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Supply-side reduction policy and drug-related harm

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Foreword | *This study examines whether seizures of heroin, cocaine or amphetamine-type substances (ATS) or supplier arrests for heroin, cocaine or ATS trafficking affect emergency department admissions related to, or arrests for, use and possession of these drugs. Two strategies were employed to answer the question. The first involved a time series analysis of the relationship between seizures, supplier arrests, emergency department admissions and use/possess arrests. The second involved an analysis of three specific operations identified by the NSW Crime Commission as having had the potential to affect the market for cocaine. The associations between supply reduction variables and use and harm measures for cocaine and ATS were all either not significant or positive. These findings suggest that increases in cocaine or ATS seizures or ATS supplier arrests are signals of increased (rather than reduced) supply. The three significant operations dealing with cocaine listed by the NSW Crime Commission did bring an end to the upward trend in the frequency of arrests for use and possession of cocaine. Thus, very large-scale supply control operations do sometimes reduce the availability of illicit drugs.*

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Supply reduction is one of the three pillars of Australia's drug policy. Some, however, have argued that supply reduction policy has failed because Australia (along with many other countries) spends very large sums of money on drug law enforcement, yet illegal drugs remain readily available and widely used (eg see Wodak & Owens 1996).

Direct evidence of the effect of supply reduction policy is fairly sparse. In their review, Mazerolle, Mazerolle, Soule and Rombouts (2007) identified four studies that examined the specific impact of supply control initiatives on drug use and drug-related harm initiatives on drug use and drug-related harm (Rumbold & Fry 1999; Smithson et al. 2004; Weatherburn & Lind 1997; Wood et al. 2003). Three of these studies (Rumbold & Fry 1999; Weatherburn & Lind 1997; Wood et al. 2003) found no effect of drug seizures on drug use patterns, drug-related deaths or overdoses, treatment enrolment or rates of crime and arrest. Smithson et al. (2004) observed that the decline in heroin supply in the Australian Capital Territory from July 1996 to April 2002 was accompanied by a reduction in non-fatal overdoses, crime and entry into methadone treatment. Their study, however, straddled the Australian heroin shortage. This was an exceptional event. To date, there is little evidence to suggest that 'routine' drug seizures are followed by a decline in drug consumption and drug-related harm.

The aim of the current study was to examine the impact of seizures and supplier arrests on the use of and harms associated with three drugs—heroin, cocaine and amphetamine-type substances (ATS). The question this study sought to address is whether seizures of heroin, cocaine and ATS, and/or supplier arrests have any effect on emergency department admissions and use/possess arrests for (a) heroin (b) cocaine and (c) ATS or on offences often committed by users of these drugs, namely (d) theft (e) robbery and (f) assault. It should be noted that use/possession arrests have been shown to be a useful indicator of trends in heroin, cocaine and ATS use (Moffatt, Wan & Weatherburn 2012).

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More specifically, our interest lies in determining whether there is an inverse contemporaneous or lagged relationship between any of the outcomes (a)–(f) and:

1. The number of heroin seizures.
2. The weight of heroin seized.
3. The number of heroin supplier arrests.
4. The number of cocaine seizures.
5. The weight of cocaine seized.
6. The number of cocaine supplier arrests.
7. The number of ATS seizures.
8. The weight of ATS seized.
9. The number of ATS supplier arrests.

Seizures and supplier arrests in jurisdictions outside New South Wales were included because they may affect the market for heroin, cocaine or ATS in New South Wales. New South Wales was chosen as the site for an examination of the effects of seizures and supplier arrests because it has one of the largest markets for these three drugs in Australia. In the next section, the methods used to answer these questions are described in more detail.

Method

Data

The study period extended from July 2001 to June 2011. Data on monthly drug seizures (weight and frequency) and drug supplier arrests were obtained from the National Illicit Drug Reporting Format system maintained by the Australian Crime Commission. Data on monthly use/possess arrests, theft, robbery and assault were sourced from the NSW crime and operational policing system database. Data on heroin, cocaine and ATS emergency department admissions were obtained from the NSW Department of Health.

