DRUG LAW ENFORCEMENT POLICY AND ITS IMPACT ON THE HEROIN MARKET

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with assistance from Yolande Dubow and Robert Jochelson

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PREFACE

Both State and Commonwealth law enforcement agencies invest considerable sums of taxpayers' money in drug law enforcement directed at disrupting the market for heroin. For the most part the impact of this investment completely escapes any form of objective assessment. Media treatment of the 'war on drugs' encourages the general community to assume that every major heroin seizure and every arrest of a 'drug baron' significantly reduces the availability of heroin on the street.

There are some, of course, who have questioned the efficacy of this investment, arguing that heroin prohibition rather than heroin per se is to be blamed for the social costs associated with heroin use. There is something to be said for this argument. It is the effect of prohibition on the price of heroin, after all, not the effect of the drug on heroin users, which causes them to commit property crime at very high rates. At the same time, critics of heroin prohibition are sometimes slow to acknowledge the fact that the high cost of heroin may be one of the reasons why the prevalence of heroin use in the general community remains surprising low. They are also often inclined to assume rather than show that the social cost of heroin use is minimised under a scheme of partial legalisation rather than under one of complete prohibition.

The present study was undertaken with two objectives in mind. The first was to assess the impact of heroin seizures (i.e. supply-side law enforcement) on the price, purity and availability of heroin. The second was to assess the impact of street-level police activity (i.e. demand-side law enforcement) on the rate of admission for methadone treatment and on the street-level price of heroin. The results show that variations in the average amount of heroin seized exert no effect on the price, purity or availability of heroin at street-level. They also show that the rate of arrest for heroin use and/or possession exerts no effect on the street-level price of heroin or on the rate at which heroin users seek methadone treatment. Heroin users seeking methadone treatment, however, frequently cite the price of heroin and police activity as determining factors in their decision to seek treatment.

The report draws several conclusions from these results and those of earlier studies.

• Firstly, street-level law enforcement may be a factor in the rate at which heroin users seek treatment but the current results cannot be read as indicating that more active street-level enforcement would increase the rate at which users seek treatment.

• Secondly, although variations in the quantity of heroin seized exert no impact on the street-level price of heroin, the risks created to heroin importers and distributors by supply-side law enforcement are probably determining factors in the high price of heroin.

• Thirdly, if the demand for heroin (at least among recreational users) can be assumed to be sensitive to its price, it can be argued that the object of supply-side policy should be to maintain the price of heroin on the illegal market rather than to maximise the quantity of heroin seized.

• Fourthly, if the goal of supply-side law enforcement policy is to be to maintain the price of heroin on the illegal market some means should be found for reducing the social cost (in terms of crime and public health) of keeping illegally obtained heroin expensive.

• Fifthly, an expansion of the methadone program and/or the provision of heroin to dependent users under controlled conditions provide the best available means of reducing the social costs associated with supply-side law enforcement policy.

• Finally, however, the proposed ACT heroin trial should be used as a means of gauging the relative costs and benefits associated with the provision of methadone and/or heroin under controlled conditions to dependent users.

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1. INTRODUCTION

According to the latest National Drug Strategy Survey, about 2 per cent of Australian residents aged 14 years and over (i.e. 242,000 persons) have tried heroin at some stage in their lives (Department of Human Services and Health 1994). As Hall (1995) points out, estimates of the number of current regular heroin users vary widely depending on the method used to obtain the estimate. The National Drug Strategy Survey indicates that about 36,000 persons across Australia have used heroin in the past twelve months. Kehoe, Hall and Mant (cited in Hall 1995), using capture-recapture methods, obtained a figure for regular heroin users of 45,000. Hall cites other methods, however, which place the number of dependent heroin users at between 90,000 and 150,000. Although there is room for debate about the precise size of the heroin population, according to Hall, all methods so far used to estimate the size of the Australian regular heroin-user population lead to the conclusion that it increased between 1984 and 1993.

For obvious reasons, the precise value of the heroin market is more difficult to determine than the number of regular heroin users. In 1989 the Parliamentary Joint Committee on the National Crime Authority (1989) placed the total annual consumption of heroin in Australia at around 350 kilograms. Having regard to the then current street price of heroin the Committee estimated the market value of the heroin consumed in Australia at about $700 million per annum. This estimate must be regarded as extremely conservative. In obtaining it the Committee rejected population survey-based advice that the number of regular heroin users lay in the range 30,000 to 50,000 and chose instead to assume that the number of frequent users of heroin in Australia in 1989 was only 3,360. If, as seems highly likely, this was a gross underestimate of the number of regular heroin users,[1] the market for heroin in Australia must have been worth well in excess of $700 million in 1989 and has probably increased in value substantially since then.

A significant proportion of the funds expended on purchases of heroin are raised through the commission of property crime. A 1984 survey of imprisoned NSW property offenders (Dobinson & Ward 1985), for example, found that 50 per cent of those who identified themselves as regular heroin users stated that heroin use had increased the amount of property crime they committed. Those who described themselves as ‘heavy’ users of heroin committed armed robberies 1.8 times more frequently and break, enter and steal offences 1.7 times more frequently than those who described themselves as ‘light’ users of heroin. The observation that regular heroin use amplifies offending frequency amongst those involved in crime has been confirmed in other studies. Blumstein, Cohen, Roth and Visher (1986), for example, cite evidence that daily heroin users committed robberies and burglaries, respectively, at rates which were 2.9 and 4.7 times higher than ‘infrequent’ users of the drug.

Strategies designed to combat illegal drug use generally fall into one of two categories. Supply-side strategies, as the term suggests, are those designed to combat the supply of an illegal drug. Such strategies include crop eradication, importation controls and undercover policing directed at high-level distributors of illegal drugs. Demand-side strategies are designed to reduce the demand for an illegal drug. Such strategies include health awareness campaigns and treatment programs. The distinction between supply-side and demand-side strategies is sometimes thought of as a distinction between law enforcement and health approaches to the problem of drug abuse. Some have argued, however, that police harassment of illicit drug users increases the rate at which they give up drug use or seek treatment (Eatherly 1974). If this is true street-level drug law enforcement may be regarded as a demand-side strategy.

Although the rate of arrest for heroin use and/or possession is much higher than that for supply (NSW Bureau of Crime Statistics and Research 1995), most Australian law enforcement agencies concentrate special effort (and place great public relations value) on 'supply-side' drug law enforcement. The Australian Customs Service reported 56 seizures of heroin in 1994, totalling just under 250 kilograms (Australian Bureau of Criminal Intelligence 1994). State police also concentrate a large part of their drug law enforcement effort on detecting and arresting domestic suppliers of illegal drugs. Some indication of the scale of this effort may be gleaned from the fact that the NSW Drug Enforcement Agency, which employs 270 officers expressly dedicated to the task of immobilising 'middle to upper level traffickers' (NSW Police Service 1993), operates on a recurrent annual budget in excess of $14 million (McLachlan 1995). In 1994, 430 persons were prosecuted in NSW courts for dealing or trafficking in narcotics (NSW Bureau of Crime Statistics and Research 1995).

Supply-side drug law enforcement is sometimes criticised as a failure on the grounds that illegal drugs, such as heroin, remain readily available. Drug law enforcement agencies, however, are entitled to be judged by less stringent criteria than total destruction of an illegal drug market. The object of supply-side law enforcement, it could be argued, is to drive up the price of heroin at street level. Conventional economic wisdom suggests this should reduce the demand for heroin even if it does not eliminate it. Of course conventional wisdom may be mistaken. There is an obligation on those who would defend supply-side drug law enforcement to show that supply-side strategies drive up the price of heroin and that increases in the price of the drug reduce the demand for it. In fact a number of economists have questioned this last assumption, arguing that the demand for heroin is price-inelastic. This argument is of central importance to drug law enforcement policy.

A price-inelastic demand is one which is unresponsive (or only very weakly responsive) to changes in the price of heroin. As White and Luksetich (1983) point out, if demand for heroin is price-inelastic and supply-side enforcement increases the price of heroin:

> ...the higher price of heroin results in an increase in the total amount spent on heroin by addicts. Many addicts finance their habit through property crime; therefore, the increase in the total amount spent on heroin by addicts generates more property crime. The greater spending on heroin by addicts means increased revenues for the sellers of heroin, who may use it to finance other crime.

In fact one does not need to assume that demand for heroin is price-inelastic to arrive at the conclusion that supply-side strategies may increase the level of expenditure on heroin. Wagstaff and Maynard (1988) have shown that, even if the demand for heroin is weakly price-elastic, expenditure on the drug could rise in response to supply-side enforcement. In theory, therefore, supply-side law enforcement could increase the level of property crime even if it reduced the consumption of heroin.

Acceptance of this conclusion has led some to argue that we would be better off trying to reduce the demand for heroin or supplying it legally than trying to reduce its illegal supply (Marks 1990). Demand-side strategies, it has been suggested, do not suffer from the problems of supply-side law enforcement, even if the demand for heroin is price-inelastic (Wagstaff & Maynard 1988). When the demand for heroin is reduced, competition among drug suppliers causes the price of heroin to fall. With a reduction in price, suppliers are forced to cut back supply, with the result that the total consumption of heroin falls along with total expenditure on the drug. The reduction in expenditure, in turn, reduces the amount of property crime which has to be committed by heroin users to fund their addiction. Thus, whereas supply-side strategies can actually increase the amount of crime committed by heroin users, demand-side strategies are said to have the reverse effect.

Although some published evidence (Kleiman, Holland & Hayes 1984; Kleiman & Smith 1990; Caulkins, Larson & Rich 1993) exists to support this contention, the spread of HIV-AIDS has tended to undermine support in this country for demand-side drug law enforcement strategies, especially where they involve police harassment of heroin users. Government-funded needle exchange programs are an important ingredient in the general strategy to prevent the spread of diseases such as HIV-AIDS. Police in NSW (and perhaps in other States as well) generally endeavour to effect arrests for heroin possession without disrupting needle exchange programs. There is a natural tension, nonetheless, between police tactics which are effective in raising the personal 'cost' (to users) of injecting illegal drugs and tactics which are effective in discouraging the use of shared or unsterilized injection equipment.

Demand-side law enforcement policies have come in for criticism on empirical and theoretical as well as on practical grounds. Caulkins, Larson and Rich (1993) studied the effects of police attempts to suppress the market for heroin in two areas of Hartford, Connecticut. They reported that, although the interventions undertaken by police to discourage demand for heroin were nearly identical in nature, duration and effort, the impact on the demand for and supply of heroin in each of the two areas was 'strikingly different'. In one area residents reported lower crime rates and far less public trade in heroin. Many residents in the second area, however, felt that the public trade in heroin had only been temporarily suppressed and far fewer reported any decline in the amount of drug-related crime. Caulkins et al. concluded that geographical and social considerations may play a key role in determining the success of demand-side drug law enforcement operations.

The arguments of Caulkins et al. do not call into question the potential value of demand-side law enforcement operations but other economists have. Lee (1993) has argued that the market for illicit drugs contains certain unique features which, when explicitly incorporated into economic models of the drug market, lead to policy conclusions about demand-side law enforcement which are quite at variance with those drawn from standard economic models. He points out that, unlike normal markets, illicit drug markets have very high transaction and possession costs. Transaction costs are those which result from being cheated or beaten by dealers and from being arrested and detained by police. Possession costs are those associated with being cheated or robbed of one's drug holdings and from being identified by the police as the owner of an illicit drug intended for consumption.

In Lee's model, when the penalty for buying an illicit drug is increased it reduces the frequency of illegal drug transactions. Ironically, this reduces a dealer's risks and therefore the costs associated with supplying illegal drugs. The result is a drop in the supply-price of illegal drugs which encourages greater consumption. Increased penalties for illegal drug possession fare no better according to Lee. Users respond to an increase in the penalties for possession by reducing the quantity of drugs held at any given time and compensating for this by buying drugs more frequently. This tactic, however, magnifies the risks faced by dealers. They respond by increasing the supply-price of the illegal drug in question. The result is a net increase in the street price of the illegal drug despite the overall fall in illegal drug consumption. Thus if Lee's market assumptions are accepted, far from reducing drug expenditures, demand-side drug law enforcement strategies may actually increase them.

Lee's model, like most conventional defences of supply-side drug law enforcement, hinges (in part) on the assumption that the demand for heroin is price-elastic. As noted earlier, this assumption has been the subject of criticism in some economic analyses of illegal drug markets. Several authors, however, have offered theoretical reasons for believing that the demand for heroin is price-elastic. White and Luksetich (1983) have argued in favour of price-elasticity because 'addicts can stretch out the time between injections'. Holahan (1973) and Bernard (1983) have argued in favour of elasticity because addicts can switch to other drugs. Blair and Vogel (1973) have argued in favour of elasticity because the market for heroin contains price-sensitive occasional users as well as price-insensitive addicts. Moore (1973) has argued that the willingness of heroin users to seek treatment is strongly influenced by the time it takes to obtain heroin.

These are plausible theoretical arguments in favour of price-elasticity but they are no substitute for hard evidence. Grapendall (1992) concluded on the basis of interview data that demand for heroin is price-elastic because heroin users report adjusting their consumption levels to their daily income rather than vice versa. This evidence only weakly supports the elasticity hypothesis because it provides no reliable guide to the long-term response of heroin users to an increase in the price of the drug. Heroin users, for example, may only temporarily reduce their consumption in the face of a cash-shortage, responding to long-term price increases through activities (for example, property crime) which raise their income. The only empirical study to date which has actually attempted to measure the price-elasticity of demand for heroin is that reported by Silverman and Spruill (1977). They obtained indirect evidence that demand for heroin shows little long-run elasticity but does exhibit significant short-run elasticity.

Unfortunately a strong argument leading to precisely the opposite conclusion has been put by Everingham and Rydell (1994). They develop a plausible model of the market for cocaine built around the simple assumption that regular cocaine users represent a portion of the flow from recreational cocaine use. Following Blair and Vogel, they argued that the rate of flow into recreational cocaine use is determined by the price of the substance, even if demand for cocaine among regular users is highly price-inelastic. It follows from their analysis, therefore, that the size of the population of regular cocaine users (and therefore the demand for cocaine) will eventually be determined by the price of cocaine, even though current demand for cocaine among regular users is relatively unaffected by price. Applying the same argument to the market for heroin leads to the expectation that demand for heroin will show little short-term but may show considerable long-term price-elasticity.

Despite its central importance to policy, the difficulties involved in measuring the demand for heroin make it hard to determine the precise relationship between demand for heroin and its price. The absence of hard evidence on price-elasticity makes it easy to build plausible but untestable theoretical models in defence of either supply-side or demand-side policy. Fortunately there are ways of assessing the merits of supply-side arguments without measuring the influence of price on the demand for heroin. If heroin seizures influence the demand for heroin they must influence its price at street level. Surprisingly few studies appear to have examined the influence of supply-side strategies on the price of illegal drugs. This is despite the fact that the question of whether supply-side law enforcement affects the street-level price of heroin is in some ways more important than the question of whether changes in the price of heroin influence demand. The latter question, after all, only derives its significance from the possibility that supply-side law enforcement may influence the price of heroin.

Perhaps the most influential analytical work to date on the impact of supply-side policies on the price of illegal drugs remains that of Polich, Ellickson, Reuter and Kalion (1984). They constructed models of the markets for various kinds of illegal drug and concluded that, in general, supply-side policies exert little effect on drug prices at street-level. They explain this in terms of the fact that the costs imposed on dealers and traffickers by supply-side drug law enforcement policies are passed on and diluted at each level of the distribution chain. A doubling of the interdiction rate for cocaine, for example, adds an estimated $2.1 million to the costs associated with importation of the drug but, because of the size of the market, the absence of monopoly control and the steep price gradient between importation and the street, the end result is an estimated street-level price increase of only 3.4 per cent.

The conclusions advanced by Polich et al., like those of many other economic analyses of drug markets, are dependent on assumptions for which there is little or no direct empirical support. Some of the assumptions adopted by Polich et al. are probably conservative. More reasonable assumptions in these instances would only strengthen their conclusions. One debatable proposition which is central to their analysis, however, is the assumption they make concerning the impact of a price increase at one level of a drug distribution chain on the price level at the next level of the chain. According to Polich et al. any additional costs incurred by importers as a result of drug seizures are simply passed on to the next level of the distribution process. In other words, distribution costs are related to the volume of drugs being distributed but not to the value of drugs at any given distribution level.

Caulkins (1994) has pointed out that, while this is a reasonable assumption to make in the analysis of markets for legal goods (where the distribution costs are principally determined by volume), it may not be a reasonable assumption to make about illegal markets. He suggests, for example, that the cost of distributing drugs like cocaine may be predominantly determined by the amount couriers have to be paid to prevent them absconding with the drugs they convey. If this were true, the distribution costs at each level of the market would increase with the price of the drug at that level. Indeed, Caulkins has shown that, if the distribution costs increased linearly with the price of the drug at each level of distribution, a fixed percentage increase in the costs of distribution as a result of high-level seizures would result in the same-sized percentage change in the price of the drug at street level.

