The War on Drugs: Methamphetamine, Public Health, and Crime

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Abstract

A government effort to reduce the supply of methamphetamine precursors successfully disrupted the methamphetamine market and interrupted a trajectory of increasing usage. The price of methamphetamine tripled and purity declined from 90% to 20%. Simultaneously, amphetamine-related hospital and methamphetamine-related treatment admissions dropped 50% and 35%, respectively. Methamphetamine use among arrestees declined 55%. Although felony methamphetamine arrests fell 50%, there is no evidence of substantial reductions in property or violent crime. The impact was largely temporary. The price returned to its original level within four months; purity, hospital admissions, treatment admissions, and arrests approached pre-intervention levels within eighteen months. (JEL: I12, K32)

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Reducing the consumption of illicit drugs and the adverse health and crime outcomes associated with their use is an important policy goal in the United States. The Office of National Drug Control Policy (ONDCP) estimates that drug abuse cost the U.S. economy $180 billion in 2002 (ONDCP 2004a).[1] Approximately $16 billion of the cost is attributed to health care, $30 billion to crime, and the remainder to reduced productivity.[2] Despite substantial efforts to reduce the supply of and demand for illicit drugs, use of certain drugs has continued to grow. Methamphetamine is of particular concern due to the rapid increase in its use and the belief that it causes substantial amounts of crime. In the early 1990s, methamphetamine use was concentrated among white males in California and nearby western states. Since then, it has spread both demographically and geographically (SAMHSA 2001; NIDA 2002; Johnston, O'Malley, and Bachman 2004). There has been particular concern in the media that this rapid expansion has increased crime in affected communities.[3]

There are three primary approaches to reducing drug use: prevention, treatment, and enforcement. Prevention and treatment are demand-side interventions. Prevention takes the form of education and community action to limit new users, while treatment is intended to reduce demand among current users. The bulk of government spending, however, is focused on enforcement efforts targeting supply.[4] While the efficacy of demand-side interventions can be evaluated experimentally, assessing the effectiveness of enforcement is a more complicated problem. In this paper, we examine the effectiveness of supply reduction strategies by evaluating how a particularly effective intervention in

[1] There have been criticisms of such studies calculating the economic costs of drug abuse. Miron (2003b), for example, notes that many crime-related costs are the result of prohibition rather than use.
[2] ONDCP (2004a) also estimates that crime-related costs may exceed $100 billion if crime-related health and productivity costs are allocated to crime.
[3] For examples, see: Butterfield, Fox. "Across Rural America, Drug Casts a Grim Shadow." *New York Times*, January 4, 2004 (http://query.nytimes.com/gst/fullpage.html?res=9905E0DE1431F937A35752C0A9629C8B63, accessed May 19, 2008); Suo, Steve. "Unnecessary Epidemic." *The Oregonian.* October 3, 2004 (http://www.oregonlive.com/special/oregonian/meth/, accessed May 19, 2008); Wilgoren, Jodi. "Too Late for Katie, Town Tackles a Drug's Scourge." *New York Times*, February 10, 2005) http://www.nytimes.com/2005/02/10/national/10meth.html?ex=1265691600&en=4caa7d96f0ac5399&ei=5090&partner=rssuserland, accessed May 19, 2008).
[4] The budget for 2005 was allocated as follows: 1) $2 billion for prevention, 2) $4 billion for treatment, and 3) $6 billion for market disruption/enforcement (ONDCP 2004b).

the market for methamphetamine precursors affected the price and purity of methamphetamine, drug use, health, and crime. This intervention was atypical in that it focused on restricting access to precursors, specifically ephedrine and pseudoephedrine, rather than the removal of the end product drug from the market. In effect, the Drug Enforcement Agency (DEA) was able to increase the cost of producing methamphetamine by making it more difficult and costly to obtain the inputs needed for production. An examination of this type of intervention is increasingly important as state and federal policymakers pursue legislation to further restrict the availability of precursors.

Researchers have long noted the various difficulties in identifying the impact of supply-side interventions (Caulkins 2000; Yuan and Caulkins 1998; DiNardo 1993): 1) most interventions fail to create a substantial and abrupt supply shock; 2) lack of market concentration results in supply-side interventions often having only a local effect; 3) the positive correlation between supply and successful interventions confounds identification; and 4) spatial and temporal data aggregation masks local or short-term impacts. As a result, it is difficult to credibly estimate the price elasticity of consumption and the direct impact of enforcement on health and crime.

This study advances the literature in four ways. First, the focus on a large and abrupt intervention makes it possible to directly measure the impact of enforcement on health and crime outcomes. Second, we examine the relationship between methamphetamine prices and purity and a variety of outcomes in a setting where the source of the changes in price and purity is known. Third, we examine how rapidly supply recovers after a substantial disruption. Fourth, we address the impact of restricting access to legal precursors, a policy that is being pursued at the federal and state level.

The Domestic Chemical Diversion Control Act (DCDCA) removed the record-keeping and reporting exemption for distributors of single-entity ephedrine products and empowered the DEA to deny or revoke a distributor's registration without proof of criminal intent.[5] In May 1995, the DEA shut down two suppliers that appear to have been providing more than 50% of the precursors used nationally to produce methamphetamine. This is probably the largest "supply" shock that has occurred in any illegal drug market in

[5] Single entity ephedrine products are capsules or tablets whose only active ingredient is ephedrine.

the United States and was made possible by the substantial concentration in the supply of methamphetamine precursors.

Prior to the intervention, methamphetamine prices and purity in California were stable and use was increasing steadily. The intervention disrupted drug markets and dramatically reduced methamphetamine use, adverse health outcomes, and arrests for drug possession and drug sale. The price of methamphetamine soared from 30 dollars to 100 dollars per gram in the four months after the intervention. The increase was substantial, but the price returned to 30 dollars within four months of the peak. The impact on purity was much longer-lived. Purity plummeted from 90% to less than 20% and, after 18 months, had only recovered to 85% of its pre-intervention level. Consequently, purity-adjusted price also remained substantially above pre-intervention levels. The intervention caused a significant reduction in our proxy for methamphetamine consumption, hospital admissions with a mention of amphetamine use, which declined by 50%. We examine the possibility that substitution to other drugs substantially reduced the effect of the intervention on overall drug use, but find little evidence of substitution. We also examine and reject the possibility that those most likely to commit crimes experienced smaller reductions in methamphetamine use than the general population.

In addition to the impact on our proxy for methamphetamine use, the intervention reduced the incidence of adverse consequences associated with methamphetamine use. Methamphetamine-related drug treatment center admissions decreased by 35%, with no compensating increase in admission for other drugs. The impact on crime was mixed. The share of arrestees testing positive for methamphetamine declined by 55%. Felony arrests for methamphetamine possession and sale fell by 50% and misdemeanor arrests by 25% statewide. However, despite the strong correlation between methamphetamine use and crime, we find no compelling evidence that the intervention affected property or violent crime, with the possible exception of an increase in robberies.

The success of the intervention was the result of the considerable market concentration in the distribution of precursors. But the impact of the intervention was largely temporary. The price of methamphetamine returned to pre-intervention levels within four months, while purity, hospital admissions, drug treatment admissions, and drug arrests recovered to near pre-intervention levels over eighteen months. The fairly

rapid recovery of the methamphetamine market after the massive intervention in the precursor market suggests that producers were eventually able to find suitable substitutes.

The paper is organized into seven sections. Section I provides background information on methamphetamine and a brief survey of the literature on supply-side interventions. Section II provides a description of the legislation targeting methamphetamine precursors and the resulting interventions. Section III describes the datasets used in the analysis. Section IV outlines the estimation strategy. In Section V, we examine the effect of the precursor intervention on methamphetamine markets, drug use, health, and crime. Section VI concludes.

I. Background and Policy Significance

After marijuana, amphetamines are the most widely abused illicit drug worldwide (Rawson, Anglin, and Ling 2002). According to the World Health Organization, amphetamine users outnumber both cocaine (2.3 to 1) and heroin users (3.5 to 1).[6] Methamphetamine use is rapidly growing in popularity in the United States. Methamphetamine can be smoked, snorted, injected, or ingested orally to produce a release of high levels of dopamine into the brain and a reduction in dopamine uptake. Methamphetamine use results in feelings of pleasure, increased energy, and greater alertness that can last up to 12 hours. Chronic methamphetamine abuse can lead to psychotic behavior, including hallucinations, paranoia, violent rages, mood disturbances, and suicidal thoughts (NIDA 2002). Cessation of use can result in depression, fatigue, intense craving for methamphetamine, and aggression (ONDCP 2003). Research also indicates that methamphetamine can have serious short and long-term impacts on health. Some users experience hallucinations (30%), paranoia (23%), chest pains (23%), depression (63%), and headaches (39%) (Rawson, Huber, Brethen, et al. 2002). A follow-up survey indicated that for some users physical and mental symptoms persisted for years.[7] In addition, Sara L. Simon, Catherine P. Domier, Tiffanie Sim, et al. (2002) found that methamphetamine use has an impact on cognitive performance similar to cocaine use.

[6] The World Health Organization estimates that there are 35 million amphetamine users, 15 million cocaine users, and 10 million heroin users (Rawson, Anglin, and Ling 2002). There may, however, be differential under-reporting across types of drugs.

[7] The physical effects became less common over time, but the mental effects remained at initial levels.

Despite amphetamines' prevalence worldwide and its severe health effects, research in the United States has concentrated largely on marijuana, cocaine, and heroin. The less extensive research on methamphetamine is likely the result of its historically low prevalence outside California and nearby western states. However, there is significant evidence that methamphetamine abuse is becoming a national problem. From 1992 to 2002, amphetamine-related treatment admission increased by 920% in the Midwest, 560% in the South, 455% in the West, and 45% in the Northeast. Results from the National Survey on Drug Use and Health indicate that 12 million Americans have used methamphetamine at some point in their lives (SAMHSA 2005). In addition, the majority of county law enforcement agencies now report methamphetamine as their primary drug problem (National Association of Counties 2005). The geographic expansion has been accompanied by a demographic shift. In the early 1990s, methamphetamine use had been concentrated among adult white males, but use is now increasing among women and Hispanics (NIDA 2002).

Although the literature on methamphetamine is not as extensive as the literature on cocaine and heroin, there is some evidence that methamphetamine use has substantial negative health and social costs and that interventions aimed at increasing the price of methamphetamine have the potential to reduce health costs. Abt Associates (2001) find a strong negative correlation between methamphetamine prices and consumption among arrestees: a 1% price increase reduces consumption by approximately 1.4%. The elasticity suggests that methamphetamine use is more price-sensitive than cocaine and heroin use.[8] If this estimate can be interpreted causally, then a reduction in precursor availability that significantly increases prices should reduce methamphetamine consumption and consequently the adverse health outcomes and crime that result from consumption. James K. Cunningham and Lon-Mu Liu (2003, 2005) examine the implementation of legislation targeting methamphetamine precursors on hospital admissions and drug arrests. They find that three of the four legislative changes are associated with reductions in amphetamine-related hospital admissions and

[8] Recent evidence estimates a 1% (or less) reduction for a 1% price increase for heroin and cocaine (Chaloupka and Pacula 2000). However, the price elasticity for methamphetamine in the Abt study was estimated using prices and use among a non-random sample of arrestees in five cities and so is unlikely to be comparable to results in the general population.

methamphetamine-related arrests.[9] In the United States, the media have devoted considerable attention to the link between methamphetamine use and crime (Butterfield 2004; Suo 2004; Wilgoren 2005), but there is limited empirical evidence. A recent survey of 655 methamphetamine users in Queensland found that a substantial share had committed property and violent crimes (Lynch et al. 2003). Determining how much a reduction in methamphetamine availability reduces adverse health outcomes and crime is one of the main goals of this study.