Treatment of seizure data

For the purpose of this study, a seizure was defined as a quantity of heroin, cocaine or ATS that lay in the top 20 percent of the distribution of heroin, cocaine or ATS seizures by weight across the entire study period. The mean weights (m), standard deviations (SD) and interquartile ranges (IQR) of seizures at or above these thresholds in each of the three drug type categories examined was:

- Heroin—m=173.46 grams (SD=2,129 grams, IQR=23 grams)
- Cocaine—m=267 grams (SD=1,825 grams, IQR=782 grams)
- ATS—m=326 grams (SD=4,146 grams, IQR=415 grams)

Special operations

The general analysis of supplier arrests was supplemented with an analysis of three specific operations identified by the NSW Crime Commission as has having had the potential to have affected the market for cocaine. The three operations identified by the Commission were:

- Operation Balmoral Athens, which in June 2010 resulted in the arrest of four people and the seizure of 240kg of cocaine;
- Operation Tempest, which in September 2010 resulted in the arrest of four people and the seizure of 50kg of cocaine; and
- Operation Collage, which in October 2010 resulted in the arrest of three people and the seizure of 450kg of cocaine.

Because the arrests occurred over a five month period, they were treated as a single intervention.

Table 1 Descriptive summary for dependent and independent variables in New South Wales

Variables	Mean	SD	Min	Max	Unit root test
UP arrests of ATS	263.67	85.00	141	533	stationary
UP arrests of cocaine	29.86	18.63	3	98	stationary
UP arrests of heroin	69.34	16.19	35	105	stationary
ED admissions for ATS	28.03	8.48	12	55	stationary
ED admissions for cocaine	5.18	2.74	0	13	stationary
ED admissions for heroin	62.08	13.56	32	108	stationary
Property crime	25,554.9	4,731.0	19,366	38,928	trend stationary
Assaults	5,821.93	506.96	4,956	6,920	stationary
Robbery	650.96	175.01	351	1,133	stationary
Number of seizure of ATS	286.91	114.32	118	512	stationary
Number of seizure of cocaine	33.42	19.88	2	82	stationary
Number of seizure of heroin	56.43	14.30	26	113	stationary
Weight of seizure of ATS (grams)	19.11	36.06	0.84	236.15	stationary
Weight of seizure of cocaine (grams)	1.84	4.66	0.01	39.01	stationary
Weight of seizure of heroin (grams)	2.00	7.13	0.03	70.55	stationary
Number of supplier arrests of ATS	65.82	31.17	18	127	stationary
Number of supplier arrests of cocaine	9.43	5.90	0	26	stationary
Number of supplier arrests of heroin	20.50	8.57	5	48	stationary

Note: UP=use/possess. ED=emergency department. ATS=amphetamine-type substances

Table 2 Summary of reduced ARDL model results for heroin										
Independent variables	**Dependent variables**									
	UP arrests					**ED admissions**				
	Lag 0	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**	**Lag 0**	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
Number of seizures	0.725				0.549					
Weight of seizures	-0.163	0.220	0.215							
Number of supplier arrests	0.354							-0.310		
Diagnostic checking	**p value**					**p value**				
	M1			**M2**		**M1**			**M2**	
Ljung-Box test (up to lag 24)	.327			.476					.562	
Engle's LM test	.881			.631					.163	
Granger causality test	**p value**									
Number of seizures	.474									
Weight of seizures	.065									
Number of supplier arrests	.054									

Note: M1 refers the ARDL model using number and weight of seizures as independent variables; M2 refers to the model with number of supplier arrests as independent variable. UP=use/possess. ED=emergency department

Statistical analysis

Modelling

Most of the time series analyses were conducted using autoregressive distributed lag (ARDL) models. To test the effect of operations Balmoral Athens, Tempest and Collage, the number of cocaine use/possess arrests and emergency department admissions were regressed against an independent variable measuring elapsed time, a dummy variable indicating the onset of the operations (0 before June 2010 and 1 otherwise) and an interaction term between time and dummy variable. By using the dummy variable, any change in the average level of use/possess arrests or emergency department admissions after the three significant operations was able to be captured. Adding the interaction between elapsed time and dummy variable allows measurement of any change in the direction of the trend after June 2010.