Caulkins examined this possibility using price data for cocaine purchased or seized at different levels of the United States drug market and found it better supported than the hypothesis that distribution costs represent a constant independent of the value of drugs being distributed. His analysis accordingly casts doubt on one of the main assumptions underlying Polich et al.'s analysis. At the same time, it must be said, Caulkins does not show (and did not set out to show) that major drug seizures actually affect the costs of distribution or supply. There is no a priori reason to assume that they do. Interdictions and seizures may constitute only a small fraction of the quantity of illegal drugs being imported and consumed at any given time. Even if this were not so, importers and large-scale domestic suppliers may have sufficient stocks of illegal drugs to offset the effects of a temporary drop in supply.

The central purpose of this report is to address the question of whether large scale seizures of heroin influence its price and/or purity at street level. While any drug market might in principle be subjected to such an analysis, the heroin market has been singled out for examination for two reasons. Firstly, although much of the analysis of illegal drug markets in the United States has focussed on cocaine and cannabis, in Australia the public health and law enforcement problems associated with heroin use (under current legal conditions) appear more significant than those associated with cocaine and cannabis. Secondly, the Australian street-level distribution process for cocaine and cannabis appears to be much less public than that associated with heroin. This makes it somewhat easier to identify major sites of heroin distribution than it is to identify corresponding sites (or methods of distribution) for cocaine and cannabis.

In outline, the study involves a time series analysis of the impact of large scale heroin seizures on the street-level price and purity of heroin in a large heroin market. The study was conducted over a two year period during which regular (fortnightly) monitoring of the price and purity of heroin was carried out through a series of undercover purchases of heroin 'caps' by police and through interviews with persons arrested for heroin use and/or possession. Purity monitoring was carried out by analysing samples of the heroin seized or purchased at street-level. At the end of the study period, the price and purity data were supplemented with data on seizures of heroin in excess of one kilogram collected by each Australian police service. A time series analysis of the impact of heroin seizures on the price and purity of heroin at street level was then conducted.

Although the principal focus of the study was upon the impact of heroin seizures on the price and purity of heroin, two other empirical relationships of interest to drug law enforcement policy were also examined. The first concerns the impact of heroin seizures on the perceived availability of heroin at street level. This analysis was undertaken in order to bolster the capacity of the study to detect any impact heroin seizures might have on the market for heroin at street-level. The second analysis undertaken concerns the impact that arrests for heroin use and possession have on the rate of admission for methadone treatment. This analysis was undertaken in order to ascertain whether the demand-side law enforcement activity at the study location exerted any effect on the rate at which heroin users entered local methadone programs.

1.1 RESEARCH QUESTIONS

The three groups of questions sought to be addressed by the study, then, were as follows:

1. Do large-scale seizures of heroin (a) increase the street-level price of heroin (b) reduce its street-level purity and/or (c) reduce its perceived availability?
2. Does an increase in (a) the street-level price of heroin or (b) a decrease in its perceived availability, increase the rate of admission to methadone treatment?

3. Does an increase in the frequency of persons arrested for heroin use/possession (a) reduce the price of heroin and/or (b) increase the rate of admission to methadone treatment?

Given the preceding discussion, the rationale underpinning questions 1(a), (b) and (c) is obvious and needs no further explanation. It should be noted, however, that changes in the supply of heroin may prompt dealers both to increase the price of heroin and reduce its purity. Considered in isolation, these changes may not be detectable, even if their combined effect is capable of altering the level of demand for heroin. To deal with this problem, an analysis of the impact of heroin seizures on trends in the price per pure gram of heroin was carried out in addition to the analyses referred to at 1(a) and 1(b). The effect of constructing a price per pure gram time series is that all purity changes are converted into price changes. The method for calculating the price per pure gram of heroin is detailed in the method section of this report.

Questions 2(a) and (b) allow us to explore the issue of whether increases in the cost of purchasing heroin cause heroin users to seek treatment. The purchase price of heroin is the most obvious cost to users. If increases in the purchase price cause users to seek treatment, we should expect to find a positive correlation between street-level price increases and the rate of admission to methadone treatment. Question 2(a) is directed toward this possibility. It has been suggested, however, that heroin users are influenced by non-monetary costs associated with the ease of obtaining heroin. Moore (1972), for example, has suggested that the 'buy-time' (i.e. the time between wanting a 'fix' and being able to obtain one) exerts a strong influence on the willingness of heroin users to seek treatment. Question 2(b) is directed toward this possibility.

Question 3(a) is predicated on two assumptions. The first is that an increase in the arrest rate for heroin use and/or possession should increase the effective risk of using the drug, thereby leading to a fall in demand for it. The second is that, if there is a drop in demand for heroin, relative to its supply, the street-level price of heroin should fall. Question 3(b) is predicated on the first of these assumptions but explores the possibility that the drop in demand for heroin is reflected in an increase in the rate of admission for methadone treatment.

2. METHOD

2.1 DATA SOURCES

Data for the study were collected over a two year period from February 1993 to January 1995. The data collected were as follows:

- regular measurements of the price and purity of street-level heroin;
- the date, location and amount seized for all heroin seizures in Australia in excess of one kilogram;
- the number of persons admitted to methadone treatment programs in the study area;
- the availability of heroin as assessed by persons attending methadone clinics;
- a measure of local law enforcement;
- the reasons for stopping use of heroin cited by persons seeking admission to methadone treatment programs.

The sources of each of these data items are described below.

2.1.1 Price and purity of street-level heroin

The cooperation of the NSW Police Service was sought in order to obtain regular information on the price and purity of street-level heroin. When the study was first conceived, it was planned to site it in Kings Cross, an inner-city area with a long-established reputation as a drug distribution centre. On the advice of the NSW Police Drug Enforcement Agency the study was relocated to Cabramatta, an area which had in recent years emerged as a major alternative venue for heroin distribution in Sydney. Cabramatta is a Sydney suburb approximately 30 km south-west of the city centre. It is an area with a high population of migrants from several South-East Asian countries but most notably from Vietnam.

According to the most recent report of the Australian Bureau of Criminal Intelligence (1994), Vietnamese involvement in the importation and distribution of heroin in Australia is both substantial and increasing. The report maintains that, whereas Chinese distributors previously used the Vietnamese as ‘runners’, the Vietnamese are now operating independently and are active in heroin distribution from wholesale to street-level. Distributors with strong links to Cabramatta are said to be ‘totally dominating’ the heroin market in Queensland and as being the primary source of rock heroin available in the Australian Capital Territory. The Sydney Daily Telegraph Mirror (the largest daily circulation newspaper in NSW) recently described the train to Cabramatta as the ‘smack express’ following the arrest of a 14 year old ‘Asian boy’ for supplying heroin. According to the newspaper report the youth is one of 30 to 40 heroin dealers operating on the streets of Cabramatta at any given time (The Daily Telegraph Mirror 29 May 1995, p.14).

The collection of samples of street-level heroin was based in the Cabramatta Police Patrol. The heroin samples for the study were obtained as undercover purchases made by police officers from the Cabramatta Patrol or recovered from persons arrested for heroin possession by these officers. Each such person arrested was asked by the arresting officer what price had been paid for the heroin. Thus, the price of each heroin sample obtained for the study was either the amount paid by an undercover police officer or the amount paid as reported by a person arrested for heroin possession. The samples of heroin, obtained both from undercover purchases and from those arrested for heroin possession, were transported by police to the Australian Government Analytical Laboratories where they were weighed and analysed. For each heroin sample, the results of the analysis provided two measures: the weight of the sample and the purity of the sample, the latter being measured as the percentage of heroin in the sample. Using the price, weight and purity data, the price per gram and the price per pure gram were calculated. (For example, a sample costing $x, weighing y gm and with a purity of z% heroin was calculated to have a price per gram of $(x/y) and price per pure gram of $ (100x/yz).)

2.1.2 Heroin seizures

Information on heroin seizures during the study period was obtained from police services in each Australian State. The information sought from each police service, for each seizure in excess of one kilogram, was the amount of heroin seized and the date of the seizure.

The same information was sought for all States from the Australian Federal Police and from the Australian Bureau of Criminal Intelligence. Using more than one source for the seizure information provided a means of checking that all relevant seizure data were obtained.

2.1.3 Admissions to methadone treatment

There are two methadone treatment clinics in the study area. One is a clinic attached to Liverpool Hospital and the other is the Scott Street Clinic, a private clinic. Both clinics provided data giving the date of admission for each person entering methadone treatment during the study period.

2.1.4 Availability of heroin

From August 1993 to January 1995 the two local methadone treatment clinics also conducted interviews with persons who were either entering methadone treatment or seeking treatment for heroin-related problems. The interviews were conducted on a voluntary basis. Those interviewed were asked the date on which they had last purchased heroin and were also asked how easy the heroin was to obtain (scored on a five point scale). The interview questions are shown in Appendix 1. Responses to these questions provided measures of heroin availability by date of purchase.

2.1.5 Local law enforcement

Arrests for use or possession of heroin would have provided an appropriate measure of local law enforcement during the study period. However, it was not possible to obtain the specific arrest data required. As a proxy measure for arrests, the data used were convictions in Fairfield Local Court for use or possession of opiates. (Cabramatta is in the Fairfield Local Government Area.) These data are available from the Bureau's database of criminal appearances before Local Courts. As the date of arrest is not recorded in this database, the date of arrest was assumed to be the date of the offence. This is a reasonable assumption because drug offences are almost always detected by police themselves, rather than reported to police by others. Hence the date of arrest would almost always be the date of offence.

Because there is a lag time from the date of arrest to the date of finalisation in court, at the time the data were analysed Local Courts conviction data were only available for offences occurring up to June 1994.

2.1.6 Reasons for stopping using heroin

The interview survey of persons attending methadone clinics included a question on the reasons for stopping use of heroin. Only those seeking admission to methadone programs were asked this question.

2.2 DATA ANALYSIS

Most of the data collected for this research consist of series of data points over time. The questions addressed in the research concern whether or not there are relationships between variables, for example, between heroin seizures and the price of street-level heroin. It is possible that the effects of one variable on another are not immediate but occur some time later. For example, it is quite possible that the effect of a large seizure of heroin is not apparent in the price of heroin on the street until some weeks after the seizure.

The objective of the analysis was to determine whether there were relationships between selected data series, either immediately or at some time lag. Using time series analysis techniques, this was achieved by calculating the correlations between relevant pairs of time series for a range of time lags.

To apply time series analysis techniques it is necessary to have data points at equally spaced time intervals. The two year study period was therefore segmented into 52 fortnightly periods. For example, fortnight 1 was the period from Sunday, 31 January 1993, to Saturday, 13 February 1993; fortnight 2 was the period from Sunday, 14 February 1993, to Saturday, 27 February 1993. All the data were then converted to fortnightly data series.

For the heroin samples, the data points became the fortnightly averages of the price and purity of all samples obtained in each fortnight (where the date of the undercover purchase or the date of the arrest determined in which fortnight a sample belonged). There was only one fortnight in which no heroin samples were obtained. This was the 17th fortnight of the study period. The heroin price and purity data points for this fortnight were estimated by averaging the data for all samples obtained in the 16th and 18th fortnights.

For seizures, the fortnightly data points were the total amounts of heroin seized in each fortnight. Similarly, for admissions to methadone treatment, the data points were the total numbers of persons admitted to treatment each fortnight. The average heroin availability scores (reported by those seeking admission to methadone treatment) were calculated for each fortnight, where the date of the person's last heroin purchase determined the fortnight to which the availability score was assigned. The fortnightly measures of local law enforcement were the total numbers of persons convicted in Fairfield Local Court for possession or use of opiates where the date of the offence determined the appropriate fortnight.

3. RESULTS

3.1 DESCRIPTION OF THE DATA

3.1.1 Purity of street-level heroin

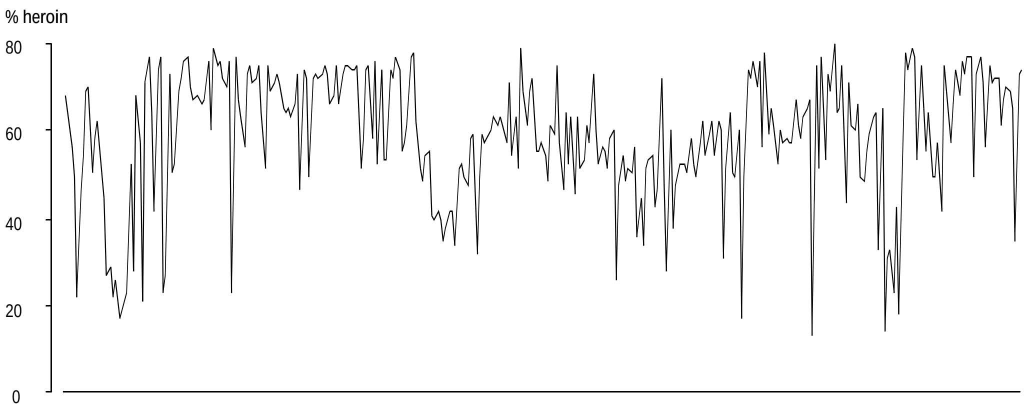
Over the two year study period there were 322 samples for which the purity of heroin was measured. Table 1 shows the frequency distribution of purity measures for all 322 samples. The purity of heroin in the samples ranged from 13.2 per cent to 79.8 per cent. Nearly 80 per cent of the samples had a purity of at least 50 per cent heroin. The average purity was 58.7 per cent.

Table 1: Frequency distribution of purity of heroin samples

	Number of samples	
Purity (% heroin)	No.	(%)
10.0 - 19.9	6	(1.9)
20.0 - 29.9	15	(4.7)
30.0 - 39.9	14	(4.3)
40.0 - 49.9	35	(10.9)
50.0 - 59.9	84	(26.1)
60.0 - 69.9	77	(23.9)
70.0 - 79.9	91	(28.3)
Total	322	(100.0)

Figure 1 shows the purity measures for all 322 samples, in chronological order of obtaining the samples. It should be noted that the time intervals between samples are equally spaced in Figure 1 whereas, in reality, these intervals varied from less than one day up to 18 days. The data in Figure 1 are presented to illustrate the amount of variability among the samples rather than provide an accurate depiction of when each sample was obtained.

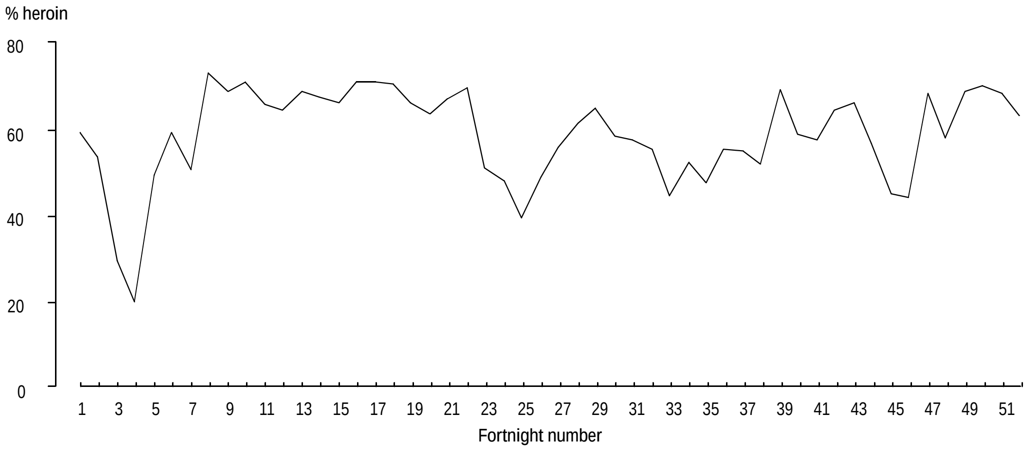
Figure 1: Purity – all heroin samples



Note: The data are presented in chronological order of obtaining the samples.

Figure 2 shows the fortnightly time series of average purity measures. Because there were no heroin samples obtained in fortnight 17, the average for this fortnight is the average purity of all samples obtained in fortnights 16 and 18.

Figure 2: Purity - fortnightly averages

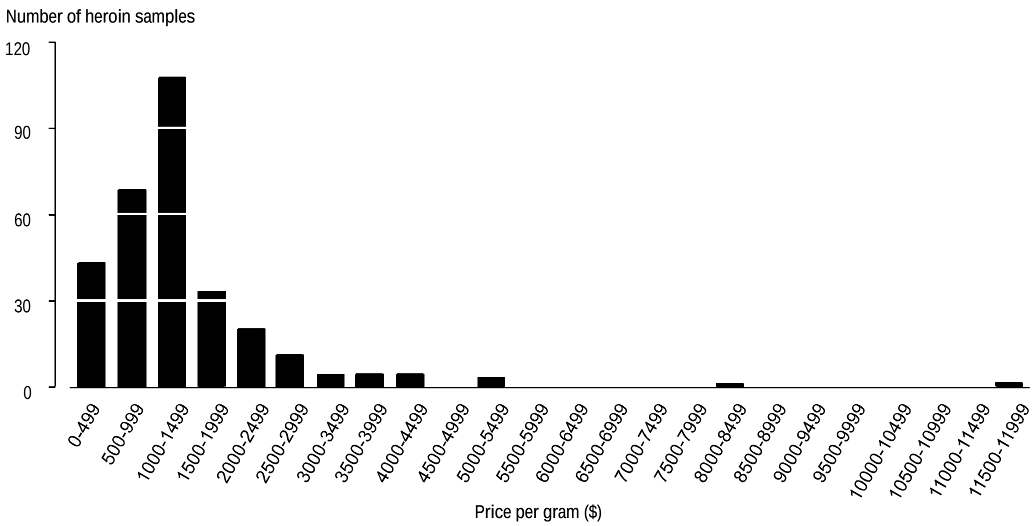


3.1.2 Price of street-level heroin

There were 299 samples over the two year period where both the sample cost was known and the purity of the heroin was measured.