Although the United States relies heavily on enforcement, there is considerable debate over the merits of supply-side interventions. Early empirical evidence suggests that supply-side strategies may be less cost-effective than treatment strategies (Rydell and Everingham 1994). A number of studies have failed to find substantial benefits from enforcement efforts. John E. DiNardo (1993) finds that enforcement does not have a significant impact on cocaine prices. Contrary to expectations regarding enforcement and drug prices, Yuehong Yuan and Jonathan P. Caulkins (1998) document a *negative* relationship between seizures and prices.[10] Jeffrey A. Miron (2003a) finds that enforcement increases prices, but that the impact on price is smaller than expected. However, more recent work suggests that enforcement and treatment are both effective strategies relative to other efforts such as incarceration (Saffer and Chaloupka 1999). Caulkins and Peter H. Reuter (1998) likewise find that enforcement increases prices. Caulkins (2000) argues that prohibition and enforcement are effective, but that there are diminishing returns to enforcement. Another strand of the literature, however, suggests that a combination of legalization and taxation may be more effective than supply-side enforcement in reducing substance abuse (Grossman 2004; Becker, Murphy, and Grossman 2004).

One of the primary limitations of the empirical literature on the efficacy of enforcement is that supply shocks are typically local and temporary. This makes measuring their impact difficult with the survey data used in most studies. In addition,

[9] Cunningham and Liu examine legislation passed in 1988, 1995, 1996, and 1997 and find that only the 1996 legislation was not associated with a significant reduction in admissions.

[10] They offer six potential explanations for the counterintuitive result: 1) aggregation of price data disguises short-term price variation due to seizures, 2) seizures temporarily lower dealer demand, 3) market power, 4) quantity-quality trade-offs, 5) increased supply is correlated with both lower prices and increases in seizures, and 6) increased quantity discounts.

enforcement successes are often correlated with prevalence, which can result in biased estimates. We address these issues by focusing on a large abrupt supply shock and using censuses of adverse events rather than survey data. Our data have the additional advantage that they include the precise timing and location of events.

The literature on drug interventions focuses on supply-side efforts targeting the drug itself. There is little empirical evidence regarding the effectiveness of efforts to control the supply of inputs to the production process. Input control strategies, such as the precursor intervention examined in this paper, have the potential to be more successful than efforts targeting the drug itself if the production or distribution of inputs is more highly concentrated than the production or distribution of the drug. With most states having implementing precursor legislation and additional legislation pending, evidence on the efficacy of precursor control strategies could help guide policy.[11]

II. Methamphetamine Precursor Regulation and Supply

Methamphetamine production in the United States in the 1980s and early 1990s was dominated by operators of small independent laboratories.[12] During the mid-1990s, these operators were partially displaced by Mexican drug trafficking organizations that operated much larger "super-labs" capable of producing 10 or more pounds of high-purity methamphetamine in a 24-hour period.[13] Methamphetamine is a Schedule II drug. However, the primary precursors – ephedrine and pseudoephedrine – have numerous legitimate uses and were considered to have a low potential for abuse. These substances are key ingredients in such over-the-counter drugs as Sudafed and Tylenol Cold and were readily available in the early 1990s.

In the 1990s, the DEA became aware that legally imported ephedrine and pseudoephedrine were being diverted to methamphetamine producers. The DEA expends considerable resources to restrict the supply of these precursors to clandestine labs. These efforts have been facilitated by recent federal legislation that increased the restrictions on both ephedrine and pseudoephedrine distribution. There were significant changes in the federal regulations enacted in 1988, 1993, 1996, 1997, 2000, and 2005. In 1988 the

[11] NDAA Capital Perspective: http://www.ndaa.org/ndaa/capital/capital_perspective_nov_dec_2005.html.
[12] Outlaw motorcycle gangs have traditionally been heavily involved in small-scale operations.
[13] Most of these super-labs were located in California and other western states during this period.

Chemical Diversion and Trafficking Act (CDTA) imposed reporting, record-keeping, and import/export notification requirements for regulated transactions in bulk (powder) ephedrine and pseudoephedrine.[14] However, it did not control tablets or capsules. The Domestic Chemical Diversion Control Act (DCDCA) was passed in 1993 and implemented in 1994 and 1995. The legislation removed the record-keeping and reporting exemption for single-entity ephedrine products. The DCDCA also required distributors, importers, and exporters of List I chemicals to register with the DEA. The DEA could deny or revoke a company's registration without proof of criminal intent. In 1996 the Methamphetamine Control Act (MCA 1996) regulated access to over-the-counter medicines containing ephedrine. The following year, the Methamphetamine Control Act (MCA 1997) regulated products containing pseudoephedrine or phenylpropanolamine with or without other active ingredients. Significant elements of the MCA were implemented in early 1998. In 2000, the Methamphetamine Anti-Proliferation Act (MAPA) established thresholds for pseudoephedrine drug products. Finally, in 2005 the Combat Methamphetamine Epidemic Act (CMEA) included limits on retail over-the-counter sales of products containing ephedrine, pseudoephedrine, and phenylpropanolamine.

This project focuses on two major enforcement efforts made possible by the DCDCA. In May 1995, the DEA executed a search and seizure warrant at Pennsylvania-based tablet manufacturer Clifton Pharmaceuticals. The seizure netted 25 metric tons of ephedrine and pseudoephedrine – an amount that would yield 16 tons of methamphetamine under typical clandestine lab production methods.[15] In addition, on May 31, the DEA executed search warrants at the mail order distributor X-Pressive Looks, Inc. (XLI). The DEA seized 500 cases of pseudoephedrine in May and shut down XLI's distribution in August. The DEA determined that XLI distributed 830 million tablets of pseudoephedrine between April 1994 and August 1995. This amount could

[14] The CDTA amends the Controlled Substances Act (CSA). The CSA provides schedules of controlled substances including methamphetamine (Schedule II drug). The Chemical Diversion and Trafficking Act (CDTA) and later amendments placed regulatory controls and criminal sanctions on chemicals (including ephedrine and pseudoephedrine as List I chemicals) to control domestic and international diversion without disrupting access for legitimate concerns.

[15] The maximum conversion rate for ephedrine and pseudoephedrine is 92%, but typically labs convert at a rate of 50% to 75%. We use the midpoint (62.5%) for this estimation.

produce 13 metric tons of methamphetamine.[16] The scale of these two supply disruptions was enormous. By contrast, the DEA seized only .76 metric tons of methamphetamine in all of 1994. As a second measure of the scale of these interventions, the ONDCP estimated that total methamphetamine consumption in the United States in 1994 was 34.1 metric tons (ONDCP 2000).[17] The size of these two firms relative to the overall market is evidence of substantial concentration in the precursor market.

III. Data

We use a variety of data sources to examine the impact of the disruption in methamphetamine precursor supply on methamphetamine price, methamphetamine purity, drug use, health, and crime. Although the intervention was national, we focus only on California because it was the primary location for the production and consumption of methamphetamine in the mid-1990s and because of the availability of detailed data. All datasets except the ADAM/DUF are administrative data that represent a near census of events. These datasets make it possible to compute monthly, county-level measures of events that facilitate the identification of short-lived or local effects. Data are available from 1994 onward for all outcomes, but due to implementation of additional precursor legislation in early 1998 we confine our analysis to the period from January 1994 to December 1997.

Estimates of price and purity are constructed from the DEA's System to Retrieve Information from Drug Evidence (STRIDE) dataset. STRIDE is a forensic database populated primarily with DEA seizures and purchases that were sent to the lab for analysis. The dataset records the purity of seized and purchased methamphetamines, the price of purchased methamphetamines, and the location and date of each purchase and seizure.[18] There are two issues are of concern. First, the recorded transactions are likely not representative of all drug transactions (ONDCP 2004c; Horowitz 2001). Nevertheless, STRIDE represents the best measures of the purity and prices of illegal drugs in the United States. Second, there are insufficient observations to construct reliable county-month level measures. This second limitation restricts our analysis of

[16] It is unclear if the two firms targeted by these interventions were associated.
[17] The size of these interventions suggests that ONDCP may be underestimating consumption.
[18] STRIDE also contains prices, purity, and seizures for other drugs, including cocaine and heroin.

price and purity to the state level and prevents us from using prices and purity in the panel regression analyses.

The health outcomes are derived from two datasets. The first dataset is the California Office of Statewide Health Planning and Development (OSHPD) census of hospitalizations. These discharge data include individual-level information on the cause of admission, other conditions present on admission, month of admission, hospital location, residential location of patient (e.g., zip code), medical costs, and payment source. Amphetamine-related admissions are identified by diagnosis (ICD-9-CM) codes: 304.4 (amphetamine and other psychostimulant dependence), 305.7 (amphetamine or related acting sympathomimetic abuse), 969.7 (psychostimulant poisoning) and E854.2 (accidental psychostimulant poisoning).[19] The second dataset contains individual-level drug treatment admission records from the California Alcohol and Drug Data System (CADDS). These data identify the primary, secondary, and tertiary drug the person is treated for (e.g., methamphetamine), month of admission, zip code of residence and county of admission, frequency of use, type of referral, type of treatment program, and patient demographics. For these datasets, we use information on the month of admission and county of residence to construct our monthly county-level measures of consumption and adverse health events.[20]

We use two data sources to examine the relationship between methamphetamine availability and crime. The Arrestee Drug Abuse Monitoring Program, formerly titled the Drug Use Forecasting (ADAM/DUF), measures drug use based on both self-reports and the results of urine analysis for a non-random sample of arrestees in 35 U.S. cities. Three of these cities – San Jose, Los Angeles, and San Diego – are in California. The second source is monthly jurisdiction-level crime data from the California Department of Justice (CDOJ). These data are a census of reported crimes, including robberies, burglaries, rapes, homicides, assaults, motor vehicle thefts, and larcenies. The CDOJ data also include counts of arrests for felony and misdemeanor drug offenses for marijuana,

[19] Amphetamine use is coded based on a toxicity screen that is administered if drug use is suspected. The hospital discharge data codes do not distinguish methamphetamine from other amphetamines. But authors' calculations using the treatment admission data indicate that methamphetamine was the type of amphetamine the person was actually uing in 95% of treatment admissions for amphetamine in California during the mid-1990s.

[20] We rely on county of admission when zip code of residence is unavailable in the CADDS data.

narcotics, dangerous drugs, and other restricted drugs. The arrests are also a census of events, but only the most serious drug offense for each arrest is recorded. As with the health outcomes, we use these data to construct county-month level measures of events: reported property crime, reported violent crime, and felony and misdemeanor drug arrests.

IV. Estimation Strategy

An intervention that successfully targets methamphetamine precursors should increase the cost and difficulty of producing high-quality methamphetamine, thereby increasing price and reducing purity. Consequently, we expect some reduction in the prevalence of methamphetamine use. Because methamphetamine consumption can directly cause a spectrum of adverse health effects ranging from dependence to overdose, the intervention should also reduce the incidence of adverse health outcomes. But the impact on crime may vary depending on the type of crime.

