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The relationship between police arrests and correctional workload

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Aim: *To estimate the impact of a 10 per cent increase in arrests on (a) the number of male and female offenders sentenced to full-time prison terms (FTP) and (b) the number of offenders given community-based supervised orders (SO).*

Method: *Three pairs of time series (arrests and SO, male arrests and male FTP, female arrests and female FTP) were constructed from counts of male and female arrests, male and female FTP and SO over the 153 months from January 1998 to September 2010. Autoregressive distributed lag (ARDL) models were used to examine the impact of changes in the number of arrests on the outcome (SO, male FTP and female FTP).*

Results: *A 10 per cent increase in police arrests results in a 2.3 per cent increase in the number of SOs one month later. If the 10 per cent change persists, the increase in SO is estimated to be 4.1 per cent in the long term. A 10 per cent increase in the number of male arrests produces an immediate (same month) 3.3 per cent increase in the number of male FTP. If the 10 per cent change persists, the increase in male FTP over the long term is estimated to be 4.0 per cent. A 10 per cent increase in female arrests produces a 4.6 per cent increase in female FTP one month later. If the increase in female arrests persists, the increase in female FTP over the long term is estimated to reduce to 3.7 per cent. The short-run costs of a 10 per cent increase in police arrests are $2.6 million (supervised orders), $18.7 million (male FTP) and $2.2 million (female FTP), spread over 11 months for supervised orders and male full-time imprisonment and over 8 months for female full-time imprisonment.*

Conclusion: *Changes in arrest rates have significant and rapid impacts on demand for correctional services. Central agencies need to pay close attention to the downstream impact of policies that are likely to result in an increased arrest rate. Correctional agencies need to closely monitor arrest rate trends.*

Keywords: *Arrest, imprisonment, supervised orders, workload, ARDL models, time series*

INTRODUCTION

Between 1998 and 2010, the monthly number of male offenders in NSW given a sentence of full-time prison (FTP) rose by 19.9 per cent, from 430 to 741, the number of female offenders given a FTP sentence rose by 45.4 per cent, from 48 to 88, while the number of persons given a supervised order (SO) rose by 37.1 per cent, from 703 to 1,488. It costs $198.00 per day (recurrent) to keep someone in prison. The corresponding average cost for a community corrections order is only $21.48 (recurrent) per day (Steering Committee for the Review of Government Service Provision [SCRGSP], 2011).[1] The growth in the number of FTP and SO has clearly been very expensive. As with all correctional agencies, Corrections NSW has very limited control over the demand for its services. It would nonetheless assist both correctional planning and resource allocation to be able to predict or forecast changes in the number of FTP and SO. The earliest point at which it is possible to reliably forecast changes in the number of FTP or SO is at the point of arrest. The purpose of this report is to present the results of a study into how the changes in the number of people arrested by police influences the number of FTP and SO. The specific questions of interest are as follows:

1. What impact does a 10 per cent increase in male arrests have on the number of male FTP and how long does it take for this effect to be realised?

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2. What impact does a 10 per cent increase in female arrests have on the number of female FTP and how long does it take for this effect to be realised?
3. What impact does a 10 per cent increase in total (male and female) arrests have on the number of SO and how long does it take for this effect to be realised?

As the costs associated with both custodial and non-custodial orders are very different to those associated with juvenile detention, the study is restricted to adult offenders. We distinguish between male and female imprisonment because the marginal cost of male and female imprisonment is likely to differ for males and females. We do not distinguish between male and female SO because the costs of community supervision do not differ.

METHOD

DATA

To study the relationship between police arrests and correctional workload, we collected data sourced from the NSW Police Force's Computerised Operational Policing System (COPS). This database holds a unique record of all criminal incidents reported to, or detected by, police in NSW. In the analysis, we use the number of persons of interest (POI) proceeded against to court as a measure of police arrests because police initiate legal proceedings against more than 90 per cent of the persons they arrest. The dependent variables in the analysis, as noted earlier, are the monthly number of FTP and the monthly number of SO issued by the courts. Since our study focuses on adults, only cases involving persons aged 18 years and older were counted.

We ignore community-based orders that do not involve any form of supervision (e.g., good behaviour bonds, suspended sentences without supervision) on the grounds that these orders cost nothing or very little to administer. SO for our purposes include suspended sentences with supervision, community service orders, supervised bonds, and home detention.