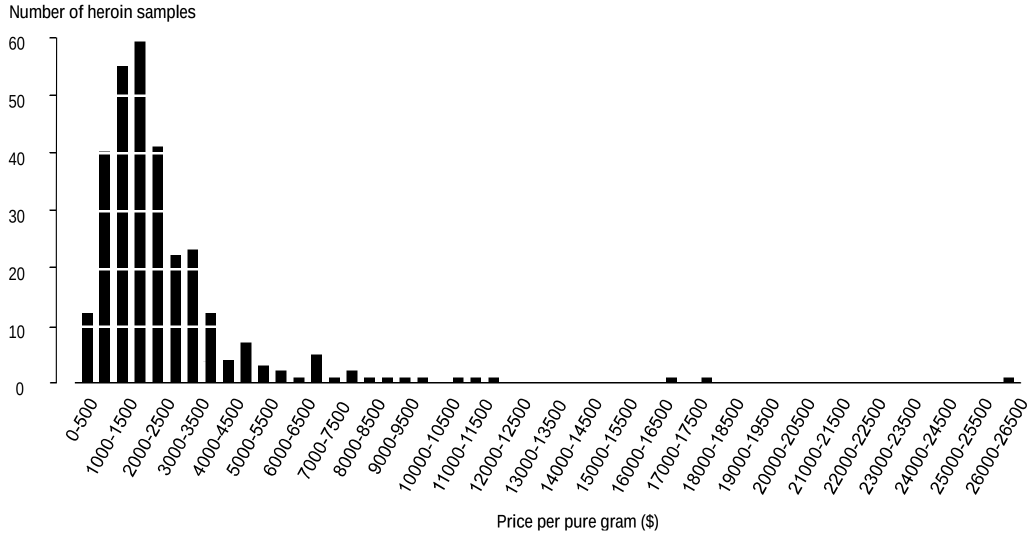
The price per gram ranged from $118 to $11,667 with an average price per gram of $1,309. Figure 3 shows the frequency distribution of price per gram. There were only two samples with a price per gram over $5,000. One of these had a price per gram of $8,000 and the other had a price per gram of $11,500.

Figure 3: Price per gram frequency distribution



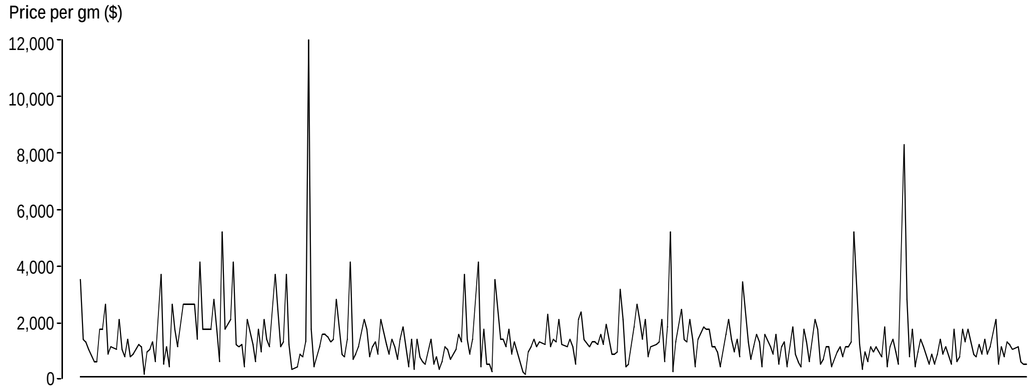
The price per pure gram ranged from $206 to $26,144 with an average of $2,500. Figure 4 shows the frequency distribution of price per pure gram. There were 24 samples (8% of the total 299 samples) with a price per pure gram of heroin in excess of $5,000. There were three samples with a price per pure gram in excess of $12,000. It is clear from Figure 4 that the highest price per pure gram ($26,144) was exceptionally high, about $8,000 more than the next highest price per pure gram.

Figure 4: Price per pure gram frequency distribution



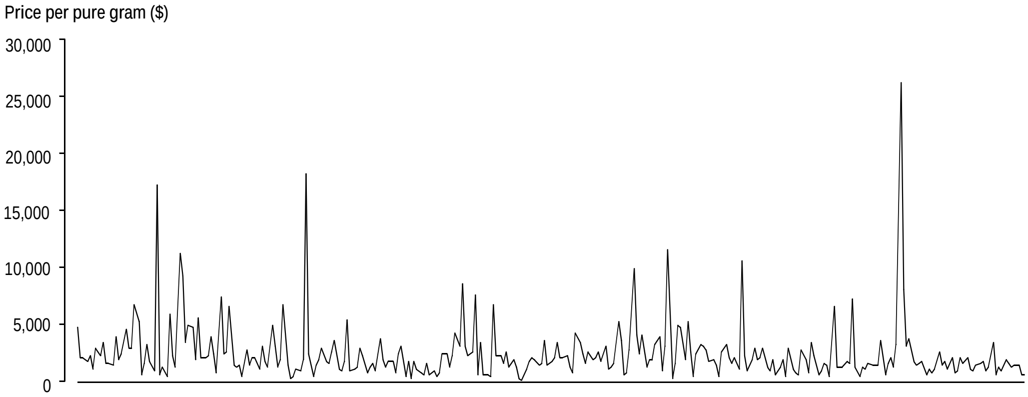
Figures 5 and 6 show the price per gram and the price per pure gram, respectively, for all samples. Again, these figures are not accurate time series; they present the values for all samples in chronological order to illustrate the variability among samples.

Figure 5: Price per gram - all heroin samples



Note: The data are presented in chronological order of obtaining the samples.

Figure 6: Price per pure gram - all heroin samples



Note: The data are presented in chronological order of obtaining the samples

Figures 7 and 8 show the time series of fortnightly averages for price per gram and price per pure gram, respectively. Because there were no heroin samples obtained in fortnight 17, the averages for this fortnight are the average price per gram and price per pure gram for all samples in fortnights 16 and 18.

Figure 7: Price per gram – fortnightly averages

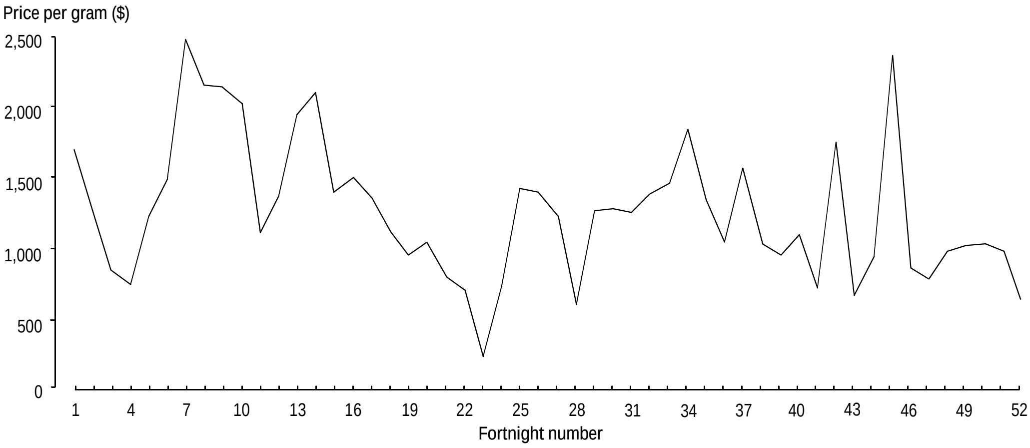
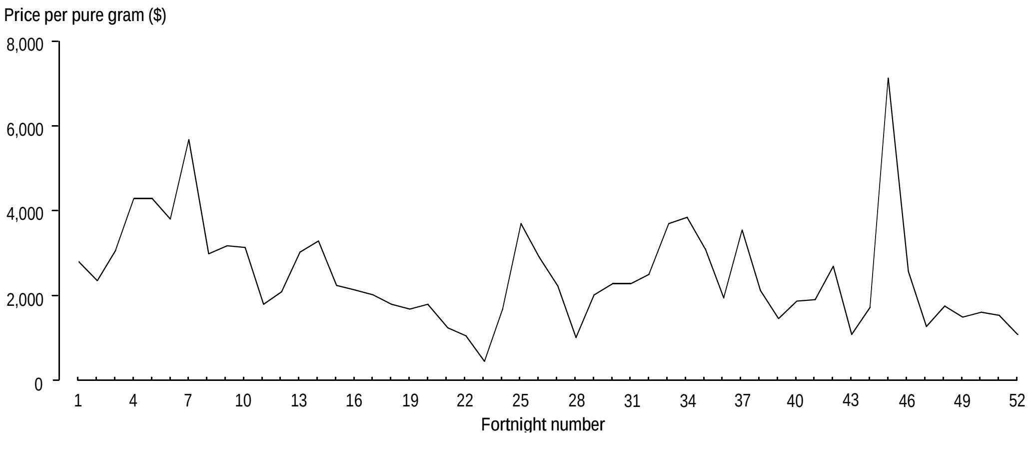


Figure 8: Price per pure gram – fortnightly averages



3.1.3 Heroin seizures

Although the seizure data sought were for seizures in excess of one kilogram, the data supplied included three seizures of exactly one kilogram. These three seizures were included in the data series. Altogether there were 36 seizures of one kilogram or more. Of these, 25 (69%) were in NSW. The largest seizure was 123.5 kilograms. Table 2 shows the frequency distribution for the seizures.

Table 2: Frequency distribution of seizures

Amount seized (kg)	Number of seizures No.	(%)
1.0 - 4.9	21	(58.3)
5.0 - 9.9	8	(22.2)
10.0 - 14.9	2	(5.6)
15.0 or more	5	(13.9)
Total	36	(100.0)

Figure 9 shows the time series of all seizures and Figure 10 shows the time series of fortnightly totals.

Figure 9: Seizures

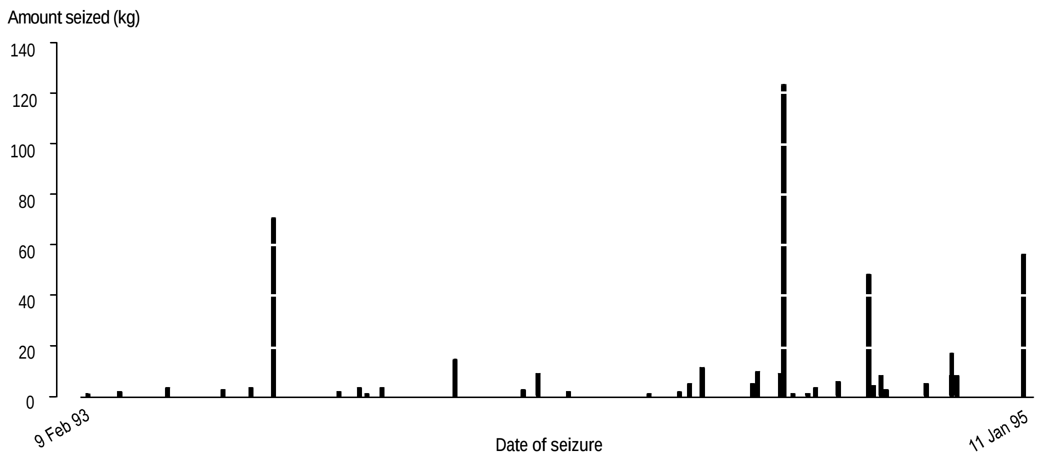
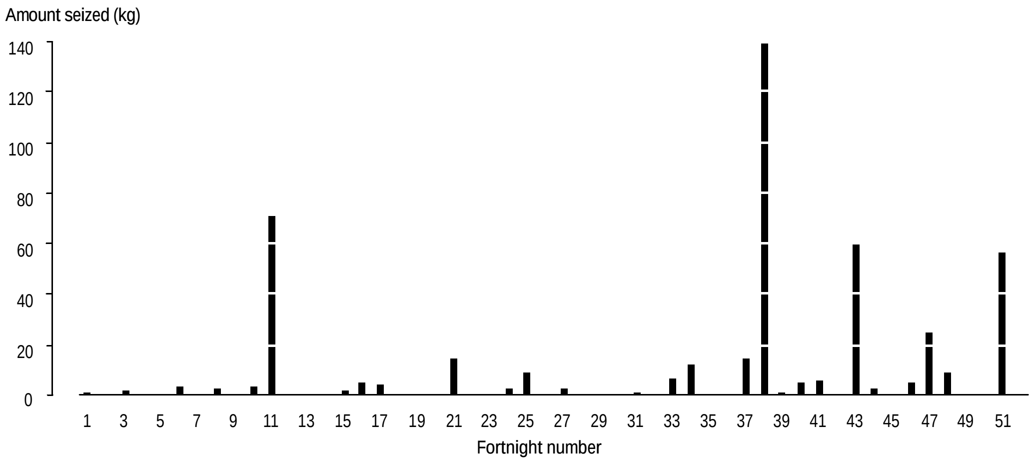


Figure 10: Seizures - fortnightly totals

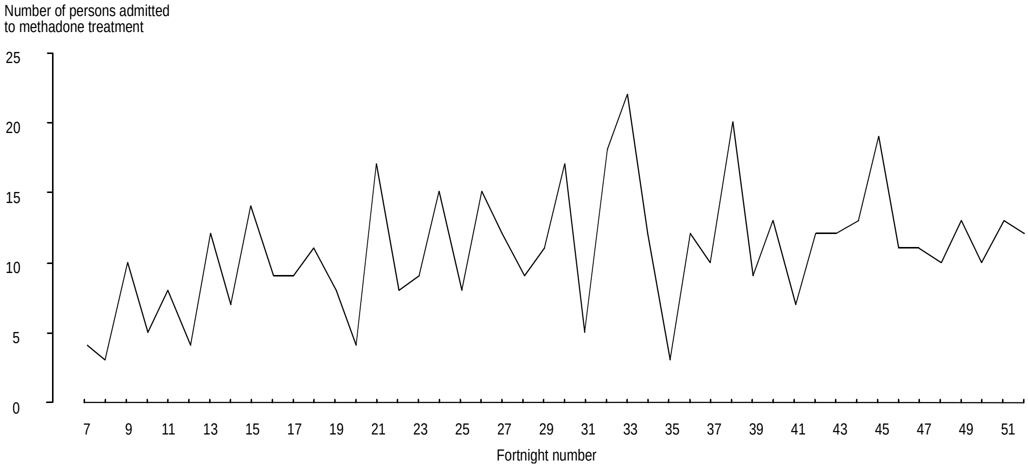


3.1.4 Admissions to methadone treatment

The data series of methadone admissions consisted of data for only 46 fortnights, from fortnight 7 to fortnight 52, because the Scott Street Clinic was not able to supply data for the first few weeks of the study period.

There were a total of 496 persons admitted to methadone treatment during this period, an average of 10.8 persons per fortnight. Figure 11 shows the time series of fortnightly numbers of admissions to methadone treatment.

Figure 11: Admissions to methadone treatment - fortnightly totals

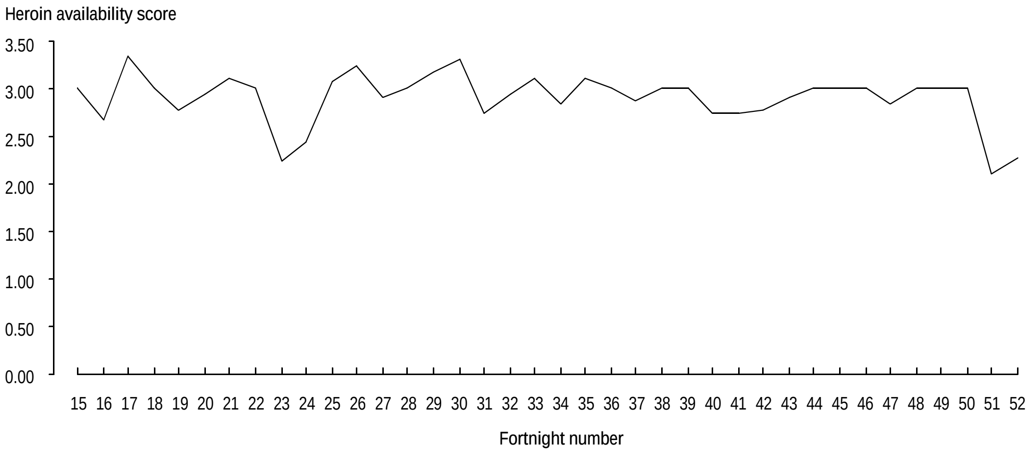


3.1.5 Availability of heroin

The availability of heroin was measured from fortnights 15 to 52. Persons attending methadone treatment clinics provided scores of the availability of heroin on the date of their last purchase of the drug. The scores were measured on a five point scale (1 = much easier than usual; 2 = easier than usual; 3 = same as usual; 4 = harder than usual; 5 = much harder than usual).