We begin our analysis by documenting the effect of the intervention in the methamphetamine precursor market on methamphetamine price and purity. Because the STRIDE data are too sparse to generate county-level measures of price and purity, we document the impact of the intervention on methamphetamine price and purity by examining the statewide time series.

We then examine the impact of the intervention on methamphetamine consumption. Unfortunately, there are no surveys large enough to generate monthly, county-level measures of methamphetamine consumption. For this reason, we use hospitalizations with a mention of amphetamine use as a proxy for methamphetamine prevalence. We estimate the following regression to evaluate the first-stage relationship between the intervention and methamphetamine consumption:

$$(1) \qquad H_{itm} = \beta_I I_{tm} + \beta_s A_{itm} + \beta_X X_{itm} + \eta_i + \varphi_t + \phi_m + \varepsilon_{itm}$$

The dependent variable H_{itm} is the log of amphetamine-related hospitalizations. The subscripts indicate the county i, year t, and month m. The explanatory variable of interest, the instrument I_{tm}, takes on a value of 1 during the peak effect of the intervention between August 1995 and September 1996.[21] The regression controls include the log of cocaine,

[21] The estimates are robust to varying the time period that is coded as the intervention period.

heroin, marijuana, and alcohol admissions A_{itm}, the shares of the population that are black and Hispanic and in particular age groups X_{itm}, and fixed effects for the county η, year φ, and month ϕ. For all regressions, we compute the heteroskedasticity robust standard errors and cluster on county (Bertrand, Duflo, and Mullainathan 2004). We confine our analysis period to January 1994 to December 1997 in order to avoid confounding our results with elements of the Methamphetamine Control Act, which took effect in early 1998.

After documenting that there is a strong first-stage relationship between the intervention and our proxy for methamphetamine consumption, we estimate the relationship between methamphetamine consumption and adverse health effects. As noted previously, the lack of county-level measures of price, purity, and consumption compel us to use amphetamine-related hospitalizations as a proxy for consumption.[22]

To generate credible estimates of the causal relationship between methamphetamine and adverse health effects, we use the intervention as a source of exogenous variation in methamphetamine consumption in Equation 2. This addresses the problems with omitted variables that are likely to bias cross-sectional or panel estimates. Using this instrumental variables approach, we first examine whether the reduction in methamphetamine use induced substitution to other drugs, which could offset some of the benefits of the intervention. We then examine the impact on treatment admissions for methamphetamine and other substances. Finally, we estimate how the reduction in methamphetamine use affected crime. The model is specified as:

$$Y_{itm} = \alpha_I H_{itm} + \alpha_s A_{itm} + \alpha_X X_{itm} + \eta_i + \varphi_t + \phi_m + \varepsilon_{itm} \quad (2)$$

where Y_{itm} is the log of adverse outcomes (i.e., drug treatment admissions, reported crimes, and drug-related arrests) in county i, year t, and month m. We use the intervention as an instrument for amphetamine-related hospitalizations H_{itm}. As noted previously, the lack of county-level measures for price, purity, and consumption motivate this approach.

[22] A potential alternative is to use methamphetamine-related drug treatment admission as our proxy for methamphetamine consumption. Regressions using treatment admissions result in very similar estimates of the impact on reported crime and drug-related arrests. We rely primarily on hospitalizations (rather than treatment admissions) because they respond immediately to changes in consumption while some types of treatment admissions respond with a lag (e.g., institutional referrals such as court-ordered admissions).

A reduction in methamphetamine availability is likely to have different effects on property, violent, and drug crimes. The impact of the reduced availability on property crime depends on the price elasticity of consumption. When faced with a substantial price increase, do users substantially reduce use, substitute another drug, or simply pay higher prices? If users quit, either because of the higher prices or decreased availability, property crime may decline. It is possible, however, that the reduced purity and increased prices due to the supply shock may result in an increase in property crime among more dependent users who are unwilling or unable to reduce their consumption.[23] The reduced availability might result in a decrease in incidents due to the pharmacological effects of methamphetamine. This suggests we may see fewer violent crimes committed by drug abusers suffering from drug-induced psychosis. Violence resulting from enforcement of property rights is also likely to decline, if it changes at all, because there are fewer dealers competing over territory.[24] Drug arrests are likely to decline because there are fewer transactions for the police to interdict when the market shrinks.

V. Results

Methamphetamine Markets

Figure 1 shows the average monthly price per gram and purity constructed from methamphetamine purchases in California that are recorded in the STRIDE data.[25] The vertical line in the figure indicates the timing of the DEA intervention. The price jumps from 30 dollars to more than 100 dollars per gram in the four months following the intervention. It is worth noting that the price per gram returns to its original level within four months of its peak. In the same period, purity declines from 90 percent to less than

[23] If the more severely dependent are more likely to commit crime and less likely to reduce their consumption, we may observe an increase in property crime even if demand for the *average* consumer is price elastic. Also, if dollars spent on methamphetamine remain constant when prices increase and quantity declines, we may also find no impact on property crime.

[24] Users may also be more vulnerable to victimization if they have limited recourse to the legal system.

[25] Price is not purity-adjusted so that we can examine the impacts of the intervention on price and purity separately and highlight their distinct responses to the intervention (see Appendix Figure 1 for the purity-adjusted price series). We also examined the relationship between nominal price and purity and found it be largely linear. We construct only statewide time series for price and purity because the STRIDE data are too sparse to construct meaningful county by month estimates.

20 percent.[26] Purity recovers much more slowly than price. However, within 18 months purity had recovered to 85 percent of its pre-intervention level.

There are several possible causes of the dramatic change in purity. One is that dealers cut the product more when they had less available. Another possibility is that producers were forced to switch to inferior sources of methamphetamine precursors. There is evidence that immediately after the intervention some producers used phenylpropanolamine, which can be extracted from commonly available and unregulated appetite suppression tablets, in the place of ephedrine. This substitution results in a product that has substantially less methamphetamine.[27] Figure 2 presents methamphetamine price and purity for small and large purchases defined as below and above 30 grams, respectively.[28] For purity, the overall size of the decline is the same for large and small purchases, but the reduction for small purchases lags large purchases. Because the small and large purchases likely represent different levels in the supply chain, the observed lag is more consistent with changes in production that take a few months to work their way through the distribution chain than with street-level dealers cutting the methamphetamine in response to a reduction in supply. It is also interesting that the price per gram for large purchases does not change despite what appears to be a significant methamphetamine shortage. Purchases of 30 grams or less show a dramatic increase in price that is not evident for large purchases (Figure 2).[29]

The impact of the intervention on the price and purity of methamphetamine was substantial and, in the case of purity, relatively long-lasting. However, the market eventually recovered to near pre-intervention levels. An examination of the precursors

[26] In the STRIDE dataset, purity is determined by laboratory testing. Purity is defined as the weight in the test sample that is methamphetamine divided by the total weight of the sample. It is measured on a 100-point scale, with 100 indicating that the sample is pure methamphetamine and zero indicating the sample contains no methamphetamine.

[27] *Journal of Clandestine Laboratory Investigating Chemists Association*: http://designer-drugs.com/pte/12.162.180.114/dcd/chemistry/clic.html (accessed September 2006).

[28] There are substantially fewer purchases – particularly large purchases – in the period immediately after the intervention. The missing observation in the time-series for purchases over 30 grams is due to the fact that there were no purchases over 30 grams in that month in California (Figure 2). After the intervention, the number of large purchases in California fell from an average of 6.5 to 3 per month and the number of small purchases fell from 7.3 to 6.5 per month. The substantial reduction is consistent with scarcity.

[29] With respect to typical supply shocks, the nominal prices of illicit products are relatively stable because changes in real prices operate primarily through purity (Abt 2001). In our post-intervention period, however, smaller purchases appear to have been unable to adjust fully to this extreme shock solely through purity.

seized at labs suggests that pseudoephedrine eventually replaced ephedrine as the most common precursor and supported the recovery in purity.

Methamphetamine Consumption

The increase in price and the reduction in purity suggest that shutting down the two precursor suppliers significantly disrupted the methamphetamine market. Because there is no survey of drug use in the general population large enough to create the county-by-month estimates of drug consumption, we use hospital admissions with a mention of amphetamine as a proxy for consumption.[30]

Figure 3 presents the monthly counts of hospital admissions in California where there is a mention of amphetamine use on the discharge record. The amphetamine-related admissions have been disaggregated into the seven most common diagnosis-related groups (DRGs).[31] The most common DRG for these admissions is psychosis, with alcohol and drug detoxification a close second. Surprisingly, more than 11% of those hospitalized with a mention of amphetamine use were pregnant women admitted to the hospital for a delivery. There is an abrupt 50% reduction for all seven DRGs, contemporaneous with the changes in price and purity documented in Figure 1. The timing and pattern of recovery in hospital admissions tracks the changes in methamphetamine purity rather than price. That the reduction in positive tests among pregnant women are the same size as the reduction in other groups suggests that changes in hospital admissions are a reasonable proxy for changes in consumption.

Regression results in Table 1 confirm the substantial impact of the intervention on amphetamine-related hospitalizations (Equation 1).[32] The variable of interest is an indicator variable that takes on a value of 1 during the peak of the intervention and 0 otherwise.[33] All regressions include county fixed effects. The first column shows the estimates of the impact of the intervention on amphetamine-related admissions without

[30] A positive test result indicates that a person has used amphetamines within the past 3 to 5 days. In this period, the vast majority of positive amphetamine tests were due to methamphetamine rather than other amphetamines.

[31] These seven DRGs account for 64% of amphetamine-related admissions during this period. The residual group has a pattern of admissions very similar to that of the seven DRGs in the figure.

[32] We add 1 to the admissions before taking the log to address observations where the count is zero.

[33] The dummy variable takes on a value of 1 between August 1995 and September 1996 and 0 otherwise. The estimates are robust to varying the window.

controlling for other covariates. The coefficient indicates that the intervention resulted in a more than 30 percent decrease in our proxy for consumption.[34] The subsequent columns add year and month indicator variables, demographic composition of the counties, and finally, admissions for cocaine, opioids, cannabis, and alcohol. The initial coefficient estimate is robust to the inclusion of all these variables, confirming a substantial and significant impact on use. This impact is both practically large and has a t-statistic of 10, which suggests we will not have a weak instrument problem in the instrumental variables analysis of substitution, treatment admissions, and crime.

Substitution of Other Drugs

The substantial reduction in methamphetamine use raises concerns that users may have substituted other drugs. Because we do not have panel data on consumption, we can examine substitution only indirectly in the general population. If users are substituting other drugs, we should observe an increase in hospitalizations for other drugs. Figure 4 presents hospital admissions where there was a mention of cocaine, opioids, cannabis, or alcohol.[35] There is little graphical evidence of substitution except with respect to alcohol. Surprisingly, hospital admissions with a mention of cocaine actually decreased.

Table 2 presents the instrumental variables regression estimates of the relationship between methamphetamine consumption and hospital admissions with a mention of these four substances. The dependent variable for each regression is the log of hospitalizations for a particular drug. The regressions include county fixed effects, indicator variables for month and year, the share of the population that is black, Hispanic, and in various age categories, and the log of hospital admissions for the other drugs. Again, there is no evidence that users substituted other illicit drugs. The change in cocaine admissions is statistically significant, but has a counterintuitive sign. Further investigation of the STRIDE data reveals that there was a substantial decline in cocaine purity, of unknown cause, which may have driven the decline in cocaine-related hospitalizations.[36] Although there is no evidence of illicit drugs being substituted for methamphetamine, the

[34] Unfortunately, it is not possible to estimate a price elasticity using hospital admissions as a quantity proxy because the STRIDE is too sparse to construct county-by-month prices.
[35] When an opioid is mentioned on the admission record, the substance is typically heroin.
[36] The change in cocaine markets does not appear to be related to the precursor intervention because the change in price predates the intervention and the change in purity begins several months later.

regression results provide evidence of statistically significant substitution to alcohol.