Results

Preliminary analysis

Preliminary analysis revealed no consistent relationships with the use/possess arrests or emergency department admissions for any of the three drugs in any state other than New South Wales. The analysis that follows is therefore limited to seizures, supplier arrests, use/possession arrests and drug-related crime in New South Wales.

Descriptive statistics

Table 1 shows the mean monthly number of seizures, monthly weight of drugs seized and monthly number of supplier arrests in New South Wales. Also shown are the standard deviation, minimum and maximum values, and the results of an augmented Dickey-Fuller unit root test, which was conducted to see if the series are stationary. The test results show that all of the series are stationary and the ARDL models can be fitted without differencing.

The results of the modelling for use/possess arrests and emergency department admissions are shown in Tables 2 (heroin), 3 (cocaine) and 4 (ATS).

Table 2 indicates that when the number of large-scale seizures of heroin increases by 10 units, use/possess arrests go up by 7.25 units in the same time period and by 5.49 units four months later. Similarly, if the number of supplier arrests of heroin increases by 10 units, the use/possess arrests in New South Wales go up by 3.54 units in the same time period. Notice, however, that there is a significant negative contemporaneous relationship between the quantity of heroin seized in a particular month and the number of use/possess arrests in the same month. There is also a significant negative relationship between the number of supplier arrests in a given month and the number of emergency department admissions two months later.

The results for cocaine and ATS are shown in Table 3. A 10 unit increase in the number of cocaine seizures is associated with a contemporaneous 10.52 unit increase in the number of use/possess arrests for cocaine. Positive effects are also found in relation to cocaine emergency department admissions. When the number of seizures increases by 10 units, emergency department admissions for cocaine increase by 1.75 units one month later. When the number of supplier arrests rises by 10 units, emergency department admissions for cocaine increase by 1.56 units two months later. In the case of ATS (see Table 4), the number of seizures and supplier arrests are both significantly and contemporaneously related to use/possess

arrests. When the number of large-scale seizures increases by 10 units, ATS use/possess arrests jump up by 11.62 units. Similarly, when the number of ATS supplier arrests increases by 10 units, the number of use/possess arrests goes up by 5.78 units.

No consistent effects of supply control measures (seizure frequency, seizure weight, supplier arrests) were found for theft, robbery or assault. In fact, in most instances, no significant effect of any kind was found. Where significant effects were found, they were often inconsistent. An increase in the monthly weight of heroin seized, for example, was associated with an increase in theft offences at lag 1 and a decrease in theft offences at lag 4. Increases in the monthly weight of cocaine seized were associated with an increase in assault at lag 1 and an increase in robbery at lag 4, but increases in the number of cocaine seizures or the number of cocaine supplier arrests were associated with decreases in theft offences at lag 1.

Interrupted time series analysis

Figure 1 shows the results of the first interrupted time series analysis on use/possess arrests of cocaine. The vertical line in June 2010 marks the point where the first of the three major cocaine operations began. The fitted line shows the modelled trend before and after the operation and those which followed.

Frequencies of use/possess arrests for cocaine can be seen to increase up to June 2010 and then level off. According to the fitted values, there was an uptrend prior to June 2010 and the trend turned downwards afterwards. This suggests that the three operations lead to a drop in the use/possess arrests in New South Wales. The result of the interrupted time series analysis are summarised in Table 5.

The results indicate that the interaction between time and the dummy variable is significantly negative and this confirms a change in the trend of use/possess arrests after June 2010.