Overall, 281 persons were interviewed over 38 fortnights. On average, there were about seven availability scores averaged each fortnight to provide the fortnightly time series of availability measures. There were no measures of availability for fortnight 20. For this fortnight heroin availability was estimated as the average of the scores for fortnights 19 and 21. Figure 12 shows the time series of average heroin availability scores.

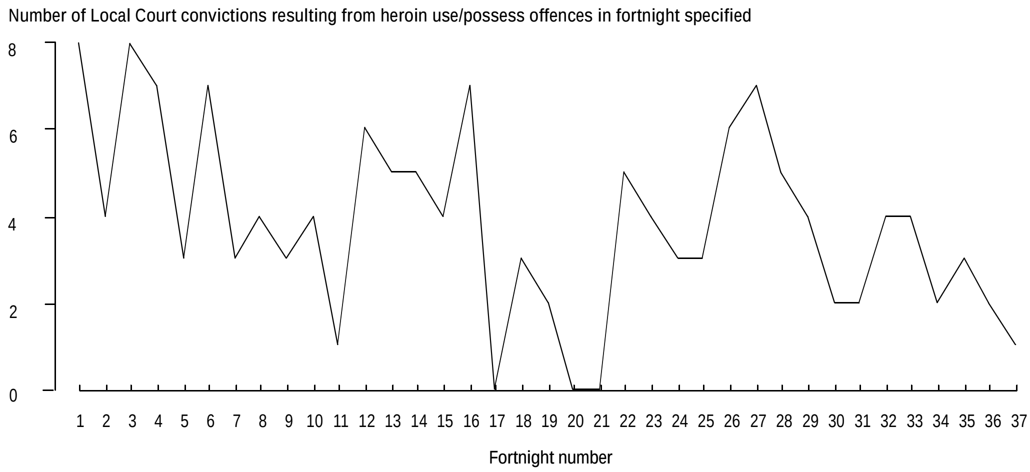
Figure 12: Availability - fortnightly averages



3.1.6 Local law enforcement

The proxy measures of arrests for heroin possession were convictions in Fairfield Local Court for offences committed during the study period. Data were only available for the first 37 fortnights of the study period. There were a total of 141 convictions where the offence occurred in this period, an average of about four per fortnight. Figure 13 shows the time series of fortnightly totals.

Figure 13: Arrests - fortnightly totals



3.1.7 Reasons for stopping using heroin

There were 247 persons seeking admission to methadone treatment who were included in the interview survey conducted at methadone clinics. Their responses to the question 'Why have you decided to stop using heroin?' are shown in Table 3.

Table 3: Reasons cited for stopping heroin use by persons seeking admission to methadone treatment programs

	Respondents who cited this reason	
Reason	No.	(%)
Family support	100	(41%)
Too expensive	165	(67%)
Cannot score	3	(1%)
Trouble with police	74	(30%)
Tired of lifestyle	239	(97%)

Note: Respondents could cite more than one reason for stopping heroin use. Hence the categories in the table are not mutually exclusive.

3.2 COMPARISON OF ARREST AND UNDERCOVER BUY DATA

As previously explained, there were two ways in which heroin samples were obtained. They were either bought by undercover police officers or recovered from persons arrested for heroin possession. Where the police made undercover purchases the price of the drug sample was known. Where the drug sample was recovered from a person arrested for heroin possession, the price was that reported by the person arrested.

The two sources of price data were compared in order to determine whether there was any systematic difference between them. Only data from March 1994 onward were included in the comparison.[2] In the period from March 1994 to January 1995, there were 21 fortnights for which there were heroin samples obtained from both undercover buys and arrests. The average values of the price per gram and the price per pure gram were calculated separately for undercover buy samples and for arrest samples, for each of these fortnights.

A Wilcoxon signed ranks test was conducted on the differences of the averages within each fortnight.[3] There was no significant difference between the arrest samples and the buy samples for either price per gram or price per pure gram ($T^+ = 140$, $N = 21$ for both data series).

Data from the arrest and undercover buy samples were therefore pooled for all subsequent data analyses.

3.3 TIME SERIES

As noted in the method section, the research questions were addressed by determining whether there were correlations between time series. For each relevant pair of time series, the cross-correlation function was calculated. The cross-correlation function measures the correlations between time series at different lag times. For two time series, X_t and Y_t say, the cross-correlation function consists of the correlations of X_t with Y_{t+k} for a range of values of k.

However, before calculating cross-correlations it was necessary to reduce each of the input series to what is known as white noise. A white noise series is a purely random series. In a random series observations at different times are independent of each other, that is, they are not correlated with each other. The autocorrelation function measures correlations between observations at different times within the one series. For a time series X_t, the autocorrelation function consists of the correlations of X_t with X_{t+k} for a range of values of k.

It is necessary to reduce the input series to white noise before calculating cross-correlations because spurious correlations can be found between series that are themselves autocorrelated. It was therefore necessary to examine each of the data series to determine whether there were any autocorrelations. Where a series was autocorrelated, a time series model was fitted to the series. Once an appropriate model was fitted to a series, the residuals from fitting that model (which can be regarded as white noise if the model fits) were used as the input series for the calculation of cross-correlations.

In this section of the report we examine the autocorrelation function (ACF) and the partial autocorrelation function (PACF) of each data series and where appropriate, fit time series models to the series. (The PACF measures the correlations between pairs of observations at different lag times, after taking account of the effects of intervening observations. It is useful in determining the most appropriate model to fit to a time series and in assessing the fit of the model chosen.) The graphs of ACFs and PACFs plot correlations on the vertical axis against time lags on the horizontal axis. For a random series, the correlations are approximately normally distributed with zero mean and variance 1/N where N is the number of observations. Hence, at the 5 per cent significance level, correlations outside the range ±2/šN are deemed to be significantly greater than zero. These significance boundaries are shown as dashed lines on the graphs of ACFs and PACFs.

Appendix 2 provides more details on time series models and the methods used for checking their fit. For each of the time series models fitted to the data in this report, Appendix 2 also gives the details of the models and the results of the diagnostic tests used for checking the fit.

3.3.1 Purity

Figures 14.1 and 14.2 show the ACF and the PACF for the series of fortnightly purity averages. The ACF shows a non-random pattern with some significant autocorrelations, indicating that the series is not random. An autoregressive model of order one was fitted to the series. Autoregressive models express each term in a time series as a function of previous terms in the series, the order of the model indicating how many previous terms are included. An autoregressive model of order p is referred to as an AR(p) model. The AR(1) model fitted the data. (See Appendix 2 for details of the model.) Figures 14.3 and 14.4 show the ACF and PACF of the fitted residuals from the model. As there are no significant autocorrelations or partial autocorrelations, the series of residuals from the AR(1) model can be regarded as white noise. This series of residuals was used as the purity data series for calculating cross-correlations of purity with other data series.

FIGURE 14.1: ACF OF PURITY

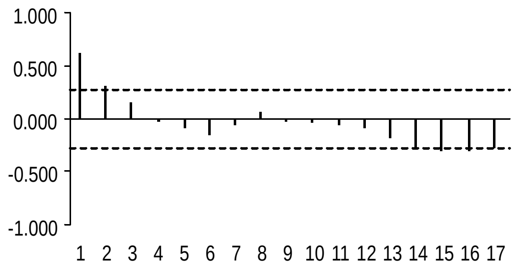


FIGURE 14.2: PACF OF PURITY

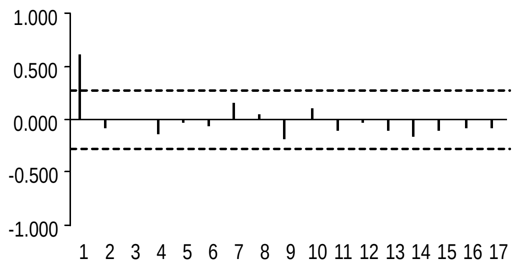


FIGURE 14.3: ACF OF PURITY RESIDUALS

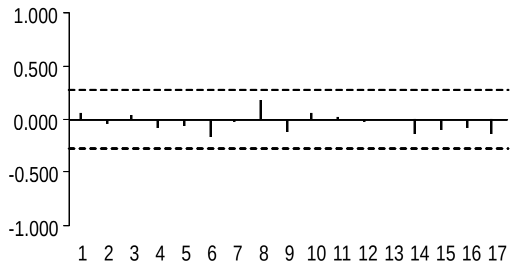
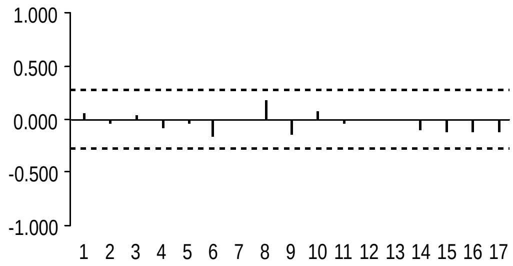


FIGURE 14.4: PACF OF PURITY RESIDUALS



3.3.2 Price per gram

The ACF and PACF for the price per gram series are shown in Figures 15.1 and 15.2. The ACF shows a significant correlation at lags 1 and 14. An AR(1) model was fitted to the series. Although the model fitted the data (see Appendix 2), the lag 14 correlation was still apparent in the ACF and the PACF of the residuals, as can be seen in Figures 15.3 and 15.4. Apart from the lag 14 correlation, the ACF and the PACF of the residuals exhibit a random pattern, unlike the ACF of the original series. A lag 14 correlation has no obvious meaning (in terms of seasonality, for example). Further, it should be noted that at the 5 per cent significance level, one can expect 1 in 20 correlations to be significant by chance. A more conservative approach is to use the Bonferroni correction where the significance level for testing K correlations is α/K. Using this level of significance, the lag 14 correlation is not significant. For these reasons it was decided to accept the model residuals as a random series. The residual series was therefore used as the price per gram series in the calculation of cross-correlations.

FIGURE 15.1: ACF OF PRICE PER GRAM

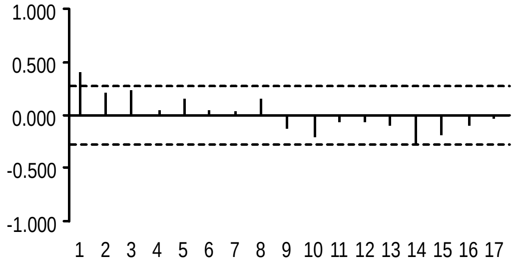


FIGURE 15.2: PACF OF PRICE PER GRAM

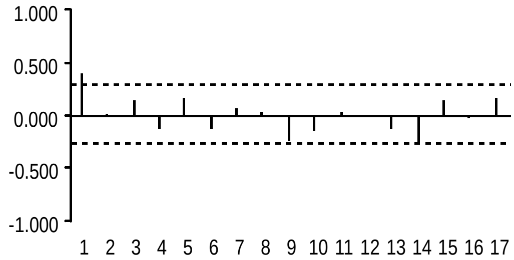


FIGURE 15.3: ACF OF PRICE PER GRAM RESIDUALS

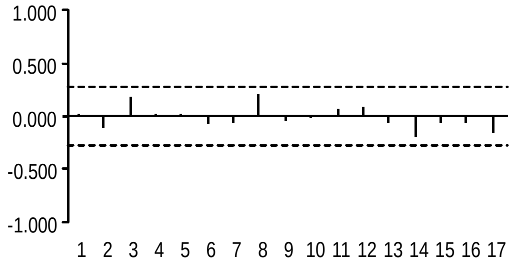
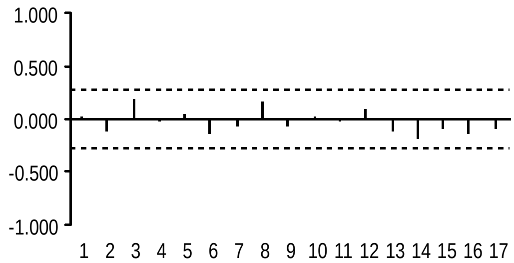


FIGURE 15.4: PACF OF PRICE PER GRAM RESIDUALS



3.3.3 Price per pure gram

The ACF and PACF for the price per pure gram series are shown in Figures 16.1 and 16.2. The ACF has a significant correlation at lag 14. An AR(1) model was fitted to the series (see Appendix 2). As can be seen in Figures 16.3 and 16.4, the ACF and PACF of the residuals from this model show no significant correlations. Hence the residuals from the AR(1) model can be considered to be random. This series of residuals was used for calculating cross-correlation functions of price per pure gram with other series.

FIGURE 16.1: ACF OF PRICE PER PURE GRAM

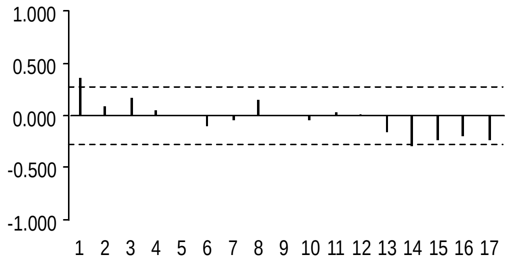


FIGURE 16.2: PACF OF PRICE PER PURE GRAM

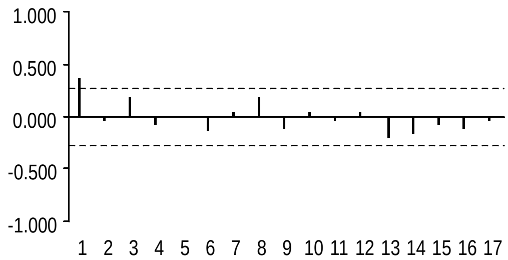


FIGURE 16.3: ACF OF PRICE PER PURE GRAM RESIDUALS

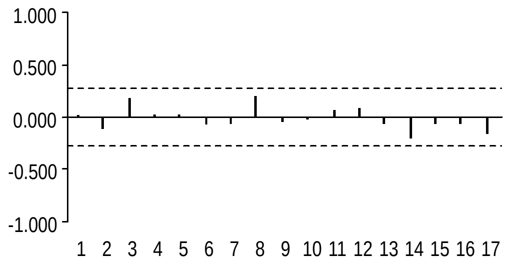
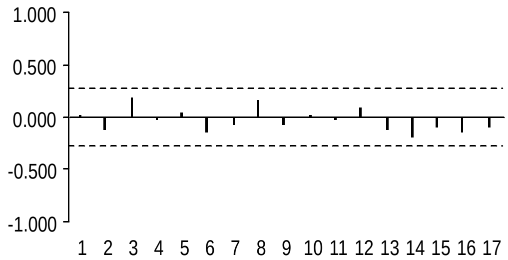


FIGURE 16.4: PACF OF PRICE PER PURE GRAM RESIDUALS



3.3.4 Seizures

As can be seen in Figures 17.1 and 17.2 there were no significant autocorrelations or partial autocorrelations for the seizures series. The seizures data series was left unchanged for the calculation of cross-correlations.

FIGURE 17.1: ACF OF SEIZURES

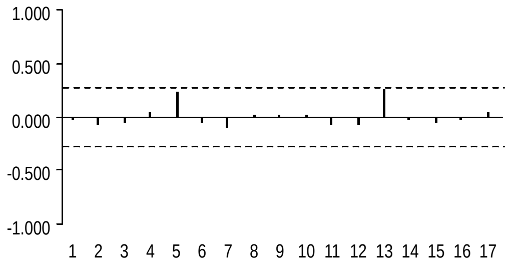
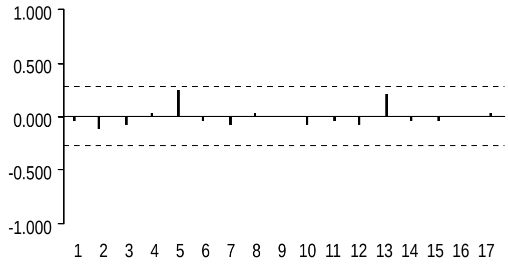


FIGURE 17.2: PACF OF SEIZURES



3.3.5 Admissions to methadone treatment

Figures 18.1 and 18.2 shows the ACF and PACF for admissions to methadone treatment. Both the ACF and the PACF show a significant correlation at lag 6. This correlation is only just greater than the 5 per cent significance point. It would not be judged significant using the more conservative Bonferroni test. Further, there is no systematic pattern in either the ACF or the PACF. For these reasons the time series of admissions to methadone treatment was considered to be equivalent to a white noise series despite the significant correlation at lag 6.

FIGURE 18.1: ACF OF METHADONE ADMISSIONS

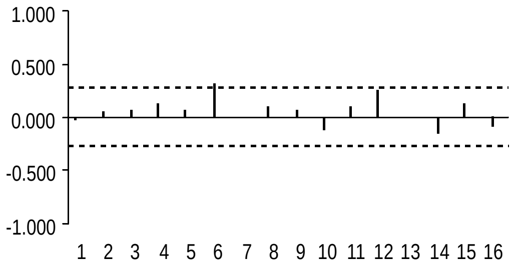
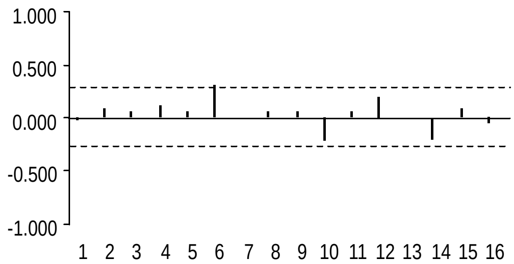


FIGURE 18.2: PACF OF METHADONE ADMISSIONS



3.3.6 Availability

Figures 19.1 and 19.2 shows the ACF and the PACF for heroin availability. There were no significant autocorrelations or partial autocorrelations for this series. The availability data series was left unchanged for the calculation of cross-correlations.