Drug Treatment Admissions

One measure of the adverse effects of drug use is the rate at which people seek treatment. Figure 5 plots the counts of individuals seeking treatment for substance abuse. Treatment counts are separated into categories based on the primary drug for which the individual sought treatment.[37] Immediately after the intervention, the number of individuals seeking treatment for methamphetamine decreased by approximately 35 percent. Given that individuals typically do not seek treatment until after they have been using a drug for a substantial amount of time, the decline in treatment admissions is probably the result of users quitting on their own in lieu of treatment. The decline in treatment admissions lags the decline in hospitalizations by a few months. When disaggregated by referral source, individual referrals respond immediately to the intervention, while institutional referrals such as criminal justice referrals show a lag of several months.[38] The pattern of recovery in treatment admissions for methamphetamine closely tracks that observed in purity and hospitalizations. There is no evidence of substantial changes in treatment admissions for other substances, which is further evidence that substitution, if it is occurring, is limited.

Table 3 presents the corresponding regression results where the intervention is used as an instrument for methamphetamine consumption. The dependent variable for each regression is the log of treatment admissions for a particular drug. For methamphetamine, a 1% reduction in our measure of methamphetamine consumption results in a 0.3% reduction in methamphetamine-related treatment admissions (column 1). There is no statistically significant impact on treatment admissions for other drugs.

Crime and Drug Arrests

According to the ONDCP, the cost to society of drug-related crime is nearly twice the cost due to drug-related health problems.[39] In contrast to health costs, which are

[37] Figure 5 also provides a category for "other" drugs to account for admissions not due to one of the five main substances examined in this paper.
[38] Figure available upon request.
[39] This estimate includes the costs of prohibition.

primarily private, criminal behavior has largely social costs. Despite the significant resources allocated to supply-side enforcement efforts, there is little compelling evidence that even successful efforts to limit drug availability reduce crime. It is clear, however, that drug use is strongly associated with criminal behavior. Both self-reports and drug testing indicate that drug use among arrestees is considerably higher than in the general population. In the 1995-1997 National Survey on Drug Abuse, only 0.5% of the adult respondents in the general population reported using methamphetamine in the past year.[40] In contrast, 15% of California arrestees in the ADAM/DUF dataset reported using methamphetamine in the past 30 days. The greater prevalence among arrestees, however, does not necessarily imply that reducing the availability of a particular drug will reduce crime.

Table 4 presents self-reported drug use and the results of urine analysis among arrestees by crime category for the period from 1994 to 1997. The arrestees are a non-random sample from three cities in California: San Diego, Los Angeles, and San Jose. The drug tests are sensitive enough to reveal methamphetamine use three to five days after use. Methamphetamine use is common among arrestees, with about 17% of arrestees testing positive. The proportion of arrestees using methamphetamine varies significantly across crime categories: 15% for property crimes, 12% for violent crimes, and 33% for drug offenses. There is evidence that arrestees underreport drug use. While 17% of arrestees test positive for methamphetamine, only 9% report using in the last 72 hours and only 15% report using in the last month. For this reason, we focus on test results rather than the less reliable self-reports of drug use.

Despite the reduction in methamphetamine consumption observed in the overall population, it is possible that the drug consumption of individuals who engage in criminal activity is less sensitive to reductions in the supply of drugs. If so, there may be no first-stage reduction in methamphetamine use for this group. Figure 6 reveals that this was not the case. After the intervention, the share of arrestees testing positive for

[40] These numbers are probably lower bounds due to reporting bias. Self-reports often understate actual use. We see considerable evidence of this in the ADAM data.

methamphetamine declined by more than 50%.[41] The decline and recovery in positive tests track the decline and recovery observed in methamphetamine purity. There was a 50% reduction in positive tests among arrestees for drug offenses, property crimes, and violent crimes, even though those arrested for drug offenses were much more likely to test positive for methamphetamine.

Another concern is that individuals who engage in criminal behavior may be more likely to substitute other drugs when methamphetamine is no longer readily available. If this is the case, substitution could significantly reduce the expected impact of the intervention on crime. The substantial polydrug use among arrestees makes this a particularly pressing concern. Among those who reported ever using methamphetamine, 97% had used marijuana, 72% cocaine, and 26% opioids (i.e., heroin).[42] Surprisingly, as seen in Figure 7, there is no evidence of large-scale drug substitution among arrestees. Among arrestees who reported ever using methamphetamine, the share testing positive for heroin increases only slightly with the peak in positive tests when the positive tests for methamphetamine are bottoming out.[43] However, the increase offsets only a small share of the decline in methamphetamine use. There is no change in positive drug tests for cocaine and marijuana and no change in self-reports of alcohol use.[44]

The analysis thus far suggests that, if the reduction in drug use induced by restricting supply actually affects crime, it is likely that we can detect the effect. First, the prevalence of methamphetamine use among arrestees in California is high. Second, a substantial reduction in use among arrestees occurred as a result of the precursor intervention, with little evidence that users turned to other drugs. Unfortunately, the ADAM/DUF dataset cannot be used to examine the impact of the intervention on crime because it is a small non-random sample. For this reason, we examine reported property crimes, reported violent crimes, and drug arrests using administrative data from the CDOJ.[45] Property crimes include larceny, motor vehicle theft, burglary, and robbery.

[41] Similar declines are evident in self-reports of use in the past 72 hours and 30 days. Because the ADAM/DUF contains few observations in the third month of each quarter, the figures have been smoothed using a moving average that weights the current month by .5 and the leading and lagging months by .25.
[42] The pattern of polydrug use is similar for self-reports of use during the past 30 days.
[43] We also examined the positive test rates among all arrestees and found no evidence of substitution.
[44] We must rely on self-reports for alcohol use because there is no alcohol test in the ADAM/DUF.
[45] Reported crimes probably provide a better estimate of actual crime rates than arrests, except for arrests for drug possession and sale, which for obvious reasons are unlikely to be reported.

Violent crimes include rapes, assaults, and homicides. The drug arrest categories include misdemeanor and felony drug offenses for broad drug classes.

Figure 8 presents the monthly statewide counts of reported property and violent crimes. The increase in all three types of violent crime immediately after the intervention was due to the seasonality of violent crimes. Similar increases occurred in 1994, 1996, and 1997. There is some evidence of a slight increase in the number of robberies in the period when methamphetamine prices were increasing, but no evidence of large changes in the other types of property crimes. The increase in robberies is consistent with the theory that methamphetamine users who rely on crime to support their consumption responded to the higher price by committing more crimes.[46] The instrumental variables estimates in Table 5 confirm that there is no statistically significant relationship for any property and violent crime categories with the exception of an increase in robberies. However, the lack of a finding on other property crimes and the fact that the increase in robberies occurred primarily in counties with low rates of methamphetamine use suggests that the finding with respect to robberies should be interpreted with caution.

The intervention had a substantial impact on drug arrests (Figure 9). There is an abrupt 50% decline in arrests for felony dangerous drugs and 25% decline in arrests for misdemeanor other drug laws. These two arrest categories include methamphetamine possession and sale. Both felony and misdemeanor arrests for marijuana possession and sale increase after the intervention. This could be evidence of substitution. However, it may also be an artifact of our data, which record only the most serious offense category for each arrest.[47] The instrumental variables regressions in Table 6 confirm what we observe in the figure. A 1% reduction in methamphetamine consumption results in a 1% reduction in felony arrests for dangerous drugs and a 0.3% reduction in arrests for other misdemeanor drug laws. The increase in arrests for marijuana sale and possession are also statistically significant. That there is no evidence of changes in arrests for cocaine and heroin suggests that the changes for methamphetamine-related arrests were not due to changes in police behavior or enforcement levels.[48] The large reductions in arrests for

[46] Seasonality may also contribute to the increase in robberies.
[47] The lack of a change in positive tests for marijuana among California arrestees is consistent with the increase in marijuana arrests being an artifact of our data reporting rather than substitution (Figure 7).
[48] The lack of any increase in arrests for cocaine and heroin is additional evidence against substitution.

methamphetamine also stand in stark contrast to the lack of changes in violent and property crimes other than robbery.

VI. Conclusion

The DEA's efforts to shut down two major precursor suppliers in mid-1995 significantly disrupted the supply of methamphetamine. The evidence suggests that, at the peak of the shortage, supply was reduced by over 50% in California. During the four months after the intervention, the price per gram of methamphetamine tripled, and purity dropped from 90% to less than 20%. Prices recovered within four months while purity required eighteen months to recover to 85% of its original level.

The reduction in methamphetamine supply had a substantial, though largely temporary, effect on methamphetamine consumption and methamphetamine-related drug treatment center admissions. The disruption also reduced methamphetamine use among arrestees. It also resulted in a significant reduction in arrests for methamphetamine possession and sale. Though the results of our study are insufficiently precise to preclude the possibility that the reduction in methamphetamine availability caused small changes in violent or property crime, we find no evidence of large changes except for a potential increase in robberies. This is surprising given the strong association between methamphetamine use and crime and the substantial reduction in methamphetamine use among individuals arrested for property crimes and violent crimes. That the enormous reduction in the availability of methamphetamine did not discernibly reduce property and violent crime suggests either that methamphetamine does not cause large amounts of crime or that supply interventions, no matter how successful, are not an effective way of reducing crime associated with methamphetamine use. The lack of an effect on crime cannot be explained by users' substitution of other drugs. Based on our analyses, the substitution of other drugs at most offsets only a small part of the reduction in methamphetamine use.

This is quite possibly the DEA's greatest success in disrupting the supply of a major illicit substance.[49] The focus on disrupting the supply of inputs rather than of the

[49] The effect of the intervention appears to be national. Hospital data from other states, including Iowa, Arizona, and Washington, also show reductions in amphetamine-related hospitalizations on the order of 50%.

drug itself proved extremely successful. This success was the result of a highly concentrated input supply market and consequently may be difficult to replicate for drugs with less centralized sources of supply, such as cocaine and heroin. That this massive market disruption resulted in only a temporary reduction in adverse health events and drug arrests and did not reduce property and violent crimes is disappointing.

