2.821*** (1.062)	1.642 (1.303)	1.841 (1.161)	1.789* (0.966)	-0.569 (1.751)	-0.535 (1.627)
Estimation method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
LAC FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y
Linear trends	Y	N	Y	Y	Y	Y	Y	Y	Y

Note. LAC = Local Area Command, FEs = Fixed Effects, cluster robust standard errors in parentheses, clusters refer to LACs of which we have 75 in each regression, $p < 0.1$ *, $p < 0.05$ **, $p < 0.01$ ***