FIGURE 19.1: ACF OF AVAILABILITY

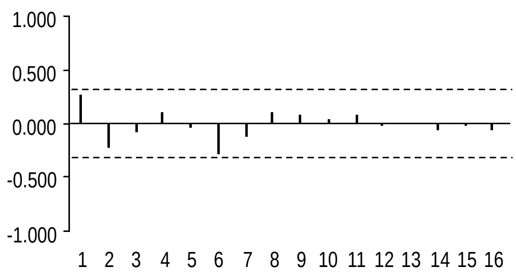
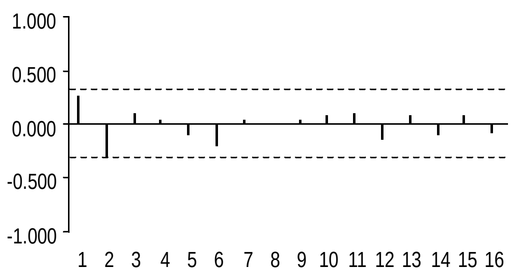


FIGURE 19.2: PACF OF AVAILABILITY



3.3.7 Local law enforcement

The ACF and PACF of the time series of arrests for heroin possession (as measured by Local Court convictions) are shown in Figures 20.1 and 20.2. There are no significant correlations and the series can therefore be regarded as white noise.

FIGURE 20.1: ACF OF ARRESTS

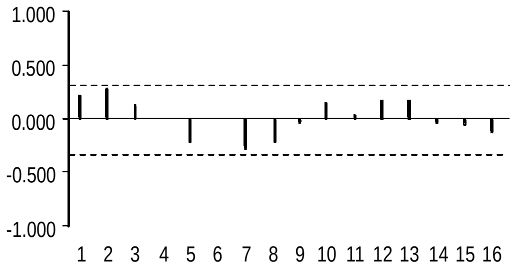
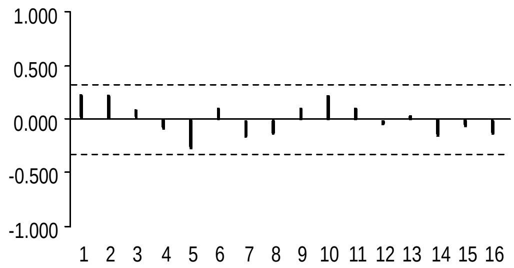


FIGURE 20.2: PACF OF ARRESTS

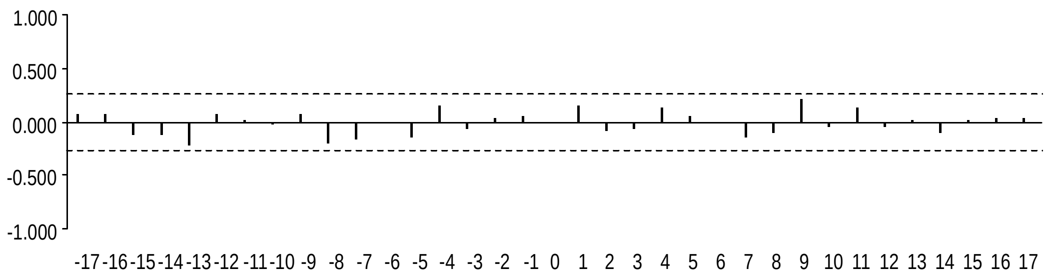


3.4 EFFECT OF SEIZURES ON PURITY OF STREET-LEVEL HEROIN

If seizures had an effect on the purity of heroin at street-level, one would expect that at some time after the seizure, there would be a correlation between the seizure and the purity of street-level heroin. That is, one would expect seizures at time t to be correlated with the purity of street-level heroin at time $t + k$ for some value of k.

To determine whether seizures had any effect on the purity of street-level heroin, the cross-correlation function was calculated. Figure 21 shows the cross-correlation function (CCF) between seizures and purity. (As noted above, the data series for purity consisted of the residuals from an AR(1) model.) There are no significant correlations for any time lag. It is concluded that seizures had no effect on the purity of street-level heroin.

FIGURE 21: CCF OF SEIZURES V. PURITY

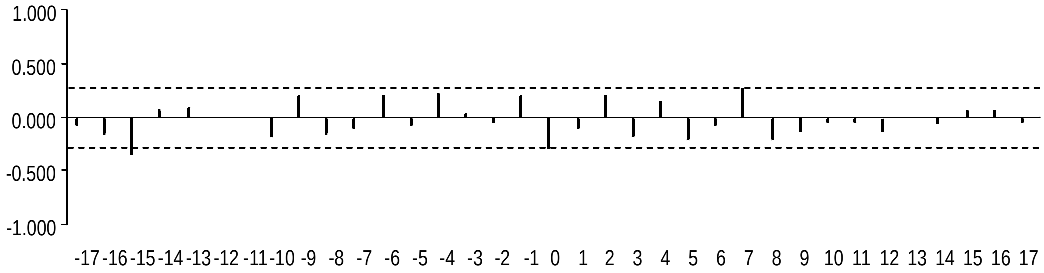


3.5 EFFECT OF SEIZURES ON PRICE OF STREET-LEVEL HEROIN

3.5.1 Price per gram

Figure 22 shows the cross-correlation function for seizures and price per gram (where the price per gram series is the series of residuals from the fitted time series model as described above). The only significant correlation is between seizures and the price per gram 15 fortnights before the seizure. This correlation has no meaning in that we are only concerned with correlations of seizures with the price per gram at some time after the seizure.

FIGURE 22: CCF OF SEIZURES V. PRICE PER GRAM



3.5.2 Price per pure gram

Figure 23 shows the cross-correlation function of seizures and price per pure gram (where the price per pure gram series is the series of residuals from the fitted model). There is a significant correlation at lag 7, indicating that seizures are correlated with the heroin price per pure gram 7 fortnights after the seizure.

FIGURE 23: CCF OF SEIZURES V. PRICE PER PURE GRAM

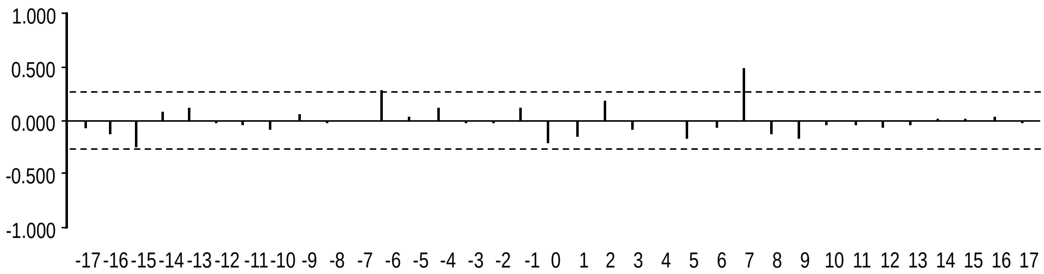
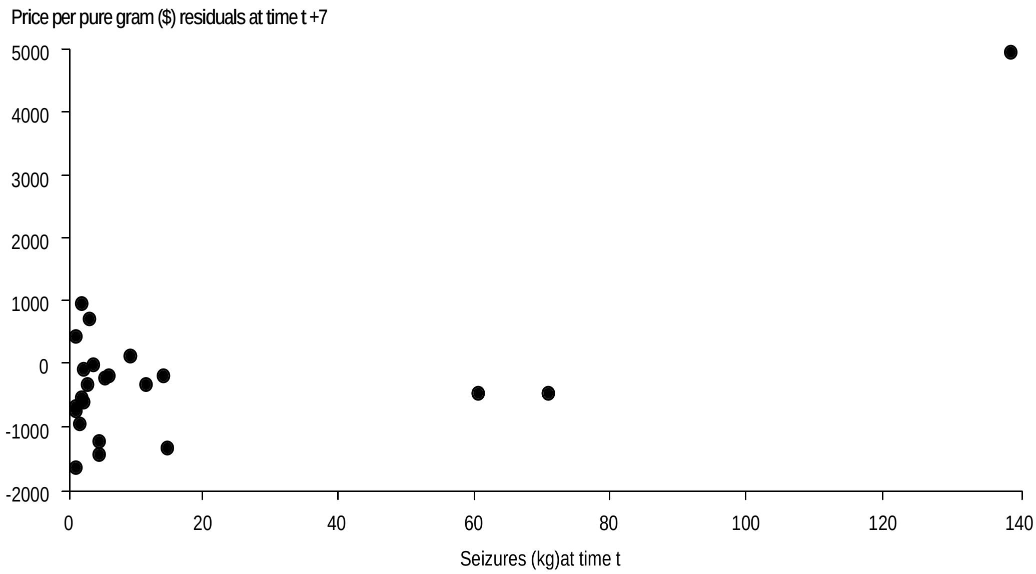


Figure 24 shows the scatter plot of seizures and price per pure gram 7 fortnights later. It is clear from this scatter plot that the significant correlation is dependent on one observation where an exceptionally high price per pure gram coincides with the largest seizure. This high price per pure gram occurred in fortnight 45. The average price per pure gram in this fortnight

Figure 24: Scatter plot of seizures v price pre pure gram seven fortnights later



was $7,091. This average was based on six heroin samples with the following values for price per pure gram:

$1,274
$1,592
$2,087
$3,268
$8,180
$26,144

This last value was in fact the highest price per pure gram recorded for any of the 299 samples in the study. At $26,144, this sample's price per pure gram was about $8,000 more than the next highest price per pure gram. The price per gram for this sample was $8,000, the second highest recorded price per gram.

Given that this one sample appeared to be responsible for the correlation of price per pure gram with seizures, it was decided to repeat the analysis with this sample removed. Therefore the fortnightly averages of the price per gram and the price per pure gram were recalculated from the five remaining samples for fortnight 45.

3.5.3 Price per gram excluding outlier

With the outlying sample removed the average price per gram for fortnight 45 changed from $2,380 to $1,256. Because there was a change in one of the 52 observations for the price per gram series, the ACF and the PACF were recalculated. Once again it was necessary to fit an AR(1) model to the series (see Appendix 2 for details of the model). However, once again, the residuals from the model had a significant autocorrelation and a significant partial autocorrelation at lag 14 as shown in Figures 25.1 and 25.2.

FIGURE 25.1: ACF OF PRICE PER GRAM RESIDUALS

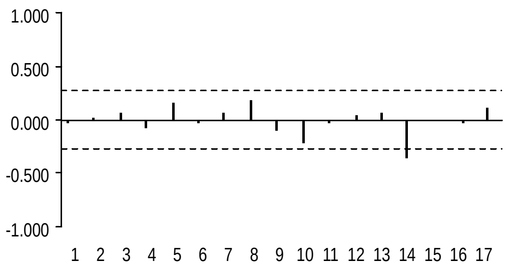
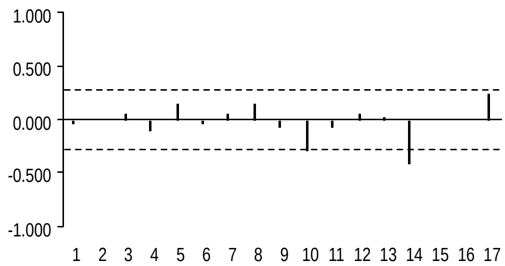
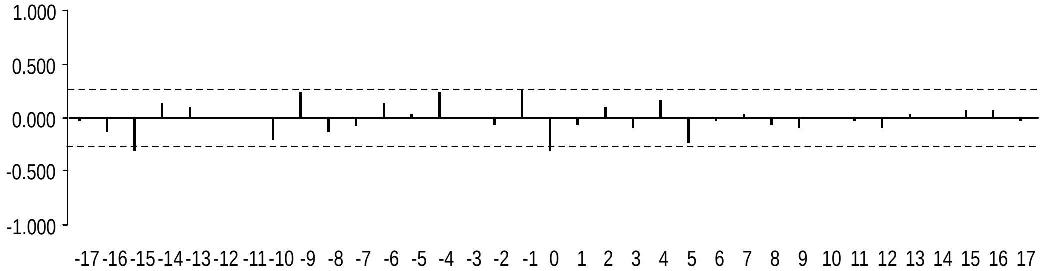


FIGURE 25.2: PACF OF PRICE PER GRAM RESIDUALS



For the same reasons as before, the series of residuals was considered to be random despite the lag 14 correlation and was used for calculating the cross-correlations of price per gram with seizures. The cross-correlation function is shown in Figure 26. There are significant negative correlations at lag -15 and at lag zero. The lag -15 correlation is meaningless in that it indicates a correlation between seizures and the price of heroin 15 fortnights before the seizure. The lag zero correlation indicates a correlation of seizures with the price per gram of heroin in the same fortnight.

FIGURE 26: CCF OF SEIZURES V. PRICE PER GRAM



3.5.4 Price per pure gram excluding outlier

With the outlying sample removed the average price per pure gram for fortnight 45 changed from $7,091 to $3,280. The revised ACF and PACF indicated some modelling was necessary to reduce the series to white noise. An AR(1) model was fitted to the data. Despite the model fitting well (see Appendix 2), the ACF and PACF of the residuals showed significant correlations at lag 14, as can be seen in Figures 27.1 and 27.2. This was similar to the result for price per gram. Once again, for similar reasons as previously, the residual series was considered to be random and was used to calculate the cross-correlations with seizures. This is shown in Figure 28.

FIGURE 27.1: ACF OF PRICE PER PURE GRAM RESIDUALS

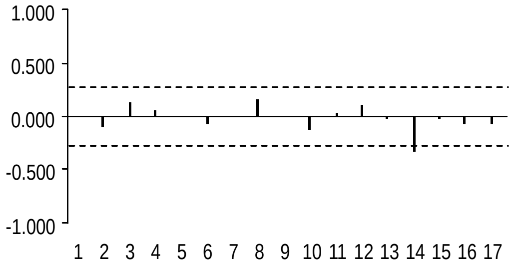


FIGURE 27.2: PACF OF PRICE PER PURE GRAM RESIDUALS

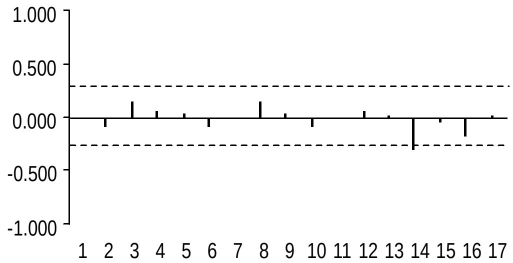
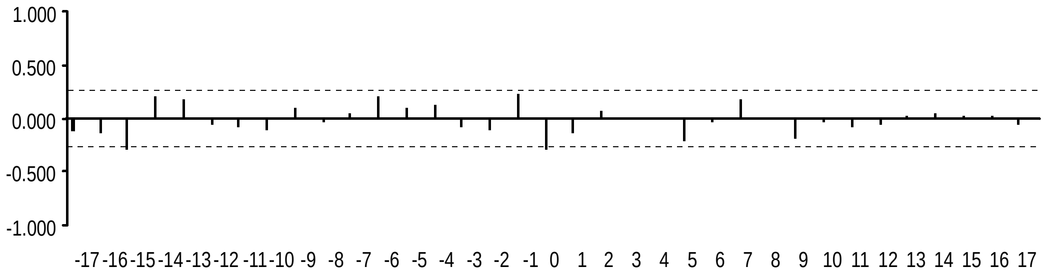


FIGURE 28: CCF OF SEIZURES V. PRICE PER PURE GRAM



The pattern is similar to that for price per gram. There are significant negative correlations at lag -15 and at lag zero. Again, the lag -15 correlation is meaningless in terms of the impact of seizures on price. The lag zero correlation indicates a correlation of seizures with the price per pure gram of heroin in the same fortnight.

3.5.5 The lag zero correlation

Figures 29.1 and 29.2 illustrate the lag zero correlations found for price per gram and price per pure gram. They show seizures plotted against price per gram and price per pure gram.