Figure 1 Use/possess arrests of cocaine in New South Wales (n)

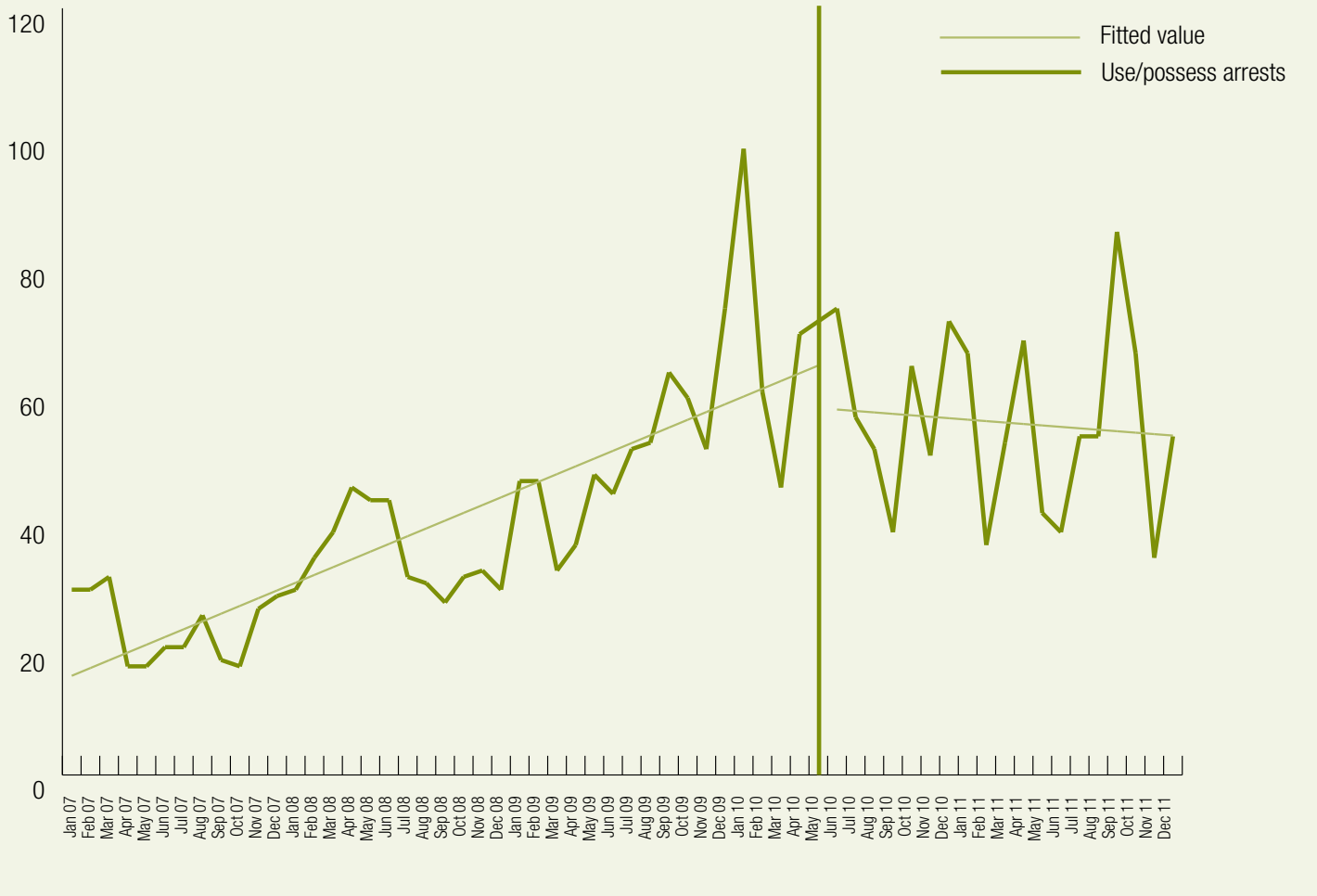

Table 3 Summary of reduced ARDL model results for cocaine										
Independent variables	Dependent variables									
	UP arrests					ED admissions				
	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4
Number of seizures	1.052						0.175			
Weight of seizures										
Number of supplier arrests								0.156		
Diagnostic checking	p value					p value				
	M1			M2		M1			M2	
Ljung-Box test (up to lag 24)	.372			.146		.436			.628	
Engle's LM test	.728			.235		.782			.948	
Granger causality test	p-value									
Number of seizures	.130									