To carry out the analysis, six time series (male FTP, male POI, female FTP, female POI, SO and total POI) were constructed from counts of male and female POIs, male and female FTPs and SO for all kinds of offences over the 153 months from January 1998 to September 2010 ($t = 1,\ldots,153$).

ANALYSIS

Two major problems arise when analysing the effect of some independent variable X on a dependent variable Y over time. The first is that factors other than X may influence the relationship between X and Y. Failure to control for this leads to what is known as omitted variable bias. The second is that X and Y may influence each other. This problem is known as endogeneity. The technique employed here to deal with these problems is known as autoregressive distributed lag (ARDL) modelling. In ARDL modelling we regress the dependent variable on lags of itself, plus contemporaneous and lagged values of the independent variable(s) of interest, plus any other variables needed to control for extraneous influences on the dependent variable. By regressing the dependent variable on lags of itself we hope to capture the influence of any omitted variable or variables on the time series up to that point. Identifying whether endogeneity was problematic was tested using the Durbin-Wu-Hausman test which will be described in the section on diagnostic checking. Note that we employed ARDL modelling rather than autoregressive integrated moving average (ARIMA) modelling, firstly because ARDL models give us better control over omitted variables and, secondly because the error term in ARIMA modelling can soak up some of the effect of independent variables on the dependent variables. The current approach therefore gives us more power to detect effects.

In the present study the dependent variables of interest (y_t), are male FTP, female FTP and SO. The independent variables (x_t) are male POI, female POI and total POI. We therefore fit models of the form:

$$\log y_t = \mu + \sum_{i=1}^{p} a_i \log y_{t-i} + \sum_{l=0}^{q} b_l \log x_{t-l} + c_1 m_1 + \cdots + c_{11} m_{11} + dt + e_t \quad (1)$$

In this equation, p and q are the largest significant lags for the dependent variable and independent variable respectively; $t = 1,\ldots,153$ represent the months of observation starting from January 1998 and ending in September 2010; $x_t,\ldots,x_{t-q}$ represent current and lagged values of the independent variables and $y_t,\ldots,y_{t-p}$ represent current and lagged values of the dependent variable. The $x_t,\ldots,x_{t-q}$ and $y_t,\ldots,y_{t-p}$ are logged so that the percentage change of each outcome variable in relation to a one per cent change in arrests (i.e., elasticity) can be easily obtained from the coefficients estimated from the model. The terms $m_1,\ldots,m_{11}$ represent monthly dummy variables to account for any seasonality in the dependent variable; while t represents a monotonically increasing time trend term, in months, to account for any deterministic linear trend in the dependent variable. The monthly dummy approach has proved useful in controlling for court sentencing seasonality, which is partly influenced by offending seasonality (e.g., more violent offenders are arrested over summer months leading to subsequent sentencing peaks around March and May) and partly influenced by court seasonal activity (e.g., January output from courts will be low due to holidays). The monthly coefficients can provide useful information for predicting seasonal regularity of court sentencing and hence variation in flow to correctional workload over the months of the year. The e_t represent the monthly residual errors, which are assumed to be identically and independently distributed with zero mean and constant variance (i.e., serially uncorrelated white noise). All analyses were carried out using Stata 10.1.

EXPECTATIONS

Since our primary interest is to investigate the extent to which changes in police arrests impact on correctional workload, the key parameters of interest are the coefficients $b_0, \ldots, b_q$. We expect these coefficients to be positive because a significant positive coefficient at lag l (b_l) indicates a significant positive correlation between police arrest and correctional workload. In other words, a positive coefficient b_0 indicates that when police arrests go up the correctional workload goes up in the same month. Similarly, a positive coefficient b_l indicates that when police arrest goes up in this month, the correctional workload rises l months later. This sort of effect would intuitively suggest an increase in correctional demand in response to police activities at different lags.