Figure 29.1: Scatter plot of seizures v price per gram in same fortnight

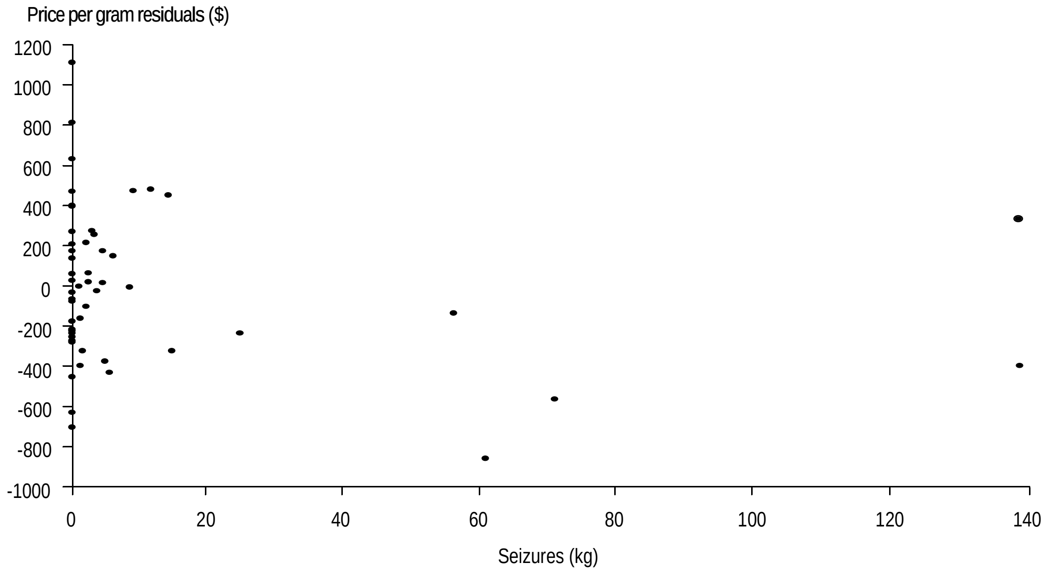
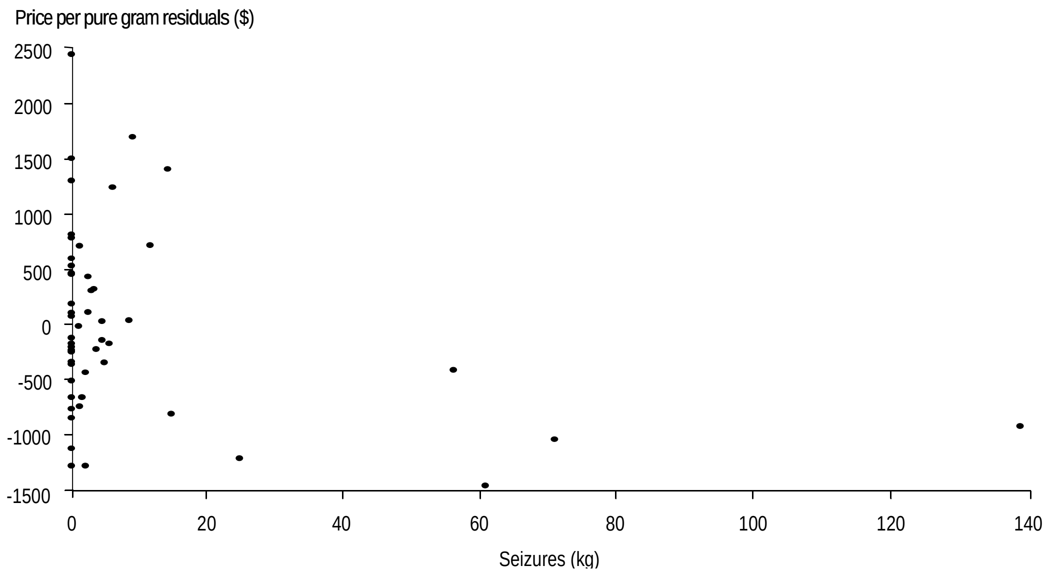


Figure 29.2: Scatter plot of seizures v price per pure gram in same fortnight



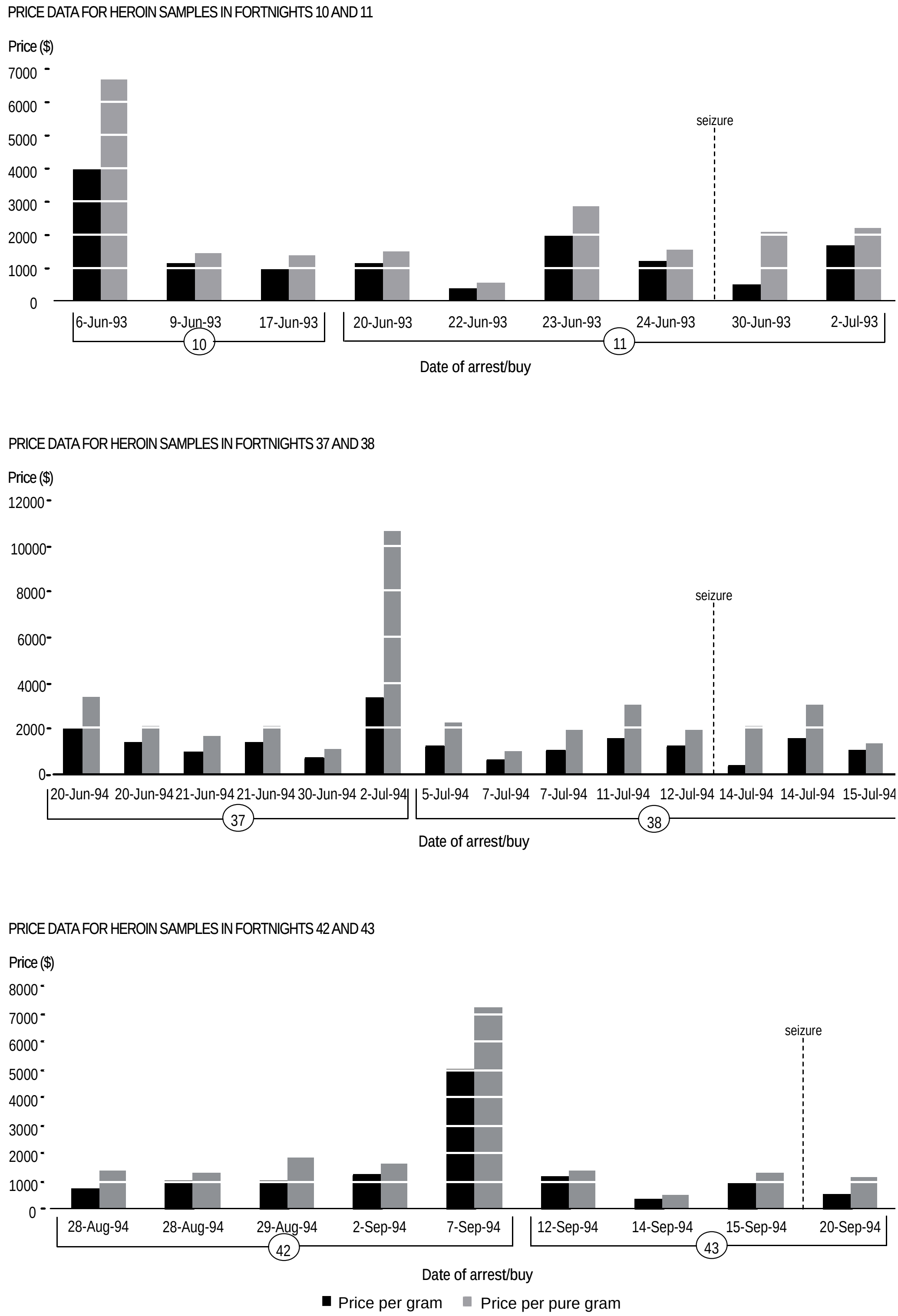
There appear to be three observations responsible for the correlations: for the three largest seizures there are relatively large negative values for the price per gram and price per pure gram residuals. These large seizures occurred in fortnights 11, 38 and 43. The data for these fortnights are shown in Table 4.

Table 4: Seizures and price data for fortnights 11, 38 and 43

		Price per gram		Price per pure gram	
Fortnight number	Fortnightly seizures (kg)	Fortnightly average	Residual from AR(1) model	Fortnightly average	Residual from AR(1) model
11	70.6	1,129	-564	1,760	-1,040
38	138.6	1,044	-397	2,094	-927
43	60.4	684	-861	1,071	-1,464

Figure 30 shows all the samples within these three fortnights and the immediately preceding fortnights, together with a line showing when the large seizure occurred. The negative correlations indicate that in the fortnight in which there was a seizure there was a drop in the price of heroin compared with the previous fortnight. It is clear from Figure 30

Figure 30: Price per gram and price per pure gram for samples in selected fortnights



that, in each case, the drop in price (relative to the price of heroin samples in the previous fortnight) was evident before the seizure occurred. It is therefore difficult to conclude that the seizure caused the drop in price.

If there were indeed an effect of seizures on the price of heroin in the same fortnight as the seizure took place, one would expect this to be more evident for seizures in NSW. For our study, all of the heroin samples were acquired in NSW whereas the seizure data included seizures all over Australia. Clearly there is likely to be less time involved in heroin making its way onto the street, for heroin already in NSW, than for heroin in other States. Hence one would expect the evidence of a real lag zero correlation between seizures and the price of heroin to be stronger if only NSW seizures are considered.

The data were therefore re-analysed including only the seizures made in NSW. However, the results were similar to those described above. There were again significant lag zero correlations for both price per gram and price per pure gram. Upon investigation these were due to the large seizures in fortnights 11 and 43. (The large seizure in fortnight 38 was in the Northern Territory.) We have already shown that the data for these fortnights do not support a conclusion that the seizure caused a drop in the price of heroin.

3.6 EFFECT OF SEIZURES ON AVAILABILITY OF HEROIN

There were only 38 fortnights for which heroin availability was measured. The seizure series for the analysis of the effect of seizures on availability was therefore also restricted to these fortnights. (For the shorter seizure series the ACF and PACF still showed no autocorrelations.)

The cross-correlation function of seizures with availability is shown in Figure 31. There were significant negative correlations at lags k = -15, k = 13 and k = 14. This means that seizures are correlated with heroin availability 15 fortnights before the seizure and with heroin availability 13 and 14 fortnights after the seizure. The first correlation is meaningless in terms of the question being addressed, that is, the effect of seizures on availability. We are not concerned with any correlations of seizures with measures of availability before the seizure.

FIGURE 31: CCF OF SEIZURES V. AVAILABILITY

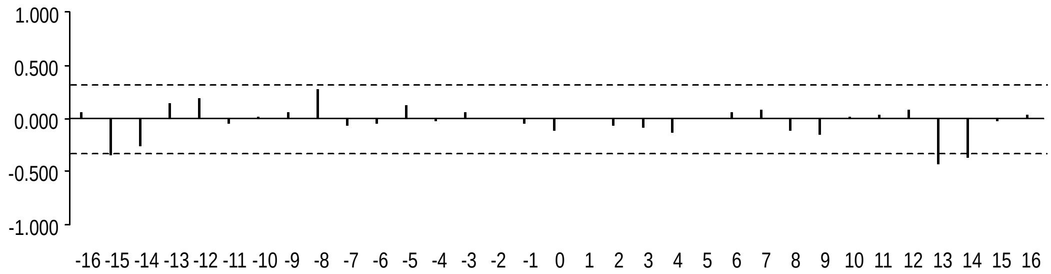
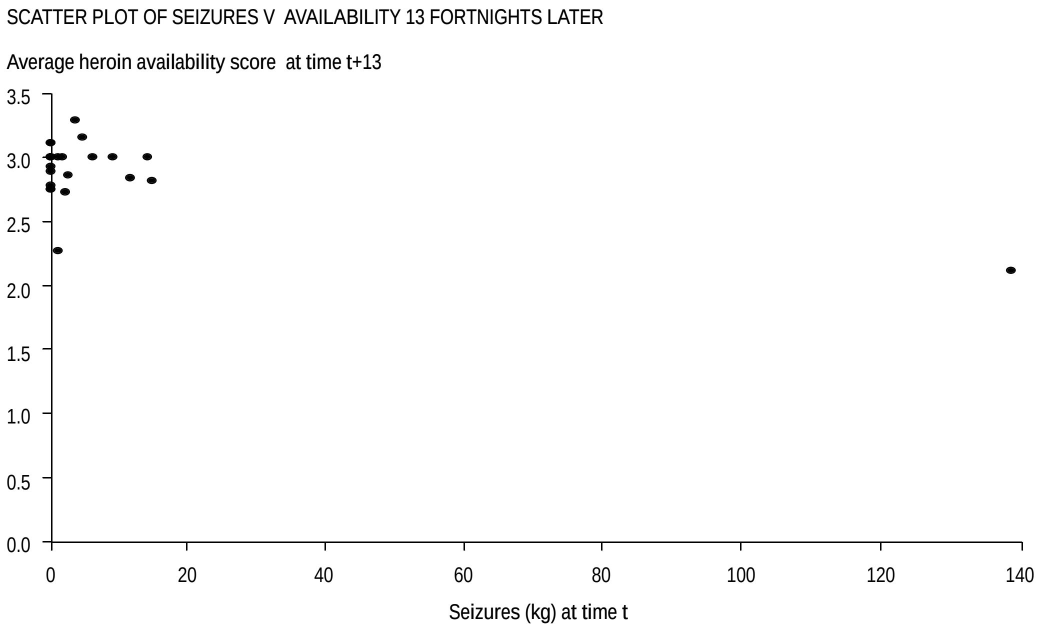
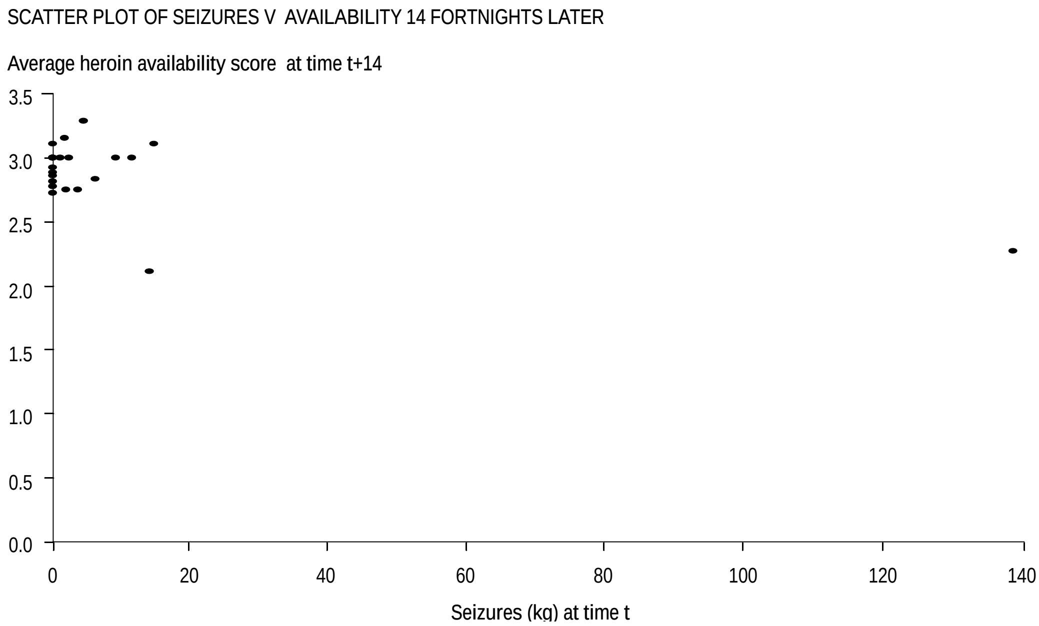


Figure 32 shows scatter plots of seizures versus heroin availability 13 and 14 fortnights later. It is clear from the scatter plots that, in each case, the significant correlations are driven by the one data point associated with the largest seizure value. At lag 13 this largest seizure corresponds with the lowest average availability score and at lag 14 it corresponds with the second lowest availability score. Apart from this one point, there is no evidence of any correlation. It is therefore concluded that seizures had no effect on the availability of heroin.

Figure 32: Scatter plot of seizures v availability 13 and 14 fortnights later



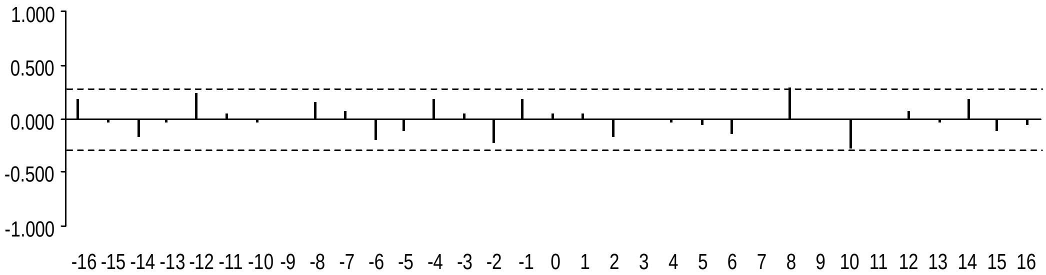


3.7 EFFECT OF PRICE OF STREET-LEVEL HEROIN ON ADMISSIONS TO METHADONE TREATMENT

For this analysis only the series of price per pure gram of heroin was included. The price per pure gram series was reduced to the observations for the 46 fortnights for which there were admissions data (fortnights 7 to 52). The extreme outlying value was excluded from the price per pure gram data series. A new AR(1) model was fitted to the reduced data series (see Appendix 2) and, as with the complete data series, there were significant lag 14 correlations in the ACF and PACF of the residuals. (The ACF and PACF are not shown as they were similar to those for the original series.) Because (a) these correlations were not significant using a more conservative Bonferroni test, (b) a lag 14 correlation has no obvious interpretation in terms of cycles in the data, and (c) the AR(1) model provided a good fit to the data, the series of residuals was accepted as a random series and used to calculate cross-correlations with the series of admissions to methadone treatment.

The cross-correlation function of correlations between price per pure gram and admissions to methadone treatment is shown in Figure 33. There are no significant correlations. It is concluded that the price per pure gram of heroin had no effect on the numbers of people entering methadone treatment programs.