Note: UP=use/possess. ED=emergency department

Table 4 Summary of reduced ARDL model results for ATS										
Independent variables	Dependent variables									
	UP arrests					ED admissions				
	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4
Number of seizures	1.162									
Weight of seizures										
Number of supplier arrests	0.578									
Diagnostic checking	p value									
	M1			M2						
Ljung-Box test (up to lag 24)	.073			.192						
Engle's LM test	.075			.195						
Granger causality test	p value									
Number of seizures	.067									
Number of supplier arrests	.143									

Note: UP=use/possess. ED=emergency department

Figure 2 indicates the observed series and fitted trends for emergency department admissions for cocaine from the interrupted time series analysis. Emergency department admissions remained stable before June 2010 but dipped sharply immediately after the three operations before they rose again in mid-2011. They then bounced back to their original level. This suggests that the three operations also led to a drop in the emergency department admissions in New South Wales. The result of the interrupted time series analysis are summarised in Table 6.

The results indicate that the dummy variable is significantly negative and this confirms a drop in the emergency department admissions after June 2010 and the significant positive interaction between time and the dummy variable reveals that the emergency department admissions rose again.

Table 7 summarises the results of the testing. A positive sign indicates a significant positive relationship between the independent variable in the same row and the outcome (use/possess arrests or emergency department admissions) in the same column. A negative sign indicates a significant negative relationship between the independent variable in the same row and the outcome in the same column. The lag at which the relationship is significant is indicated in brackets.

Discussion

The question we sought to address in this study was whether supply reduction efforts exert any measurable effect on emergency department admissions for drug use and arrests for use and possession of drugs. The associations between supply reduction

variables, and use and harm measures for cocaine and ATS were all either non-significant or positive. These findings suggest that increases in cocaine or ATS seizures or ATS supplier arrests are signals of increased (rather than reduced) supply. No consistent effects were found between any of the supply reduction measures and police reports of theft, robbery and assault.

On the whole, these results are not especially favourable to the hypothesis that increases in seizure frequency, seizure weight and supplier arrests within the normal range are have an effect over the short term on heroin, cocaine and ATS-related harm. In only three of the 18 ARDL analyses did a supply reduction measure have a significant relationship with emergency department admissions (number of heroin supplier arrests, cocaine seizures, cocaine supplier arrests). In only two of these analyses was the expected negative relationship confirmed for one or other of the two outcome variables. In no analysis was it confirmed for both. The majority of significant effects suggested a positive relationship between the relevant measures of supply reduction activity on the one hand, and use/possess arrests and emergency department admissions on the other. If use/possess arrests are a guide to consumption, increases in heroin, cocaine and ATS seizure quantity or frequency, within the normal range, are more likely to signal an increase rather than a reduction in drug consumption. If emergency department admissions are accepted as a guide to drug-related harm, increases in heroin, cocaine and ATS seizure quantity or frequency, within the normal range, have little if any impact on the harms associated with heroin, cocaine and ATS.