The coefficients $b_l, l = 0, \ldots, q$ give the short-run elasticity at lag l. By elasticity, we mean the estimated percentage change in correctional demand associated with a one per cent change in police arrests at the specified lag. If the one per cent change in police arrests is sustained permanently, the total effect on correctional workload, also known as the long-run elasticity (E_{LR}) is given by:

$$E_{LR} = \frac{\sum_{l=0}^{q} b_l}{1 - \sum_{i=1}^{p} a_i} \qquad (2)$$

DIAGNOSTIC CHECKING

An adequate ARDL model should be free from the following three problems: (1) endogeneity; (2) non-constant variance in the residuals; and (3) serial correlation in the residuals. A problem of endogeneity may arise if the coefficient b_0 is significant. While this might suggest that arrests have a contemporaneous (same month) impact on correctional workload, it could equally suggest that correctional workload has an impact on police arrests. To test if the feedback relationship exists (if police arrest is endogenous), Durbin–Wu–Hausman tests for endogeneity were performed. Before performing the test, we regressed correctional workload on police arrests using the lags of police arrests as instruments via the generalized method of moments (GMM) approach. The Durbin-Wu-Hausman test was then performed to check if the police arrest is endogenous.[2] A large p-value on the test indicated that the null hypothesis (that police arrest is exogenous) was not rejected.

Secondly, as mentioned above, our residuals are assumed to be identically and independently distributed with zero mean and constant variance (i.e., serially uncorrelated white noise). To test that they are identically distributed with constant variance, we performed the Bartlett's periodogram-based test (null hypothesis: the residuals are white noise). To test that they are independently distributed with no serial correlation, we used the Portmanteau test (null hypothesis: no serial correlation in the residuals up to lag l) and tested up to lag order 24. Large p-values of the two tests confirmed the model assumption for the residuals in each of the ARDL models. The p-values are reported in Table 2.

RESULTS

RAW DATA SERIES

Figures 1 to 3 in the Appendix show, respectively, male POI and male FTP, female POI and female FTP and total POI and SO. The key point to note about the figure is that all six series are trending upwards. All six series also show a strong seasonal pattern. These observations confirm the importance of including a variable to control for the upward trend and month variables to control for seasonal effects in the ARDL models.

Table 1. Descriptive statistics for model variables

Variables	N	Mean	SD	Max	Min
Male FTP	153	692.05	97.27	910	253
Female FTP	153	73.62	15.47	113	21
SO	153	1,321.57	193.86	1,721	703
Male POI	153	10,809.84	854.90	13,181	7,455
Female POI	153	2,271.43	254.38	2,868	1,345
Total POI	153	13,081.84	1,075.81	15,958	8,801

Table 1 provides some descriptive statistics for the variables used in the model. The variation in each of the series is quite substantial.

MODEL FITTING

While each of the series showed increasing trends over time, there was no evidence of stochastic trends according to the Phillips-Perron unit root test because the p-values for all series were extremely small ($p < .001$). Each of the models was therefore modelled in levels, rather than taking first differences.

Table 2. Parameter estimates of ARDL models for male FTP, female FTP and SO

		Male FTP			Female FTP			SO		
Variable	**Parameter**	**estimate**	**SE**	***p*-value**	**estimate**	**SE**	***p*-value**	**estimate**	**SE**	***p*-value**
$\log y_{t-1}$	a_1	-0.020	0.092	.825	-0.111	0.090	.222	-0.005	0.097	.959
$\log y_{t-2}$	a_2	0.063	0.050	.214	-0.110	0.077	.152	0.122*	0.051	.018
$\log y_{t-3}$	a_3	0.090	0.061	.140	0.085	0.069	.224	0.189*	0.095	.048
$\log y_{t-4}$	a_4	0.044	0.071	.534	-0.095	0.073	.191	0.130	0.090	.151
$\log x_t$	b_0	0.329*	0.139	.020	-	-	-	-	-	-
$\log x_{t-1}$	b_1	-	-	-	0.457*	0.166	.007	0.228*	0.097	.020
m_1	c_1	-0.225*	0.036	<.001	-0.265*	0.078	.001	-0.100*	0.034	.004
m_2	c_2	0.086*	0.041	.038	0.023	0.070	.739	0.134*	0.039	.001
m_3	c_3	0.182*	0.039	<.001	0.109	0.057	.057	0.277*	0.035	<.001
m_4	c_4	0.081	0.050	.107	0.083	0.055	.133	0.111*	0.052	.034
m_5	c_5	0.184*	0.042	<.001	0.145*	0.066	.031	0.253*	0.039	<.001
m_6	c_6	0.131*	0.038	.001	0.136*	0.062	.028	0.162*	0.028	<.001
m_7	c_7	0.029	0.034	.388	0.031	0.064	.633	0.149*	0.028	<.001
m_8	c_8	0.097*	0.037	.010	0.103	0.058	.080	0.173*	0.030	<.001
m_9	c_9	0.023	0.077	.766	-0.019	0.107	.860	0.065	0.051	.200
m_{10}	c_{10}	0.088*	0.037	.019	0.178*	0.070	.012	0.116*	0.029	<.001
m_{11}	c_{11}	0.117*	0.034	.001	0.084	0.054	.121	0.157*	0.032	<.001
t	d	0.001*	0.000	<.001	0.003*	0.001	<.001	0.001*	0.000	.003
constant	μ	2.145	1.404	.129	1.440	1.213	.237	1.673	0.919	.071
Portmanteau test		*p*-value			*p*-value			*p*-value		
lag 12		.344			.796			.083		
lag 24		.516			.774			.321		
Bartlett's test		.943			.588			.194		