FIGURE 33: CCF OF PRICE PER PURE GRAM V. ADMISSIONS TO METHADONE TREATMENT



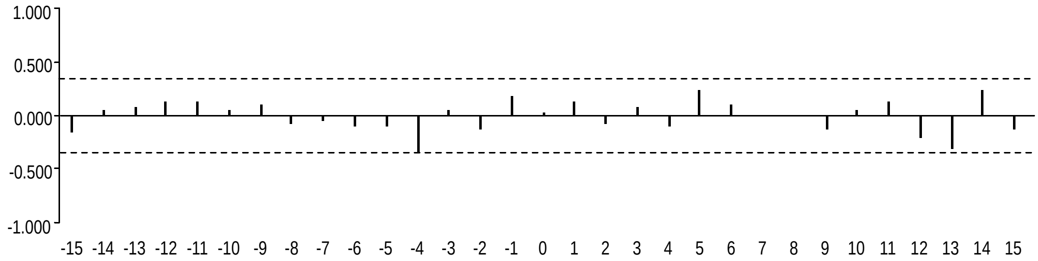
3.8 EFFECT OF LOCAL LAW ENFORCEMENT ON ADMISSIONS TO METHADONE TREATMENT

There were only 31 data points available to calculate the cross-correlation function between arrests and admissions to methadone treatment, because arrests were only measured for fortnights 1 to 37 and methadone admissions for fortnights 7 to 52.

Because both series were reduced to their observations for fortnights 7 to 37 only, the ACFs and PACFs of both reduced series were examined prior to calculating the cross-correlation function. For methadone admissions there were no significant autocorrelations. For the reduced time series of arrests, both the ACF and the PACF showed a significant negative autocorrelation at lag 5. Attempts were made to fit various models to the arrest data but none provided a good fit and this significant autocorrelation at lag 5 always remained in the residuals. It was considered that this correlation could be ignored given that (a) a correlation at a lag of 5 fortnights has no particular meaning (in terms of seasonality, for example), (b) the correlation was not much greater than the 5 per cent significance point (and not significant on a Bonferroni test), and (c) with only 31 data points, there were only 26 pairs of observations available for calculating the lag 5 correlation. Both series were therefore left unchanged for the calculation of the cross-correlation function.

Figure 34 shows the cross-correlation function between arrests and admissions to methadone treatment. The only significant correlation is between methadone admissions and arrests four fortnights later. There is therefore no evidence of any effect of local law enforcement on admissions to methadone treatment.

FIGURE 34: CCF OF ARRESTS V. ADMISSION TO METHADONE TREATMENT

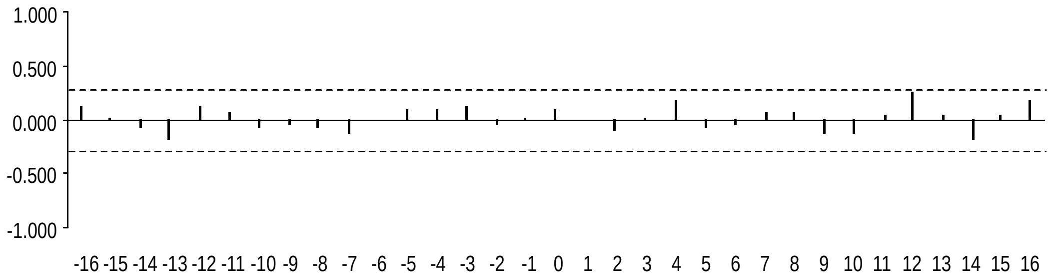


3.9 EFFECT OF THE AVAILABILITY OF HEROIN ON ADMISSIONS TO METHADONE TREATMENT

There were measurements of both heroin availability and admissions to methadone treatment for 38 fortnights, fortnight 15 to fortnight 52. The ACF and PACF for the reduced data series for methadone admissions (fortnights 15 to 52 rather than 7 to 52) showed random patterns with no significant correlations. Both data series were therefore equivalent to white noise.

Figure 35 shows the cross-correlation function between the two series. There are no significant correlations. It is concluded that the availability of heroin had no effect on the numbers of persons entering methadone treatment programs.

FIGURE 35: CCF OF HEROIN AVAILABILITY V. ADMISSIONS TO METHADONE TREATMENT



3.10 EFFECT OF LOCAL LAW ENFORCEMENT ON THE PRICE OF STREET-LEVEL HEROIN

Because measures of local law enforcement were only available for the first 37 fortnights of the study period the data series for both price per gram and price per pure gram were reduced to the first 37 observations. (The outlying value in fortnight 45 was therefore not included in the price data series.) The ACFs and PACFs for both reduced price series were calculated. For both series the ACF showed a non-random pattern with significant correlations. AR(1) models were fitted to both series (see Appendix 2). Figures 36.1 and 36.2 show the ACF and PACF of the residuals for price per gram and Figures 37.1 and 37.2 show the ACF and PACF of the residuals for price per pure gram. For price per gram there was a significant partial autocorrelation at lag 14. For price per pure gram there were no significant correlations. Both series of residuals were considered to be equivalent to white noise.

FIGURE 36.1: ACF OF PRICE PER GRAM RESIDUALS (N=37)

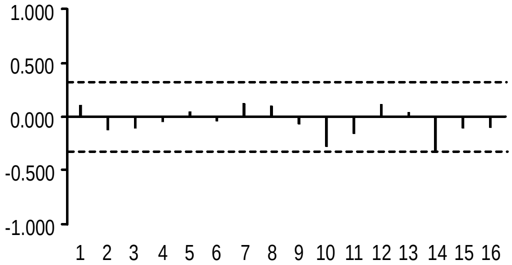


FIGURE 36.2: PACF OF PRICE PER GRAM RESIDUALS (N=37)

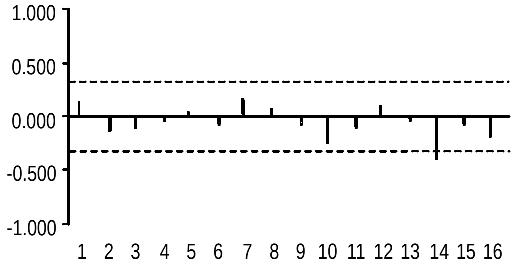


FIGURE 37.1: ACF OF PRICE PER GRAM RESIDUALS (N=37)

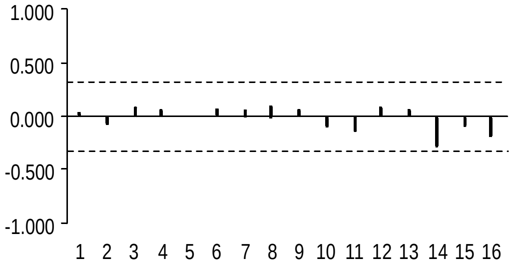
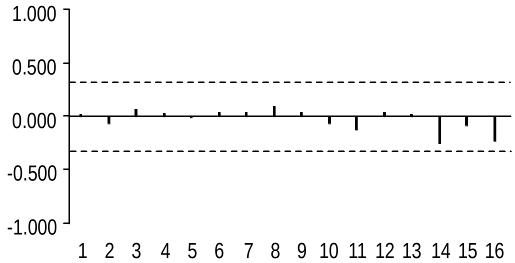


FIGURE 37.2: PACF OF PRICE PER GRAM RESIDUALS (N=37)



Figures 38.1 and 38.2 show the cross-correlation functions for price per gram and price per pure gram with the proxy arrest measures. For price per gram there are no significant correlations. For price per pure gram the only significant correlation is at lag -9. This correlation has no meaning in terms the question being addressed as it is a correlation of arrests with the price of heroin nine fortnights earlier. There is therefore no evidence of any effect of arrests on the price of street-level heroin.

FIGURE 38.1: CCF OF ARRESTS V. PRICE PER GRAM

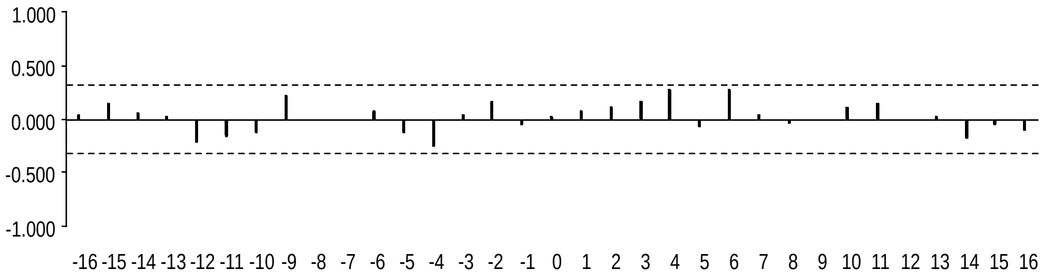
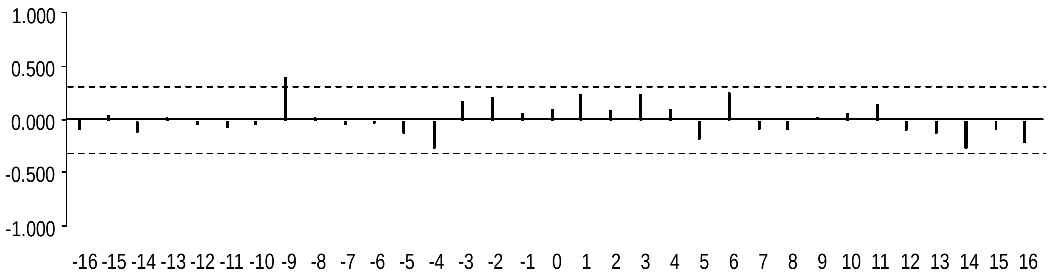


FIGURE 38.2: CCF OF ARRESTS V. PRICE PER PURE GRAM



4. SUMMARY AND DISCUSSION

The results shown in section 3 indicate that:

- there is no detectable relationship between the price, purity or perceived availability of heroin at street-level in Cabramatta and average amount of heroin seized, either (a) across Australia or (b) within New South Wales, and
- there is no detectable relationship between the rate of admission to local methadone clinics and either (a) the price per pure gram at street-level in Cabramatta (b) its perceived availability or (c) the rate of arrest in Cabramatta for heroin use/possession. Nor is there any detectable relationship between the rate of arrest for heroin use/possession and the price of heroin.

In this section we discuss how these findings might be interpreted and what implications they might hold for law enforcement policy.

There are several possible explanations which might be given for the absence of any detectable relationship between heroin seizures, price, purity and perceived availability. Firstly, seizures of heroin recorded over the two year study period might be thought to have varied over too small a range to exert a measurable effect. Secondly, it could be said that a significant proportion of the heroin seized may have been destined for heroin markets other than Cabramatta. Thirdly, it could be said that the quantities of heroin seized may have been too small relative the quantities being imported to exert much effect on heroin price, purity and availability. Fourthly, it could be said that importers consciously import sufficient quantities of heroin to compensate for the expected losses due to seizures. Finally, it could be said that the quantities seized by law enforcement agencies may be small relative to the quantities of heroin 'stockpiled' by importers and/or distributors.

The first of these possibilities must be considered distinctly unlikely. Table 2 shows that the amount of heroin seized during the course of the study varied over a wide range. Although 21 of the 36 average fortnightly seizure values were in the range 1 to 5 kilograms, 8 were in the 5 to 10 kilogram range, 2 were in the 10 to 15 kilogram range and 5 were in excess of 15 kilograms. Nor does it seem likely that the heroin seized by authorities at the customs barrier or within Australia was destined for other overseas markets. Studies of heroin distribution between countries do not generally identify Australia as a transhipment point for heroin destined for other countries (Childress 1994). Cabramatta, on the other hand, is undoubtedly one of the best known and most frequently patronised street markets for heroin in Australia. It has been cited by the Australian Bureau of Criminal Intelligence (1994) as Australia's major distribution centre for high grade 'rock' heroin and is regarded in some quarters as having superseded Kings Cross as a focal point for heroin distribution in Australia.

The remaining explanations for the absence of any impact of heroin seizures on heroin price and/or purity invite some assessment of the rate at which heroin is seized by Australian authorities. In theory such an assessment is straightforward. We may define the seizure rate as the amount of heroin seized divided by the amount consumed. In any given year the amount of heroin consumed is given by the product of (a) the number of heroin users and (b) their average annual consumption. Conventional estimates of (a), however, usually distinguish between regular and recreational heroin users on the basis of variations in consumption levels. To estimate average annual consumption for regular and recreational heroin users, therefore, one must make some assumption about (c) the relative numbers of regular and recreational heroin users, (d) the average amount of heroin injected on each occasion of use and (e) the average frequency of heroin injection (i.e. use) among regular and recreational heroin users.

The present data provide us with reliable information on the amount of heroin seized by Australian authorities, at least where seizures in excess of one kilogram are concerned. But there is considerable scope for debate about the true value of each of (c) to (e). Estimates of the number of regular heroin users, for example, range between 36,000 and 150,000 (Hall 1995). The average amount of pure heroin consumed by heroin users in each injection has not been precisely determined nor has the average injection frequency, although it is possible to obtain plausible estimates of these two quantities. Rather than attempt a 'best' estimate of the proportion of heroin intended for domestic consumption which is seized in Australia, therefore, it is preferable to try to set plausible upper and lower bounds on the seizure rate. This may be done by comparing estimates of Australian heroin consumption based on the smallest and largest plausible estimates of the size of the Australian heroin-using population, the average amount of pure heroin consumed in each injection and the weekly injection frequency.

The results of such calculations (see Appendix 3) suggest that, over the course of this study, the upper bound for the proportion of pure heroin seized by authorities was 17.2 per cent while the lower bound was 3.7 per cent. The true percentage of heroin seized almost certainly lies much closer to the estimated lower bound than the upper bound. Because regular heroin users consume much more heroin than recreational users, estimates of the total volume of heroin consumed are extremely sensitive to the assumed number of regular heroin users. The upper bound for the proportion of heroin seized was derived on the basis of assumptions which would imply that nearly 40 per cent of the existing population of regular heroin users were in methadone treatment during the course of the study.[4] This would seem unlikely. Twenty per cent of the Sydney heroin street dealers studied by Dobinson and Poletti (1988), for example, had never been in treatment. Only 39 per cent reported having ever been on a methadone program at any stage in their lives.

If the Australian heroin seizure rate is as low as 3.7 per cent, one would not expect individual seizures to exert much effect on heroin price or purity. In fact, even if the proportion of heroin seized by authorities is as high as 17 per cent, individual seizures might not necessarily be expected to exert much effect on the supply of heroin. Those involved in heroin importation may fully expect certain quantities of heroin (and their couriers) to be seized by authorities but compensate for this by increasing the amount of heroin they import. Naturally, the profits made in this circumstance would need to be sufficient to compensate for their importation/distribution losses (and for the risks involved in importation and distribution). If they were sufficient for this purpose, however, individual seizures would only be expected to affect the price and/or purity of heroin if their average quantity rose significantly above that expected by importers and/or distributors.

Heroin importers/distributors can also avoid raising prices where seizure rates do unexpectedly rise above their prevailing levels. One way of achieving this is to maintain 'stockpiles' or inventories which can be drawn on to offset unexpected losses due to seizures. The maintenance of such inventories undoubtedly carries risks and costs which would have to be factored into the supply-price of heroin. As with any business, though, there are advantages for heroin importers and distributors in preserving a reputation for being a reliable supplier. In the case of an illegal drug like heroin, maintaining a reliable supply serves the special purpose of allowing importers and distributors to deal only with established and trusted clients. This reduces their risk of apprehension. If large inventories were maintained by heroin importers and distributors (and there is no monopoly control of the heroin market), one would not necessarily expect to see any relationship between average heroin seizure quantities and heroin price and/or purity.

The observation that the fortnightly rate of admission to methadone treatment is not correlated with time series variations in the price per pure gram of heroin, its perceived availability or the rate of arrest for heroin use and/or possession seems to suggest two conclusions. One is that regular heroin users are not affected by the price of the drug or its availability. The other is that arresting heroin users does not affect the rate at which they seek treatment. The data shown in Table 3 do not provide support for either of these propositions. Only one per cent of respondents cited 'cannot score' as a reason for seeking treatment so it can hardly be argued that the impact of heroin availability on treatment admissions was adequately addressed. On the other hand, 67 per cent cited the cost of heroin as a reason while 30 per cent cited 'trouble with the police'. Furthermore, 97 per cent cited 'tired of lifestyle', a response which may well have been conditioned, at least in part, by both the cost of heroin and trouble with the police.

How do we reconcile these results with those of the time series analyses? There are two possible explanations for the apparent discrepancy. Firstly, there was little variation throughout the study period in the number of persons convicted of heroin use/possession offences. The maximum number of persons convicted for offences committed in any given fortnight over the study period was eight, while the minimum number was zero. The capacity of the study to detect a time series relationship between arrests for heroin use and possession and the rate at which users seek treatment is therefore fairly restricted. Secondly, street-level drug law enforcement may prompt heroin users to seek treatment but only because it creates a lifestyle which heroin users eventually tire of. If this hypothesis is correct, an individual's cumulative arrest history may be a better predictor of willingness to seek treatment than the arrest rate prevailing in his or her locality at any particular point in time.