VII. Appendix: Data Sources

Data source	**Agency**	**Data Elements**
System to Retrieve Information from Drug Evidence (STRIDE)	US Drug Enforcement Agency (DEA)	Drug prices, purchases, and seizures
Arrestee Drug Abuse Monitoring (ADAM), formerly Drug Use Forecasting (DUF)	United States Department of Justice, National Institute of Justice (USDOJ-NIJ)	Survey and drug tests of arrestee population
Uniform Crime Reporting Program (CDOJ)	California Department of Justice, Criminal Justice Statistics Center (CDOJ-CJSC)	Reported crime and arrest counts
California Alcohol and Drug Data System (CADDS)	California Department of Alcohol and Drug Programs (CADP)	Treatment admissions
California Office of Statewide Health Planning and Development. California Hospital Discharge Data (OSPHD)	California Office of Statewide Health Planning and Development (OSPHD)	Hospital admissions
Census County Population by Race and Ethnicity (Census)	U.S. Census Bureau (Census)	County population by race and ethnicity

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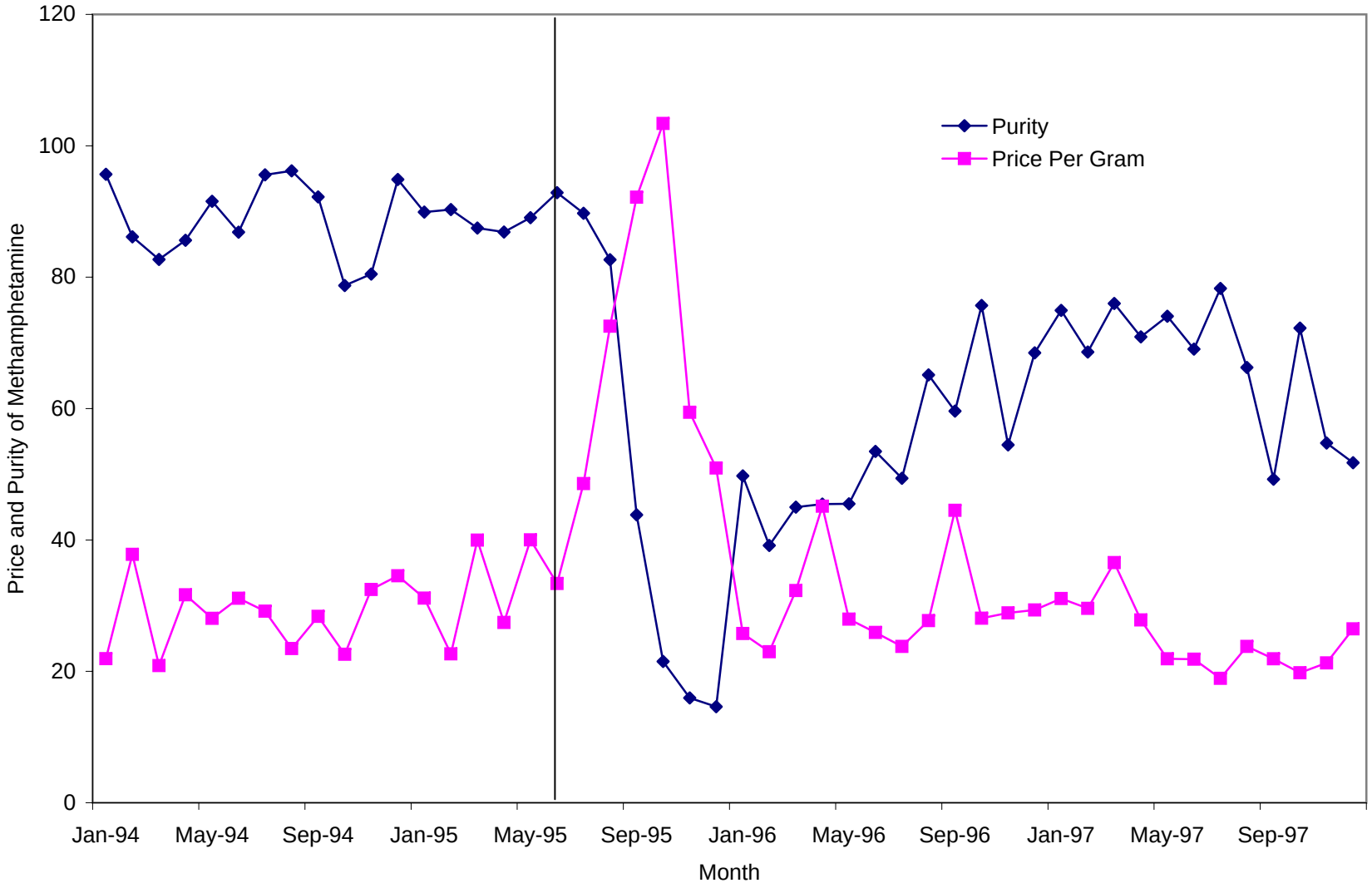
Figure 1: Methamphetamine Price and Purity in California

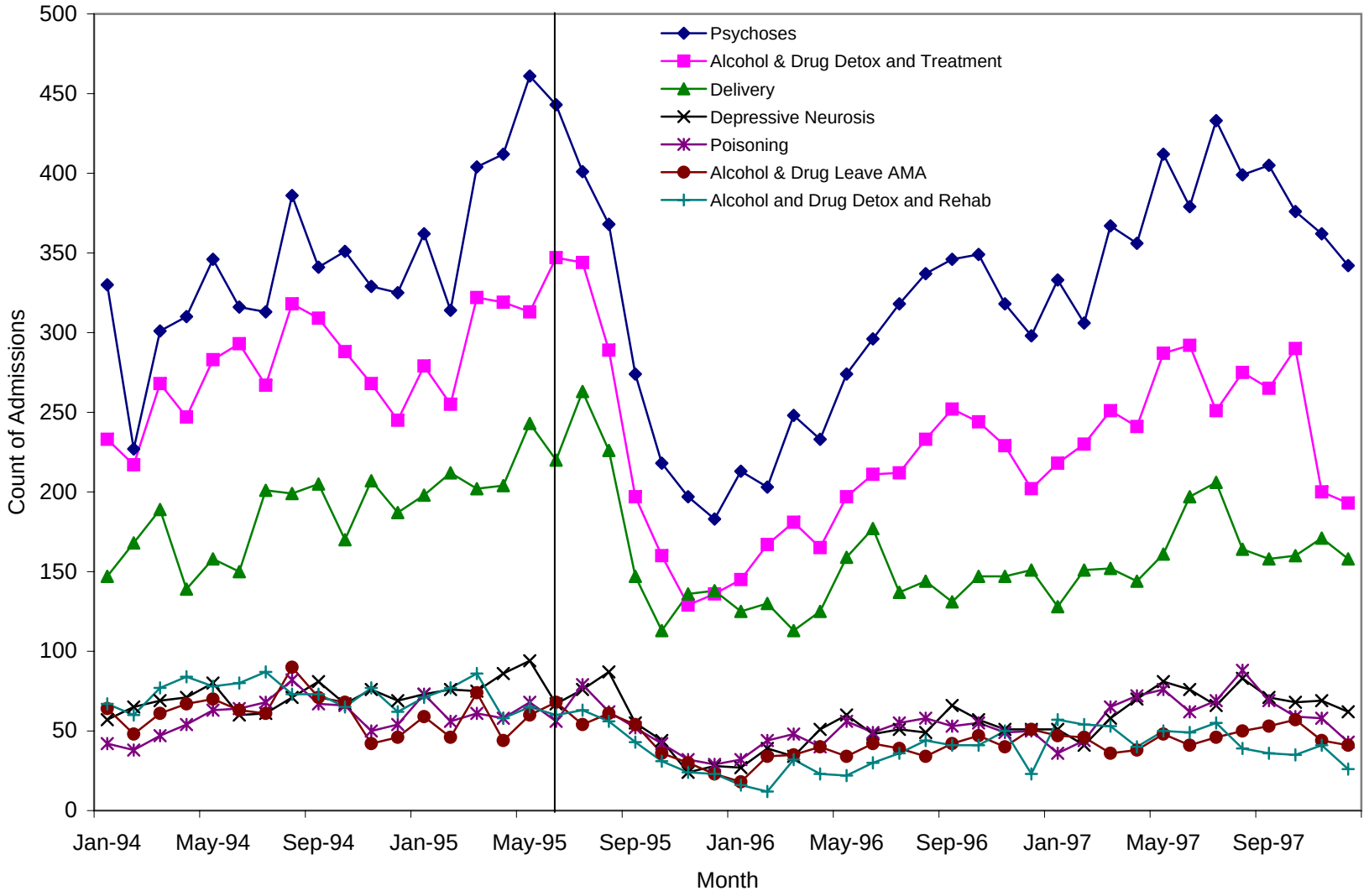


Notes: These figures are derived from the STRIDE data. There are an average of 14.2 observations per month for the entire period and 9.1 observations per month between 8/1995 and 3/1996. Observations with prices over $200 per gram have been dropped.

Figure 2: Methamphetamine Price and Purity in California by Size of Purchase

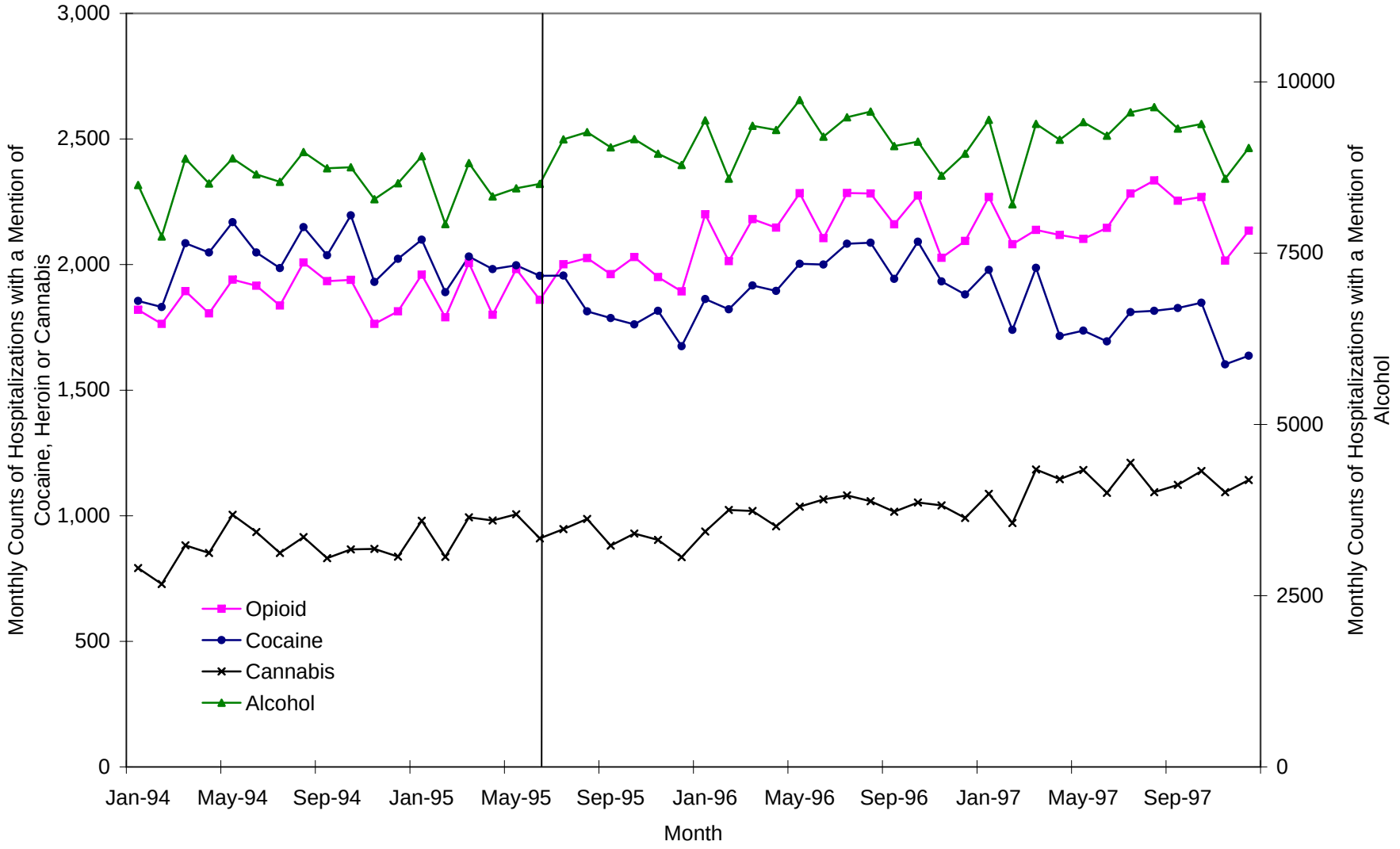
Notes: There are an average of 7.3 purchases per month under 30 grams and 6.9 purchases per month over 30 grams. For the 8/1995 to 3/1996 period these dropped to 6.5 and 3 respectively. Purchases with prices over $200 per gram have been dropped.