* significant at 5% level

Table 3. Summary of ARDL models for male FTP, female FTP and SO

Dependent variable	Independent variable	Significant lags of independent variable	Short-run elasticity (in 10%)	Long-run elasticity (in 10%)	*p*-value of Durbin-Wu-Hausman test
Male FTP	Male POI	0	3.29	4.00	.964
Female FTP	Female POI	1	4.57	3.71	-
SO	Total POI	1	2.28	4.05	-

Supervised orders

Table 2 and Table 3 show the results of the ARDL models regressing male FTP, female FTP and SO on male, female and total POIs respectively. With respect to SO, after accounting for the serial correlation, seasonal pattern and deterministic linear trend, we found a significant positive lag effect of POI on SO, but the contemporaneous effect was found to be insignificant and hence the coefficient b_0 is omitted in Table 2. The significant coefficient b_1 indicates that for a 10 per cent increase in police arrests, sentences to supervised orders will increase by 2.28 per cent one month later (short-run elasticity). If the 10 per cent change persists permanently, the long run elasticity (see Equation (2)) is estimated to be 4.05 per cent.

Male full-time imprisonment

For full-time imprisonment, Table 2 shows a significant positive contemporaneous association between male FTP and male POI. There is no lag effect of male POI on male FTP and therefore the coefficient b_1 is omitted. As there is a contemporaneous relationship between male FTP and male POI, we fitted a model using the lags of male POI as instruments for male POI via GMM. The Durbin-Wu-Hausman test for endogeneity of male POI was performed and the *p*-value (p=.964), as shown in Table 3, revealed that male POI is indeed exogenous and thus there is no problem of endogeneity in the ARDL model for male FTP. The short-run elasticity (b_0=0.329) indicates that there is a contemporaneous 3.29 per cent increase of male FTP for a 10 per cent rise in male POI. In the long-term, the increase jumps to 4.00 per cent if the 10 per cent increase is sustained permanently.

Female full-time imprisonment

As with SO, there is a significant positive lag effect of female POI on female FTP (b_1=0.457) and no contemporaneous effect (b_0 is omitted). The short-run elasticity is estimated to be 4.57 per cent indicating a 10 per cent increase in female POI is associated with a 4.57 per cent increase in female FTP after 1 month. In addition, a 10 per cent permanent increase in female POI will produce a 3.71 per cent increase in female FTP as revealed by the long-run elasticity in Table 3.

Note that for female FTP in Table 3, the long-run elasticity is smaller than the short-run, indicating that the response of Correctional Services to a temporary shock in female arrests in the previous month is more vigorous than that to a permanent shock. This can be explained by the negative sum of coefficients of the lags of female FTP (a_1,a_2,a_4) in Equation (2), resulting in a denominator of greater than one. In other words, the impact of the increase in female arrests on female FTP is weakened over time while the impact of the increase in male arrests on male FTP and total arrests on SO is strengthened before the system reaches the long-run equilibrium.

DISCUSSION

Findings from this study confirm that police arrests have a significant impact on correctional workload. A 10 per cent increase in police arrests results in a 2.28 per cent increase in the number of SO one month later. If the 10 per cent change persists, the increase in SO is estimated to be 4.05 per cent in the long term. A 10 per cent increase in the number of male arrests produces an immediate (same month) 3.29 per cent increase in the number of male FTP. If the 10 per cent change persists, the increase in male FTP over the long term is estimated to be 4.00 per cent. A 10 per cent increase in female arrests produces a 4.57 per cent increase in female FTP one month later. If the increase in female arrests persists, the increase in female FTP over the long term is estimated to be 3.71 per cent. These effects apply after taking into account serial correlation, seasonality and the long-term upward trend in POIs and correctional workload measures.