What implications do these observations have, then, for drug law enforcement policy in Australia? One conclusion which should be drawn from the current results is that attempts to increase the street price of heroin (and therewith reduce the demand for it) by creating a shortage of the drug are not likely to prove successful. Given the current standard of public debate in Australia about drug law enforcement policy this is not an inconsequential point to make. Regular news footage showing large amounts of seized heroin is the only tangible evidence of success in the 'war against drugs' often presented by authorities to the general public. Drug law enforcement agencies, by accident if not by design, have tended to encourage a view among policy makers and within the wider community that their success curtailing the activities of 'drug barons' can be measured in terms of the quantities of heroin seized. Such a view ought not to be encouraged by those interested in a rational assessment of heroin law enforcement policy.

The present results, nonetheless, should not be read as indicating that investment in both demand-side and supply-side law enforcement is pointless. The fact that 30 per cent of heroin users entering methadone treatment cited 'trouble with the police' as a reason for seeking treatment suggests that street-level enforcement activity may exert some effect on the demand for heroin. On the supply-side, it must be remembered that the knowledge that heroin importers and distributors are regularly arrested and imprisoned must engender a perception among those involved in importation and supply that there are risks associated with their activity. They will seek to be compensated for accepting these risks and the scale of that compensation can be expected to be reflected in the retail price of heroin. Paradoxical as it may seem, this is true even if variations in seizure rates exert no effect on the price, purity or availability of heroin at street-level.

These considerations give prima facie support to the proposition that the object of demand-side enforcement should be to make life unpleasant for heroin users so they are encouraged to seek treatment while the object of supply-side law enforcement should be to raise the cost of heroin to users. Given the attractiveness of this view, in the light of results showing that neither the heroin seizure rate nor the arrest rate of heroin users appears to influence the heroin market, some discussion of it is in order.

There are three important considerations in determining the role of street-level enforcement in relation to heroin. The first is the extent to which such enforcement encourages heroin users to seek treatment. The present results suggest that it does but it should be remembered that, while 30 per cent of those who sought treatment cited 'trouble with the police' as their reason, we do not know what percentage this group makes up of the general population of heroin users. Without further research we cannot rule out the possibility that only a small percentage of those who eventually give up using heroin do so because of 'trouble with police'. The second is the extent to which more active street-level enforcement would increase the rate at which heroin users seek treatment. The danger here is the implicit assumption that 'if some is good, more is better'. There is no guarantee that higher levels of street-level enforcement would increase the rate at which heroin users seek treatment.

The third consideration is perhaps the most important. If the goal of policy in this area is taken to be harm minimisation then we need to be wary of strategies which purchase a reduction in the number of heroin users at the cost of increased health problems. Police explicitly charged with responsibility for 'harassing' heroin users may find it very difficult to avoid targeting needle exchange centres and methadone clinics. Whatever its impact on treatment admissions, such an outcome would, at the very least, be inimical to efforts to reduce the spread of diseases such as hepatitis and HIV-AIDS. It would also tend to be corrosive of the present high level of cooperation between law enforcement and health agencies. Such an outcome should be viewed with a great deal of concern since it would tend to undermine both efforts to reduce crime and efforts to enlist general public support in preventing the spread of disease.

We turn, then, to consider the question of whether the role of supply-side enforcement should be to lift the risks and costs associated with importation and supply. Note that, on this view, instead of seeking to 'turn off the heroin tap' by targeting those at the top of the heroin distribution chain, supply-side law enforcement should target those levels of distribution where maximum leverage can be obtained on the street price of heroin.

A defence of supply-side drug law enforcement along these lines is sustainable but only if demand for heroin is price-elastic (at least among recreational users) and only if the benefits associated with a law enforcement regime directed at maintaining the price of the drug can be made to outweigh the costs. The fact that 67 per cent of heroin users in the present study cited the cost of heroin as a reason for seeking treatment is strongly suggestive of the possibility that the demand for heroin is in fact price-elastic, even among regular users. More compelling support would be provided, though, if there were empirical evidence indicating (a) that the price of heroin influences the demand for the drug among recreational users or (b) that it influences the rate of initiation into recreational heroin use or (c) that there is a substantial moderation in heroin consumption among those whose decision to seek treatment is prompted by the cost of heroin. To date, none of these issues has been the subject of empirical research.

Can the benefits of a policy designed to moderate the demand for heroin by maintaining its street price be made to outweigh the associated costs? Certainly, the long-run benefits of a policy which does nothing except keep the price of heroin high may be largely, if not entirely, offset by high rates of income-generating property crime. While it is easy to persuade the public that increased numbers of police and tougher penalties provide an effective solution to these problems, the actual impact of police numbers and sentencing policy on crime rates is probably extremely limited (see, for example, Jochelson 1995; Chan 1995). If supply-side policy is to be used to erect an entry barrier to recreational heroin use or to accelerate the rate of departure from regular heroin use, therefore, some strategy should be sought to ameliorate the impact of heroin prices on rates of property crime among regular heroin users.

One option is to increase the rate of placement on methadone. There is both Australian and overseas evidence to suggest that heroin users reduce their offending rates when they move onto methadone (Ryan, White & Ali 1995; Newman, Bashkow & Cates 1973). Australian methadone programs compare very favourably with most other countries (Wodak 1995). The number of persons placed on methadone in Australia, moreover, also appears to be increasing fairly rapidly. At present, however, the public sector of the health system cannot provide sufficient places to meet the demand for the drug. Heroin users can obtain methadone from private clinics but they charge a weekly prescription fee ranging from $35 to $50. Although this may appear a small sum of money it probably represents a significant disincentive to methadone use for heroin users whose legitimate source of income is limited to social security benefits.

A second, more controversial option would be partially to legalise the use of heroin by allowing the prescription of heroin to dependent users under tightly controlled conditions. Both proponents and opponents of this option have in the past been inclined to rely rather more on rhetoric and supposition to support their case than on properly conducted empirical research. Partial legalisation carries potential risks as well as potential benefits (Weatherburn 1992). It may attract a far greater number of regular heroin users out of the illegal market than the provision of methadone. It may also do a good deal more to promote public health. The only way to be sure about these (and any unintended) effects, nevertheless, is to conduct a trial in which both methadone and heroin are made available to dependent users in a way which allows objective assessment of their social and health effects. Bammer (1995) has recently designed such a trial. It is to be hoped that funding and political support will allow it to be conducted.

For many people, of course, the idea of experimenting with a treatment strategy to deal with a crime problem will appear an anathema. As one leading United States drug policy analyst (Reuter 1995) recently put it, it is natural to assume that if heroin use is a crime problem, law enforcement must be the answer. Ironically, law enforcers themselves are increasing looking beyond the traditional formula of increasing the number of police and raising the sanctions for criminal conduct in their search for effective ways of reducing crime. It may be an exaggeration to argue that if heroin use is a crime problem treatment must be the answer. For those genuinely concerned to reduce the social costs associated with drug use, however, it may be time to reconsider the question of whether we have struck the right balance between treatment and law enforcement in minimising the harm associated with illegal drug use.

NOTES

1 The Committee's estimate of the population of heroin users was obtained from a survey of heroin use among cannabis users aged between 15 and 30 years of age. The authors of the survey provided cogent arguments to the effect that the estimate of regular heroin users they had obtained was likely to be a significant underestimate. The Committee chose to ignore this caveat on the peculiar ground that low estimates of the number of regular heroin users 'should not be rejected simply because it does not match our expectations'. (p. 40).

2 For the first 13 months of the study period it was difficult to distinguish 'buys' (heroin samples purchased by undercover police officers) from 'arrests' (heroin samples recovered from persons arrested for heroin possession). This situation arose because, quite frequently, after making a 'buy' a police officer would immediately arrest the person who sold the heroin. The data collection form used in the first part of study did not distinguish between arrests following undercover buys and arrests which were not preceded by undercover buys. Hence some undercover buys were wrongly classified as arrests. From March 1994 onward, a new data collection form was used.

3 The Wilcoxon signed ranks test is the non-parametric equivalent of a paired t-test. (A paired t-test was not considered appropriate because the averages were based on different numbers of observations in each fortnight.) The differences were calculated as follows. The average price per gram for all arrest samples in the first fortnight was calculated. Similarly the average price per gram for all undercover buy samples in the first fortnight was calculated. The difference between these two averages was then calculated. The same calculations were performed for all fortnights leading to a set of differences, one for each fortnight.

4 There were 14, 056 people on methadone in January 1994 (half way through the study period). This represents 39 per cent of the assumed lower bound for the number of heroin users.

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APPENDIX 1

OFFICE USE ONLY

- Date of (day) (month) (year)

1 Sex (1=male; 2=female)

2 Age (in years)

3 What is the postcode of the suburb where you live?

4 When was the last time you bought heroin? ____________

5 On a scale from 1 to 5 how hard was it to score that heroin?
(1=much easier than usual, 2=easier than usual, 3=same as usual, 4=harder than usual, 5=much harder than usual)

6 How would you rate the purity of that heroin?
(1=lowest ever, 2=lower than usual, 3=same as usual, 4=higher than usual, 5=highest ever)

7 In which suburb did you score? ____________

8 How much did it cost? $

9 What did you get? ____________
(Weight; No. of caps, foil, wraps, other)

10 Did you cut the heroin? (1=yes, 2=no)

11 How many times have you bought heroin in the last month?

12 What was your main source of income in the last month?
(1=Salary/wages, 2=Social Security, 3=family or friends, 4=selling heroin or other drugs)

Other offences, e.g. break and enter, shoplifting (please specify) ____________

Other (please specify) ____________

FOR PEOPLE SEEKING ADMISSION OR BEING ADMITTED TO THE METHADONE

13 Why have you decided to stop using heroin?

Family support (1=yes, 2=no)

Too expensive (1=yes, 2=no)

Cannot score (1=yes, 2=no)

Trouble with police (1=yes, 2=no)

Tired of lifestyle (1=yes, 2=no)

Other (please specify) ____________

APPENDIX 2

TIME SERIES MODELS

Time series models are generally of three types: autoregressive models, moving average models or a mixture of both.

Autoregressive models express each term in a time series as a function of previous terms in the series, the order of the model indicating how many previous terms are included. An autoregressive model of order p (called an AR(p) model) is a model of the following form:

$$X_t = \mu + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \alpha_3 X_{t-3} + \ldots + \alpha_p X_{t-p} + \varepsilon_t$$

where X_t is the value of the series at time t; μ, α_1, α_2, . . . α_p are constants; and the ε_t are identically independently distributed variables with zero mean. The ε_t series is a random or white noise series.

In a moving average model the random effects persist over time. The order of the model indicates how many previous random terms are included. A moving average model of order p (called an MA(p) model) is a model of the following form:

$$X_t = \mu + \varepsilon_t - \beta_1 \varepsilon_{t-1} - \beta_2 \varepsilon_{t-2} - \beta_3 \varepsilon_{t-3} - \ldots - \beta_p \varepsilon_{t-p}$$

where X_t is the value of the series at time t; μ, β_1, β_2, . . . β_p are constants; and the ε_t are identically independently distributed variables with zero mean (white noise).

The significance of fitted model parameters is tested by the t-ratio, which because of the (usually) large number of observations (and, therefore, degrees of freedom) can be assumed to be approximately N(0,1). Hence values of the t-ratio greater than 2 (in absolute value) indicate that the parameters are significantly different from zero.

The modified Box-Pierce chi-squared statistic is used to test the hypothesis that the first k autocorrelations are all zero (against the alternate hypothesis that they are not all zero). It is usually calculated for a series of values of k.

RESULTS OF MODEL FITTING

Purity (section 3.3.1)

Number of observations: 52
Model fitted: $X_t = 22.955 + 0.611X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	5.4
Constant	18.6

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36	48
Chi-squared statistic	6.4 (11 d.f.)	22.8 (23 d.f.)	35.6 (35 d.f.)	65.3 (47 d.f.)

Price per gram (section 3.3.2)

Number of observations: 52
Model fitted: $X_t = 719.1 + 0.434X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	3.3
Constant	11.7

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36	48
Chi-squared statistic	10.5 (11 d.f.)	22.9 (23 d.f.)	33.2 (35 d.f.)	43.6 (47 d.f.)

Price per pure gram (section 3.3.3)

Number of observations: 52
Model fitted: $X_t = 1515.9 + 0.3771X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	2.8
Constant	9.8

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36	48
Chi-squared statistic	6.6 (11 d.f.)	19.3 (23 d.f.)	25.7 (35 d.f.)	46.5 (47 d.f.)

Price per gram excluding outlier (section 3.5.3)

Number of observations: 52
Model fitted: $X_t = 545.03 + 0.5635X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	4.7
Constant	10.1

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36	48
Chi-squared statistic	8.8 (11 d.f.)	26.3 (23 d.f.)	37.0 (35 d.f.)	46.2 (47 d.f.)

Price per pure gram excluding outlier (section 3.5.4)

Number of observations: 52
Model fitted: $X_t = 986.3 + 0.5802X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	4.9
Constant	8.5

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36	48
Chi-squared statistic	5.8 (11 d.f.)	21.6 (23 d.f.)	31.6 (35 d.f.)	46.6 (47 d.f.)

Price per pure gram excluding outlier, 46 observations (section 3.7)

Number of observations: 46
Model fitted: $X_t = 1011.5 + 0.5594X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	4.5
Constant	8.3

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36
Chi-squared statistic	8.9 (11 d.f.)	23.7 (23 d.f.)	36.4 (35 d.f.)

Price per gram, 37 observations (section 3.10)

Number of observations: 37
Model fitted: $X_t = 514.3 + 0.6274X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	4.7
Constant	8.1

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36
Chi-squared statistic	9.5 (11 d.f.)	26.6 (23 d.f.)	32.9 (35 d.f.)

Price per pure gram, 37 observations (section 3.10)

Number of observations: 37
Model fitted: $X_t = 1065.3 + 0.5962X_{t-1}$

Significance tests for model parameters:

	t-ratio
AR(1) coefficient	4.3
Constant	7.5

Modified Box-Pierce chi-squared statistics:

Lag	12	24	36
Chi-squared statistic	2.3 (11 d.f.)	13.3 (23 d.f.)	23.8 (35 d.f.)

APPENDIX 3

Estimates of population of heroin users, frequency of use and amount of heroin used

Estimates of population of heroin users

	Regular users	Recreational users
Lower bound	36,000	72,000
Upper bound	150,000	450,000

Estimates of frequency of use

	Regular users	Recreational users
Lower bound	17.5 times per week	0.5 times per week
Upper bound	17.5 times per week	1.0 times per week

Estimate of amount of heroin used in each injection: 0.03 gm

Sources and assumptions

- The lower bound for the population of regular users is as estimated by the National Drug Abuse Data System, cited in Hall (1995).
- The upper bound for the population of regular users is as estimated by Hall (1995).
- Hall (1995) estimates that there are two to three times as many recreational users of heroin as there are regular users. We have used a factor of two for the lower bound and three for the upper bound.
- Those directly involved in the administration of methadone programs in NSW estimate that regular users use heroin two to three times per day. Based on this advice, we have estimated the frequency of use for regular heroin users to be 2.5 times per day, that is, 17.5 times per week.
- The most informed guess for the frequency of use for recreational heroin users is based on these users being weekend users only. We have used once per fortnight (0.5 times per week) as the estimated lower bound frequency and once per week as the estimated upper bound frequency. However, it should be noted that sensitivity analyses indicate that changes within this range of frequencies have little effect on the overall estimated heroin consumption because the frequency of use for recreational users is so much smaller than that for the regular users.
- The estimated amount of heroin used in each injection came from the samples of heroin obtained for this study. Those who are directly involved in the administration of methadone programs in NSW estimate that users pay up to $80 for each heroin use. We therefore calculated the average weight of the pure heroin in each sample for all samples costing up to $80. The average weight of pure heroin in these samples was 0.03 gm. (It is worth noting that, for the samples obtained in the study, the average weight of pure heroin in each sample was still 0.03 gm even for samples costing $30 or less.)

Lower and upper bound estimates of total heroin consumption

The lower and upper bounds for the total consumption of heroin over the two year period of the study were estimated by multiplying the appropriate population and frequency of use per week estimates, by the average amount of heroin used, and by 104 (the number of weeks in the two year period) as shown below:

Lower bound: [(36,000 x 17.5) + (72,000 x 0.5)] x 0.03 x 104 = 2,077,920 gm

Upper bound: [(150,000 x 17.5) + (450,000 x 1.0)] x 0.03 x 104 = 9,594,000 gm

Estimate of pure heroin seized

The purity of all seizures was not known for all seizures during the study period. The average purity of the heroin seized was calculated from those seizures where purity was known. For these seizures the total weight of pure heroin as a proportion of the total weight of the seizures was 78.1 per cent.

The total weight of all seizures included in the study was 457,554 gm. The estimated weight of pure heroin in these seizures is therefore 357,350 gm (= 457,554 x 0.781).

Lower and upper bound estimates of proportion of pure heroin seized

Dividing the estimated amount of pure heroin seized in the two year period by the lower and upper bound estimates of pure heroin consumed in Australia in the two year period provides the following lower and upper bound estimates for seizures as a proportion of heroin consumed:

Lower bound: 357,350 / 9,594,000 = 0.037

Upper bound: 357,350 / 2,077,920 = 0.172