Figure 3: Hospital Admissions with Amphetamine Mentioned on Discharge Record by Diagnosis Related Group



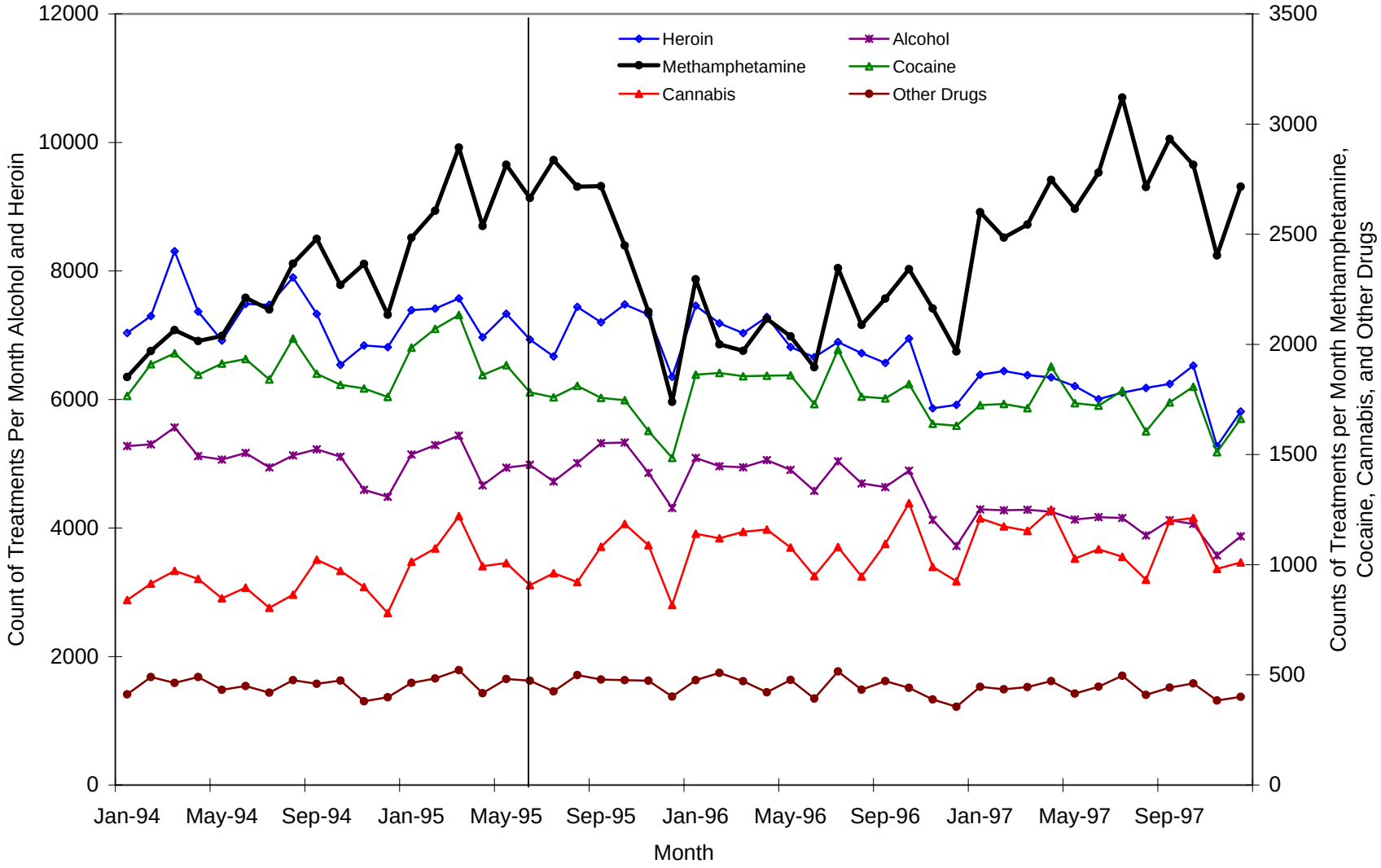
Notes: These are the counts of hospital admissions per month with a mention of amphetamine use for the most common Diagnosis Related Groups.

Figure 4: Hospitalizations with a Mention of Drug Use



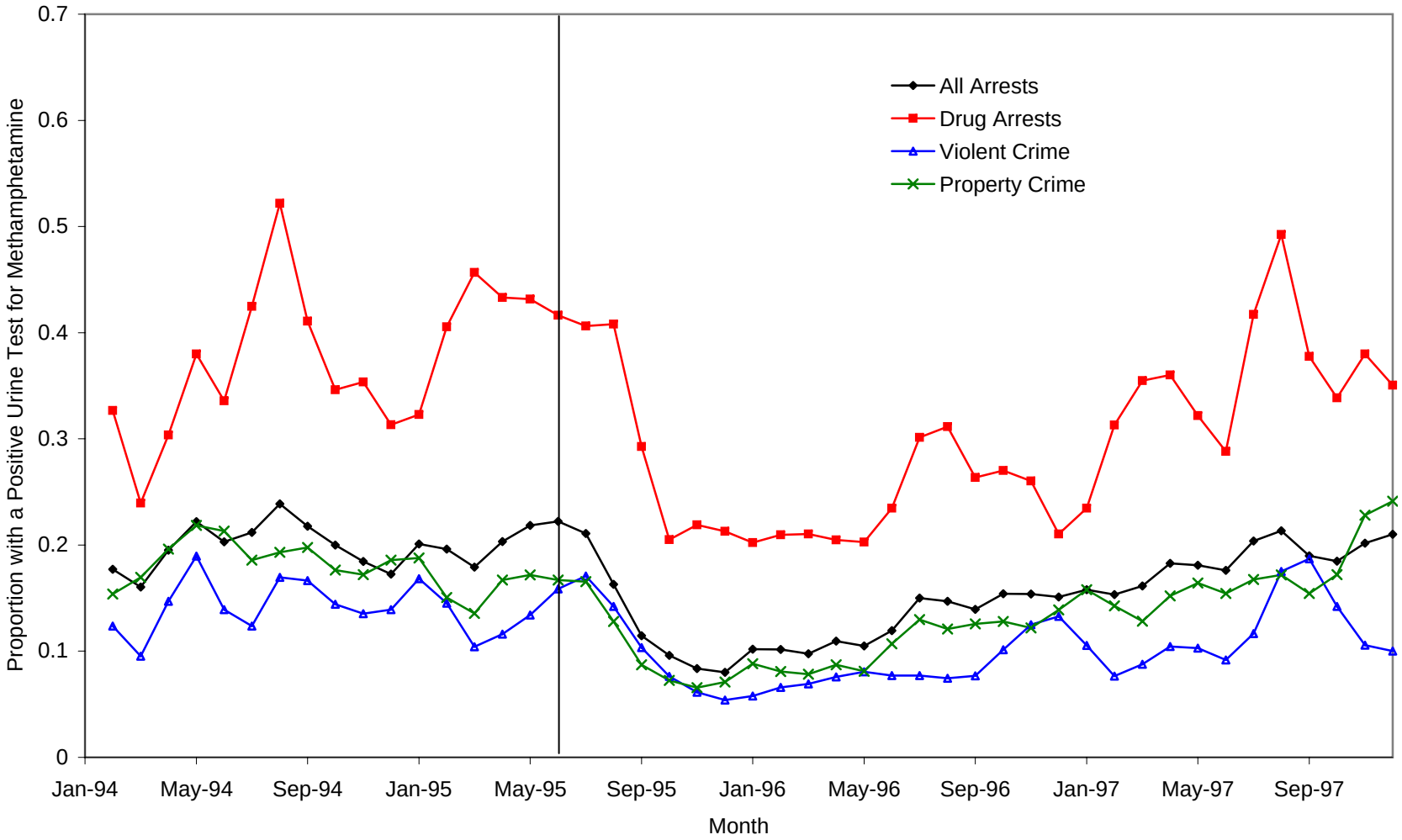
Notes: The correlation in the admission counts and some of the variance is due to the different number of weekends and holidays that occur in each month. The opioid category is composed largely of heroin admissions.

Figure 5: Drug Treatments by Primary Substance



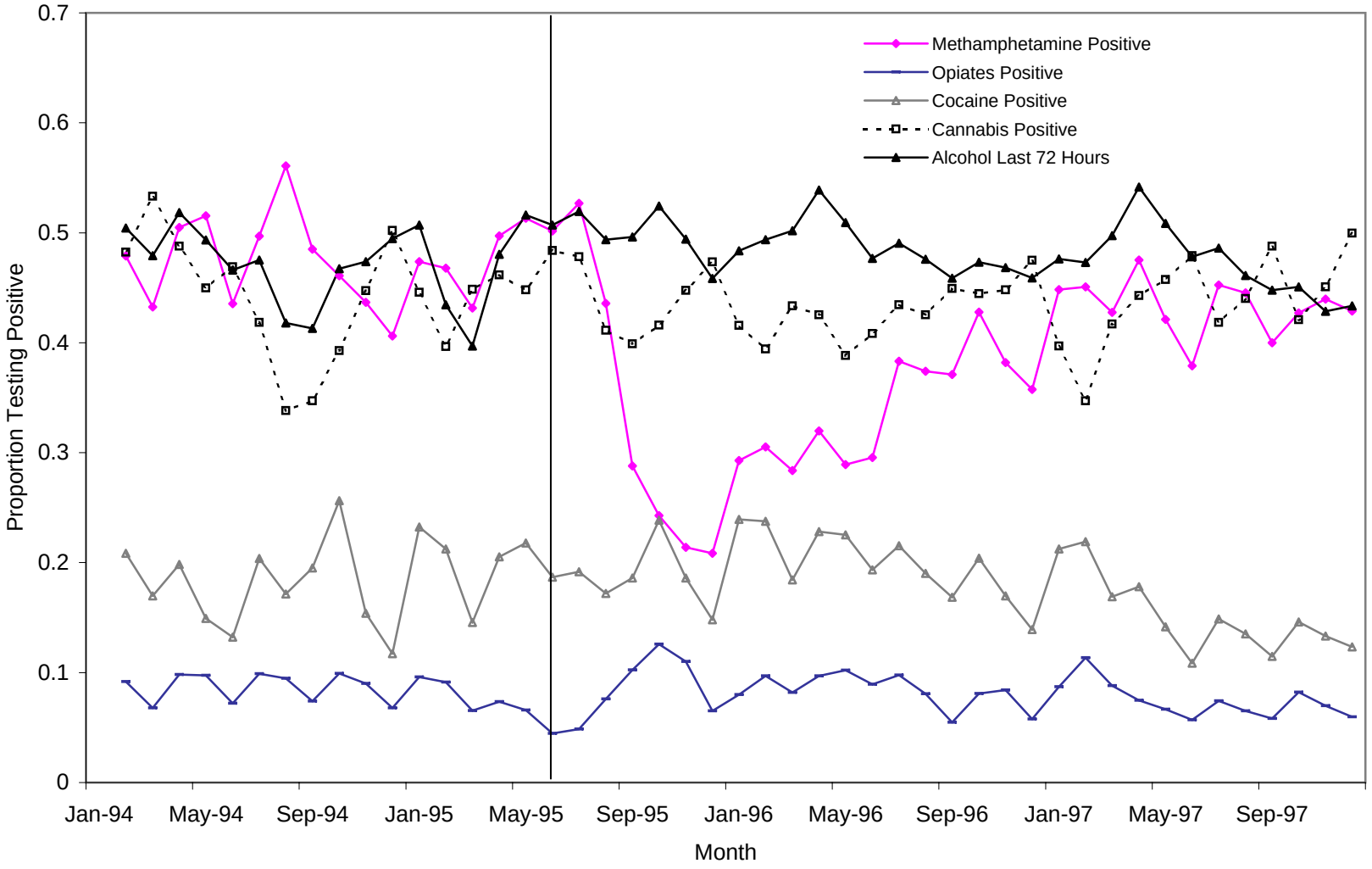
Notes: Admissions are allocated to the primary drug the person is treated for. The monthly counts are rescaled to adjust for the different month lengths.