An estimate of the short-run cost of a 10 per cent increase in arrests can be obtained by multiplying the short-term increase in custody/supervision orders by (a) the cost per day of each type of order and (b) the average lengths of time in custody or on supervised orders. It is impossible to obtain data on the true marginal cost per day of custody and supervised orders but the Productivity Commission (SCRGSP, 2011) does publish data on the recurrent cost per person per day of custodial orders and community based orders. These costs are, respectively, $198.00 (separate costs are not provided for male and female prisoners) and $21.48. The average duration of the minimum term of an offender sent to prison is 340 days for male full-time prisoners and 239 days for female full-time prisoners. We have been unable, unfortunately, to obtain separate estimates of the daily cost of imprisonment for male and female prisoners so we use the overall cost reported by the Productivity Commission (SCRGSP, 2011). The average duration of a supervised order (as defined earlier) is 315 days. On this basis, the short run costs of a 10 per cent increase in arrests are $2.6 million (supervised orders), $18.7 million (male FTP) and $2.2 million (female FTP). These costs are spread over 11 months for supervised orders and male full-time imprisonment and over 8 months for female full-time imprisonment.

These results have significant policy implications. The finding that an increase in arrests results in more work for corrective services is hardly unexpected but the size of the effect is a surprise. Prison and community-based orders are not the most common penalties imposed by courts. Large numbers of offenders are fined or given a community-based sanction that does not require any supervision by Corrective Services NSW. The sensitivity of correctional workload to police activity stems from the fact that a 10 per cent increase in the number of persons proceeded against by police represents a very large influx of cases into the criminal justice system. Even if only a small fraction of these people end up in prison or on a supervised order, the percentage change in workload for Corrective Services NSW would be substantial. Governments contemplating policies that might result in a significant increase in arrests clearly need to be mindful of their short and long-term downstream effects. It is also worth noting that the lag between changes in arrest rates and changes in correctional workload is very short. Correctional agencies may not be in a position to influence the rate of arrest. To the extent that early warning of an increase in workload assists in planning the correctional response to it, however, correctional agencies need to keep close tabs on changes in the rate of arrest.

There is one final point worth mentioning. Figures 1 to 3 show that the month to month variation in the number of POIs is considerable. The number of male POI, for example, can increase or fall by more than 2,000 over the course of a year. Changes to total POI can exceed 13 per cent in just two months. The impact of this will be felt within a month or two. The volatility in the arrest series means that Corrective Services NSW needs spare capacity if it is to cope at such short notice with the significant shocks to correctional workload, particularly after summer arrest peaks.

NOTES

1. The marginal cost for a community corrections order is not available and therefore the average cost is used as an approximation.
2. Note that the Durbin-Wu-Hausman test assumes that the instruments are valid. A valid instrument is one that is uncorrelated to the error term in Equation (1). This assumption can be assessed by performing the Hansen's test of overidentifying restrictions in Stata 10.1. A large *p*-value (p=.558) on the model for male full-time imprisonment indicated that the null hypothesis (the instruments are valid) is not rejected.

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APPENDIX

Figure 1. Monthly counts of males sentenced to full-time imprisonment (Male FTP) and proceeded against to court (Male POI) in NSW, January 1998 – September 2010