Figure 2 Emergency department admissions of cocaine in New South Wales (n)

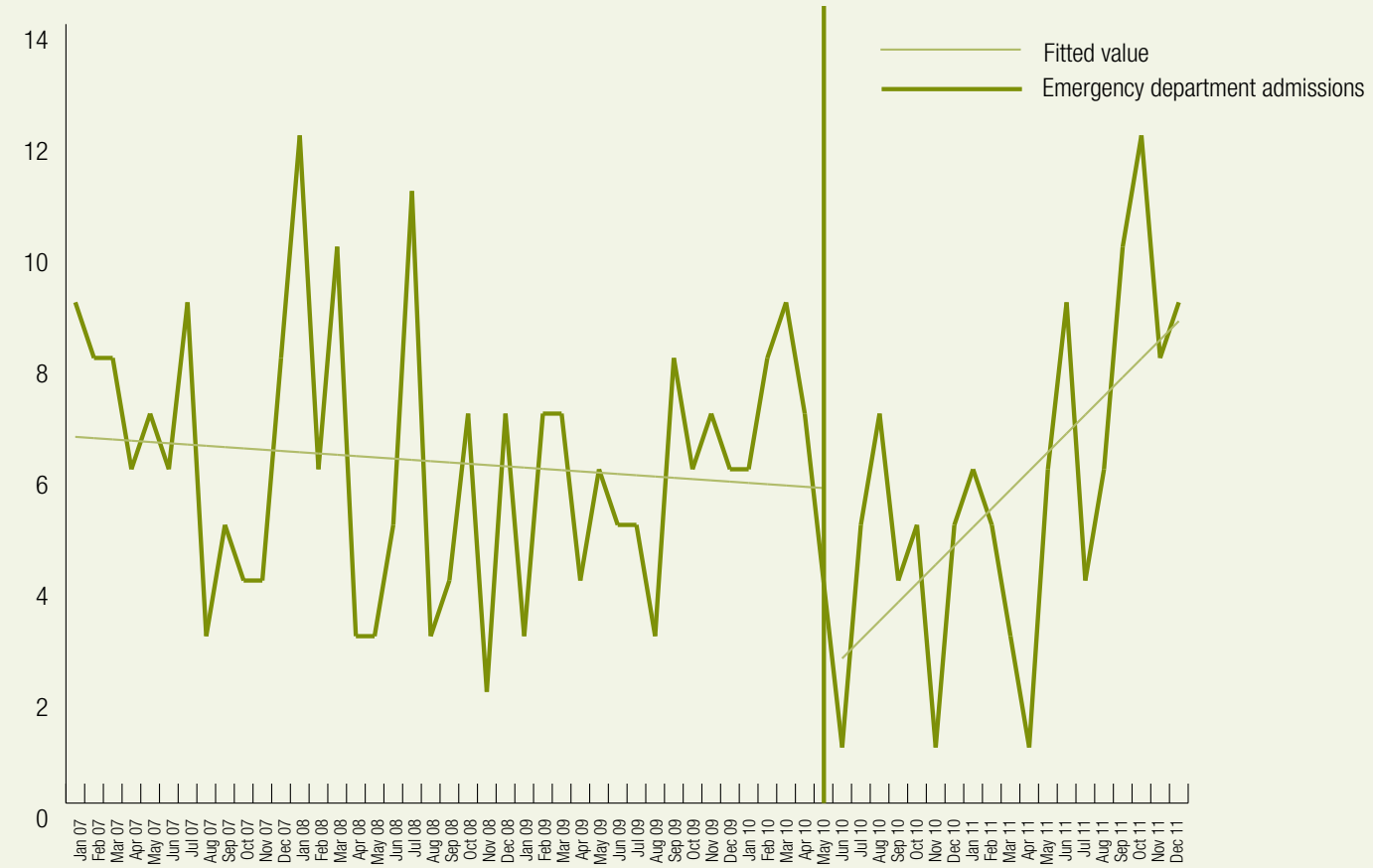

Table 5 Results for interrupted time series analysis on use/possess arrests of cocaine in New South Wales during January 2007 and December 2011

Variable	Estimate	SE	p value
Time	1.214	0.163	<.001
Dummy variable	173.387	81.902	.039
Time*dummy	-1.440	0.621	.024
Constant	-87.677	16.404	<.001