Figure 6: Positive Methamphetamine Test Among Arrestees in San Diego, Los Angeles and San Jose by Type of Crime



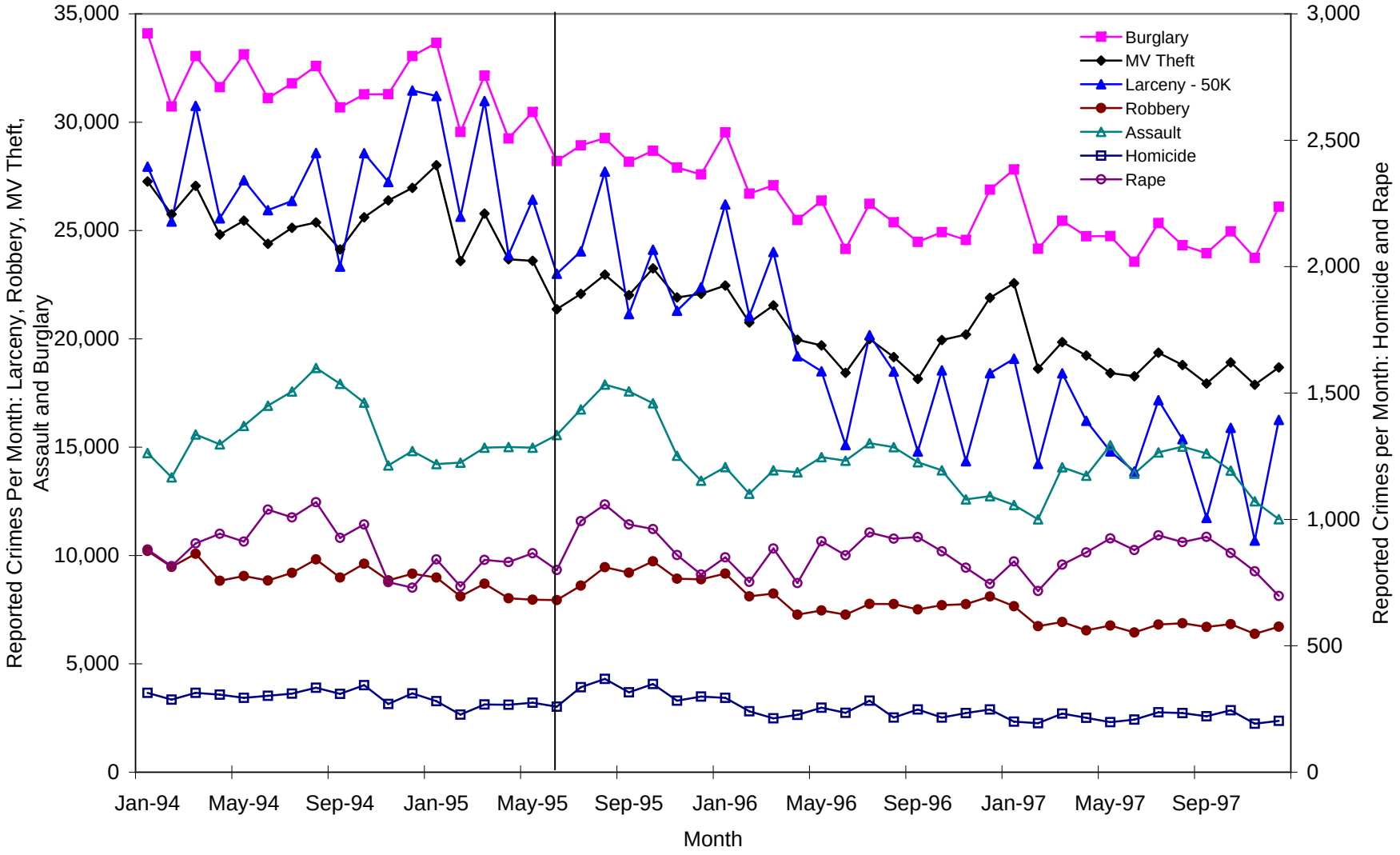
Notes: Data ADAM/DUF. Due to the sampling frame it is necessary to smooth the data with a moving average with a weight of .5 on the current month and .25 on the prior and following months.

Figure 7: Positive Drug Test Among Arrestees in San Diego, Los Angeles and San Jose Who Report Ever Having Used Methamphetamine



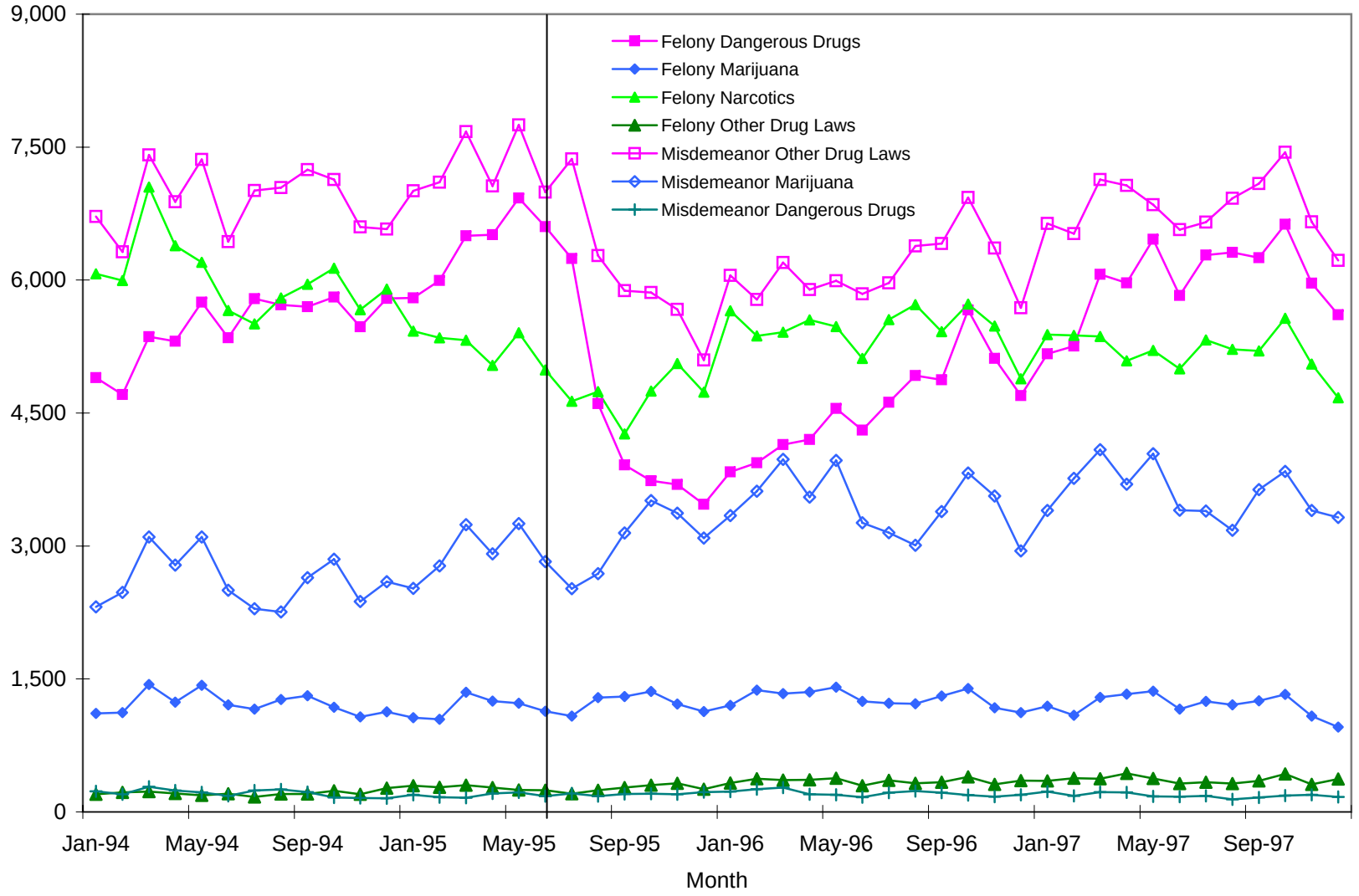
Notes: See notes for Figure 6. The cannabis results are from a test with a 50 nanogram threshold. This test was not performed Jan-Sept 1994 so the values for that period have been imputed based on the result of a test with a 100 nanogram threshold.

Figure 8: Reported Property Crime and Violent Crime in California



Notes: Larceny has been rescaled by subtracting 50K so it fits in the figure. The correlation between the various series is due to the different number of days, holidays and weekends in each month.

Figure 9: Drug Arrests in California



Note: These are counts of monthly arrests in California. For an individual charged with multiple crimes stemming from a single event, only the most serious crime is coded on the arrest record.

Table 1: Effect of Intervention on Hospital Admissions with a Mention of Amphetamines (Proxy for Consumption)

	(1)	(2)	(3)	(4)	(5)
Intervention Dummy	-0.307	-0.393	-0.391	-0.331	-0.315
	[0.030]**	[0.028]**	[0.029]**	[0.035]**	[0.034]**
Proportion Black			-20.291	17.517	12.885
			[17.752]	[26.910]	[23.818]
Proportion Hispanic			-12.357	2.265	-3.455
			[10.062]	[7.863]	[8.156]
Proportion Age 15-19				-139.449	-145.884
				[34.803]**	[31.508]**
Proportion Age 20-24				-96.274	-97.469
				[31.042]**	[23.426]**
Proportion Age 25-29				-147.675	-132.422
				[51.762]**	[40.121]**
Proportion Age 30-34				-40.554	-41.256
				[24.155]	[22.752]
Proportion Age 34-39				-205.208	-208.273
				[69.054]**	[48.667]**
Log Cocaine Hospitalizations					0.139
					[0.020]**
Log Opioid Hospitalizations					0.035
					[0.026]
Log Cannabis Hospitalizations					0.208
					[0.028]**
Log Alcohol Hospitalizations					0.108
					[0.042]*
Constant	3.721	3.549	10.468	104.321	103.754
	[0.009]**	[0.035]**	[3.483]**	[29.749]**	[23.192]**
Year and Month Dummies	No	Yes	Yes	Yes	Yes
Observations	2784	2784	2784	2784	2784
R-squared	0.96	0.97	0.97	0.97	0.97

Notes: All of the regressions include county fixed effects. Standard errors are in brackets, they are robust and clustered on county. * significant at 5%; ** significant at 1%. The dependent variable is the log of the count of hospital admissions with a mention of amphetamine on the discharge record in a county in a month + 1. This is our proxy for consumption. The unit of observation is county by month. The instrument takes on a value of 1 between August 1995 and September 1996 and the estimates are robust to varying the starting and ending date.