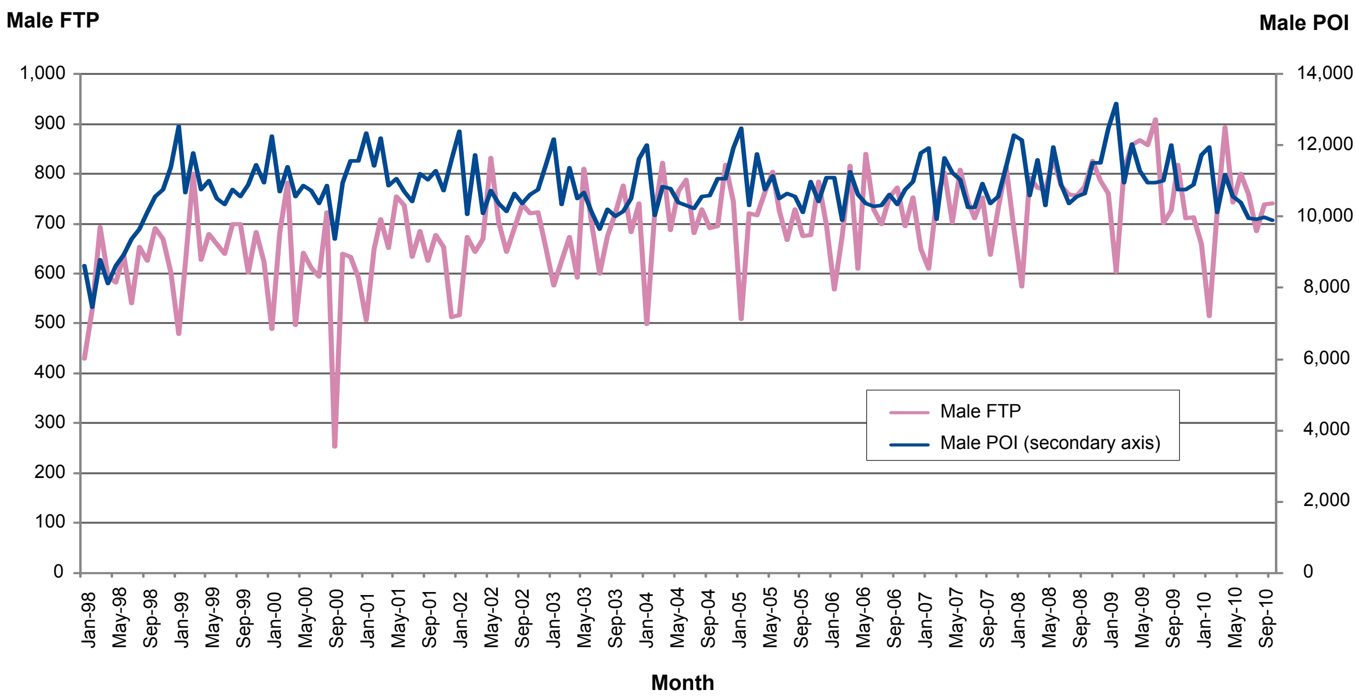


Figure 2. Monthly counts of females sentenced to full-time imprisonment (Female FTP) and proceeded against to court (Female POI) in NSW, January 1998 – September 2010