Table 6 Results for interrupted time series analysis on emergency department admissions of cocaine in NSW during January 2007 and December 2011			
Variable	Estimate	SE	p value
Time	-0.023	0.032	.473
Dummy variable	-48.379	14.043	.001
Time*dummy	0.360	0.106	.001
Constant	8.537	3.360	.014

Table 7 Summary of results		
IV	UP arrests	ED admissions
No. heroin seizures	+ (lag 0),+(lag 4)	NS
Weight heroin seizure	- (lag 0),+ (lag 1),+ (lag 2)	NS
No. heroin supplier arrests	+ (lag 0)	- (lag 2)
No. cocaine seizures	+ (lag 0)	+ (lag 1)
Weight cocaine seizure	NS	NS
No. cocaine supplier arrests	NS	+ (lag 2)
No. ATS seizures	+ (lag 0)	NS
Weight ATS seizures	NS	NS
No. ATS supplier arrests	+ (lag 0)	NS
Special operations on cocaine	n/a	n/a

Note: IV=independent variable. UP=use/possess. ED=emergency department. ATS=amphetamine-type substances. NS= the coefficient is not significant at 0.05 significance level

The only significant negative effects in the ARDL models were confined to heroin but the results for this drug were mixed. On the one hand, a significant negative relationship was found between the weight of heroin seized in a particular month and the number of persons arrested for use and possession of heroin in the same month. A significant negative relationship was also found between the number of heroin supplier arrests in a particular month and the number of emergency department admissions for heroin use two months later. These findings suggest that increases in the weight of heroin seized or the number of heroin supplier arrests may signal a reduction in heroin availability. This interpretation of the data, however, is hard to reconcile with two other findings. The first is that the number of heroin seizures was positively related to the number of arrests for heroin use and possession in the same month. The second is that the number of heroin supplier arrests was positively related to the number of emergency department admissions in the same month. The explanation for these inconsistent findings is unclear but the results may reflect the effects of some unobserved and unmeasured factors.

The three major operations dealing with cocaine listed by the NSW Crime Commission as significant did bring an end to the upward trend in the frequency of arrests for use and possession of cocaine. Prior to these operations, the number of use/possess arrests for cocaine was rising by an average of 1.21 incidents per month during the period January 2007 to May 2010. After the operations, the frequency of use/possess arrests for cocaine actually fell slightly from 71 to 53, at an average rate of 0.23 incidents per month until the end of 2011. The number of emergency department admissions also fell from an average of 6.12 incidents during January 2007 to May 2010 to 3.91 incidents during June 2010 to April 2011 before it started to bounce back again in May 2011.

As always, there are qualifications surrounding these results. It is possible that the principal outcome measures, use/possess arrests and emergency department admissions, are not sensitive to changes in consumption or drug-related harm that occur in response to variations in seizures or supplier arrests. This seems unlikely in the case of emergency department admissions because past research has shown them to have a strong inverse relationship with the purity-adjusted price of these drugs (Dave 2005). It is more likely with use/possess arrests because they are sometimes affected by changes in police resources or policing policy. It is possible that the effects of seizures and supplier arrests on use/possess arrests and emergency department admissions take longer than four months to appear (the maximum lag at which effects were tested for in the current study). This finding, however, does not sit well with the effects seen in Figures 1 and 2.

Finally, it is possible that one or more of the supply reduction measures failed to pick up changes in supply. In the case of seizure weight and frequency, a somewhat arbitrary judgement had to be made about what constituted a 'significant' seizure in terms of weight. Although this judgement was reached after trying out different weight thresholds to see which produced

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the most coherent pattern of results, there is no independent way of knowing whether the thresholds finally settled on were of a size that would be expected to affect the use of and harms associate with heroin, cocaine and ATS. Supplier arrests presented a similar problem. The data on supplier arrests collected by the Australian Crime Commission included all arrests for supply, regardless of the level of the drug distribution chain at which arrests are effected. It is entirely possible that the 'signal' coming from the few high-level supplier arrests that do influence the drug market is hidden in the 'noise' coming from large numbers of low-level supplier arrests.

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