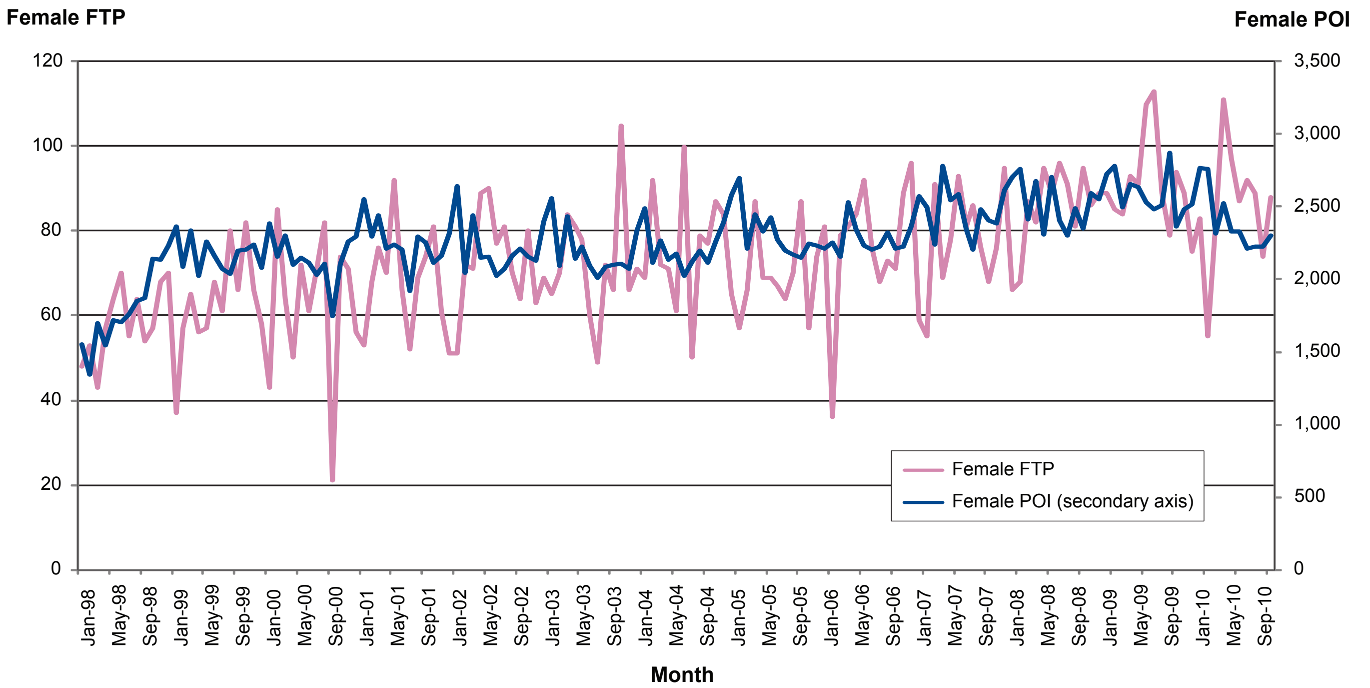
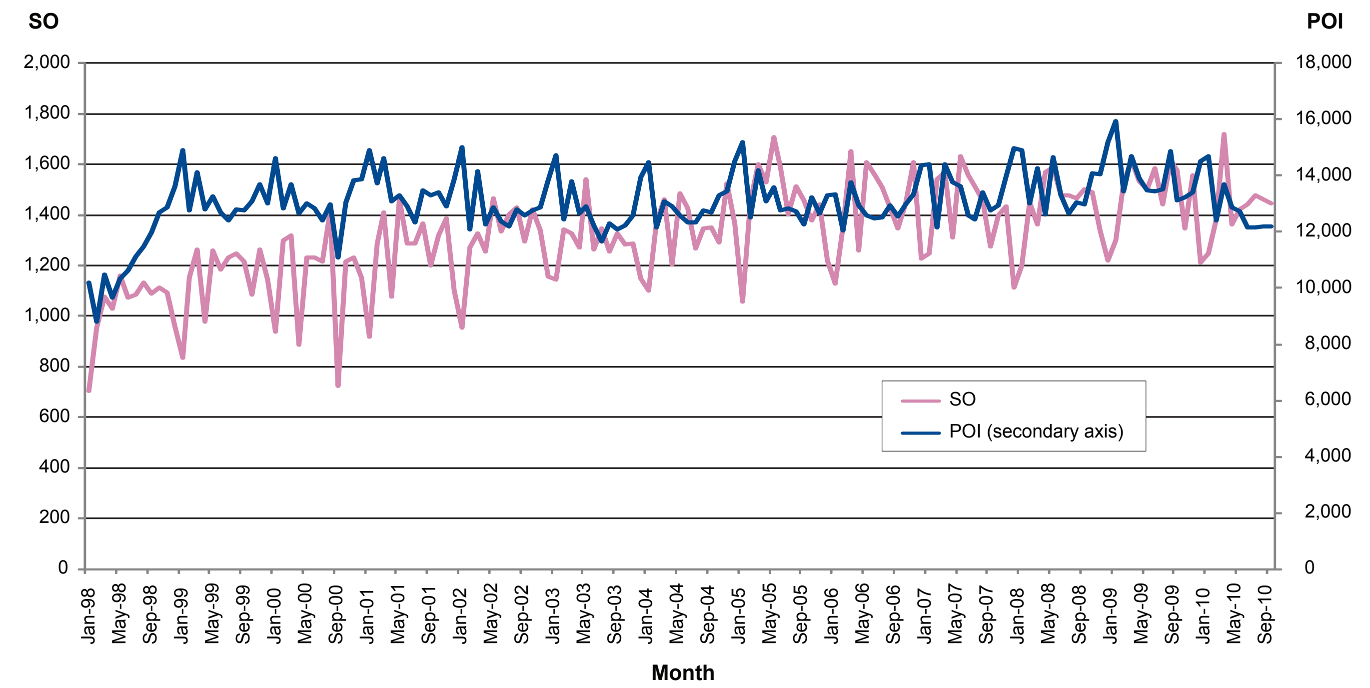


Figure 3. Monthly counts of persons given supervised orders (SO) and proceeded against to court (POI) in NSW, January 1998 – September 2010



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