Table 2: Instrumental Variables Estimates of the Relationship Between Methamphetamine Consumption and Hospitalizations With a Mention of Other Drugs

	Log Cocaine Hospitalization	Log Opioid Hospitalization	Log Cannabis Hospitalization	Log Alcohol Hospitalization
	(1)	(2)	(3)	(4)
Log Amphetamine Hospitalizations	0.209	0.013	0.120	-0.139
	[0.062]**	[0.059]	[0.081]	[0.035]**
Proportion Black	12.401	-8.625	-5.724	12.693
	[22.072]	[22.483]	[31.355]	[15.106]
Proportion Hispanic	8.018	10.184	8.834	0.891
	[7.231]	[7.063]	[7.900]	[5.850]
Proportion Age 15-19	7.670	95.944	-4.720	11.489
	[25.598]	[35.088]**	[36.943]	[24.165]
Proportion Age 20-24	-16.593	70.633	2.184	7.847
	[21.978]	[27.026]*	[33.979]	[19.304]
Proportion Age 25-29	-33.909	65.341	-11.282	-13.602
	[42.430]	[40.188]	[56.867]	[30.236]
Proportion Age 30-34	-2.991	40.007	-15.770	14.279
	[17.508]	[22.536]	[23.863]	[16.572]
Proportion Age 34-39	-25.240	126.617	11.111	11.861
	[47.373]	[54.848]*	[75.205]	[44.216]
Log Cocaine Hospitalizations		0.113	0.208	0.109
		[0.029]**	[0.039]**	[0.018]**
Log Opioid Hospitalizations	0.112		0.059	0.087
	[0.027]**		[0.026]*	[0.018]**
Log Cannabis Hospitalizations	0.138	0.047		0.125
	[0.032]**	[0.027]		[0.020]**
Log Alcohol Hospitalizations	0.210	0.205	0.297	
	[0.047]**	[0.041]**	[0.053]**	
Constant	10.208	-64.934	1.834	-3.264
	[21.841]	[25.137]*	[32.224]	[18.019]
Year and Month Dummies	Yes	Yes	Yes	Yes
Observations	2784	2784	2784	2784
R-squared	0.99	0.98	0.97	0.99

Notes: All of the regressions include county fixed effects. Standard errors are in brackets, they are robust and clustered on county. * significant at 5%; ** significant at 1%. The proxy for consumption is the log of the count of amphetamine related hospital admissions in a county in a month + 1. The other hospital admissions variables also have 1 added to them before taking the log. The unit of observation is county by month. The instrument takes on a value of 1 between August 1995 and September 1996 and the estimates are robust to varying the starting and ending date.

Table 3: Instrumental Variables Estimates of the Relationship Between Methamphetamine Consumption and Drug Treatment Admissions

	Log Methamphetamine Treatment	Log Cocaine Treatment	Log Heroin Treatment	Log Cannabis Treatment	Log Alcohol Treatment	Log Other Treatment
	(1)	(2)	(3)	(4)	(5)	(6)
Log Amphetamine Hospitalizations	0.292	-0.013	-0.084	-0.157	-0.283	-0.284
	[0.098]**	[0.070]	[0.100]	[0.232]	[0.158]	[0.178]
Proportion Black	-9.051	-31.832	-22.983	-51.069	-63.34	-45.064
	[40.277]	[44.745]	[40.306]	[48.882]	[42.187]	[43.615]
Proportion Hispanic	3.111	12.318	-18.982	-27.011	-26.325	4.063
	[17.241]	[13.184]	[12.064]	[16.085]	[13.784]	[12.402]
Proportion Age 15-19	-146.103	-176.453	-9.82	-166.528	-11.958	-81.432
	[91.921]	[75.273]*	[68.781]	[97.324]	[78.157]	[69.061]
Proportion Age 20-24	-126.891	-95.527	-20.679	-102.482	-26.406	-49.392
	[69.930]	[57.020]	[56.489]	[71.525]	[63.930]	[53.878]
Proportion Age 25-29	-74.867	-104.951	45.354	-51.602	-12.877	-36.526
	[89.569]	[100.425]	[93.750]	[110.621]	[90.319]	[101.253]
Proportion Age 30-34	-70.484	-109.295	2.6	-48.403	50.015	3.698
	[65.719]	[48.464]*	[45.468]	[66.468]	[48.486]	[39.402]
Proportion Age 34-39	-100.994	-97.305	-61.79	-107.061	-129.616	-127.422
	[89.880]	[107.331]	[104.088]	[128.821]	[125.606]	[123.674]
Log Cocaine Hospitalizations	-0.026	0.062	-0.004	0.02	0.083	-0.004
	[0.030]	[0.032]	[0.022]	[0.051]	[0.038]*	[0.049]
Log Opioid Hospitalizations	-0.007	-0.026	0.062	0.029	0.046	0.047
	[0.023]	[0.033]	[0.028]*	[0.038]	[0.036]	[0.030]
Log Cannabis Hospitalizations	-0.007	0.059	0.001	0.044	0.104	0.167
	[0.037]	[0.039]	[0.026]	[0.063]	[0.038]**	[0.056]**
Log Alcohol Hospitalizations	-0.136	0.014	-0.029	-0.015	0.023	0.048
	[0.044]**	[0.041]	[0.040]	[0.058]	[0.043]	[0.062]
Constant	87.537	100.762	23.029	94.985	45.104	56.106
	[57.579]	[55.893]	[53.705]	[66.673]	[62.526]	[55.223]
Year and Month Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2784	2784	2784	2784	2784	2784
R-squared	0.95	0.98	0.99	0.92	0.97	0.94

Notes: All of the regressions include county fixed effects. Standard errors are in brackets, they are robust and clustered on county. * significant at 5%; ** significant at 1%. The proxy for consumption is the log of the count of amphetamine related hospital admissions in a county in a month + 1. The unit of observation is county by month. The instrument takes on a value of 1 between August 1995 and September 1996 and the estimates are robust to varying the starting and ending date.

Table 4: Drug Use by Type of Crime in San Diego, Los Angeles and San Jose 1994-1997

Drug Testing Revealed	All Arrests	Property Crime	Violent Crime	Drug Arrests
Marijuana	0.33	0.35	0.27	0.36
Cocaine	0.25	0.28	0.16	0.40
Opiates	0.07	0.08	0.03	0.10
Methamphetamine	0.17	0.15	0.12	0.33
Survey Reported Methamphetamine Use				
Last 72 Hours	0.09	0.07	0.05	0.21
Last 30 Days	0.15	0.12	0.10	0.29
Have used ever	0.31	0.26	0.23	0.46
Times in Last Month if > 0	11.0	11.3	9.0	12.5
Spent Some Money on Drugs in Last Month	0.32	0.35	0.20	0.49
At Time of Arrest				
Under Influence of Drugs or Alcohol	0.28	0.24	0.27	0.38
Need Drugs or Alcohol	0.07	0.08	0.04	0.11
Observations	21,233	7,805	5,075	3,784

Note: The drug test used is EMIT screening which is known to be sensitive to false positives. Positive methamphetamine tests are confirmed using gas chromatography. Tests will pick up cocaine, heroin and methamphetamine use in the 3-5 days prior to the test. Arrestees are tested within 48 hours of arrest. The three categories Property Crime, Violent Crime and Drug Arrests are not exhaustive. The positive test results for marijuana are based on a 50 nanogram threshold. The results above for marijuana exclude January through September 1994 data because in this period only a test with a 100 nanogram threshold was performed.

Table 5: Instrumental Variables Estimates of the Relationship Between Methamphetamine Consumption and Property and Violent Crime

	Log Burglaries	Log Larcenies	Log MV Thefts	Log Robberies	Log Rapes	Log Homicides	Log Assaults
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log Amphetamine Hospitalizations	0.005	0.008	0.078	-0.179	-0.142	-0.188	-0.032
	[0.042]	[0.035]	[0.046]	[0.051]**	[0.103]	[0.133]	[0.049]
Proportion Black	41.266	13.719	26.809	31.775	3.830	-29.206	-15.665
	[14.164]**	[12.125]	[20.792]	[18.001]	[18.496]	[28.445]	[21.720]
Proportion Hispanic	-6.351	3.248	-9.271	-15.521	-12.813	-31.207	-13.162
	[5.291]	[5.120]	[8.538]	[6.741]*	[7.228]	[10.205]**	[10.389]
Proportion Age 15-19	-63.974	-31.397	-78.622	-31.958	13.085	23.901	-13.485
	[21.826]**	[19.334]	[31.082]*	[25.976]	[37.341]	[50.417]	[33.688]
Proportion Age 20-24	-61.609	-28.355	-78.430	-34.023	12.767	8.978	-34.121
	[18.412]**	[15.896]	[27.867]**	[23.455]	[27.712]	[32.633]	[25.133]
Proportion Age 25-29	-66.981	-6.405	-52.453	-27.373	20.089	87.914	25.204
	[28.950]*	[21.520]	[43.878]	[37.046]	[49.270]	[57.572]	[44.284]
Proportion Age 30-34	-37.617	-25.282	-54.760	-37.365	7.841	32.803	4.390
	[11.884]**	[13.783]	[21.316]*	[16.364]*	[22.582]	[33.879]	[20.426]
Proportion Age 34-39	-89.574	-8.015	-115.123	-34.039	8.972	-12.636	-49.545
	[40.805]*	[34.217]	[58.276]	[51.414]	[60.153]	[72.828]	[49.798]
Log Cocaine Hospitalizations	-0.017	-0.016	-0.018	0.017	-0.015	0.034	-0.006
	[0.011]	[0.011]	[0.013]	[0.018]	[0.032]	[0.032]	[0.016]
Log Opioid Hospitalizations	0.007	-0.010	-0.002	0.008	-0.014	-0.034	-0.010
	[0.011]	[0.008]	[0.015]	[0.016]	[0.023]	[0.039]	[0.014]
Log Cannabis Hospitalizations	0.009	-0.001	-0.030	0.044	0.033	0.046	0.000
	[0.014]	[0.012]	[0.016]	[0.017]*	[0.033]	[0.062]	[0.015]
Log Alcohol Hospitalizations	-0.011	-0.031	-0.055	-0.008	-0.002	-0.046	0.037
	[0.016]	[0.017]	[0.030]	[0.031]	[0.039]	[0.058]	[0.027]
Constant	55.651	21.382	68.826	33.723	-2.869	-6.210	23.737
	[17.410]**	[13.532]	[25.589]**	[21.855]	[29.210]	[33.925]	[23.506]
Year and Month Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2784	2784	2784	2784	2784	2784	2784
R-squared	1.00	1.00	0.99	0.99	0.97	0.96	0.99

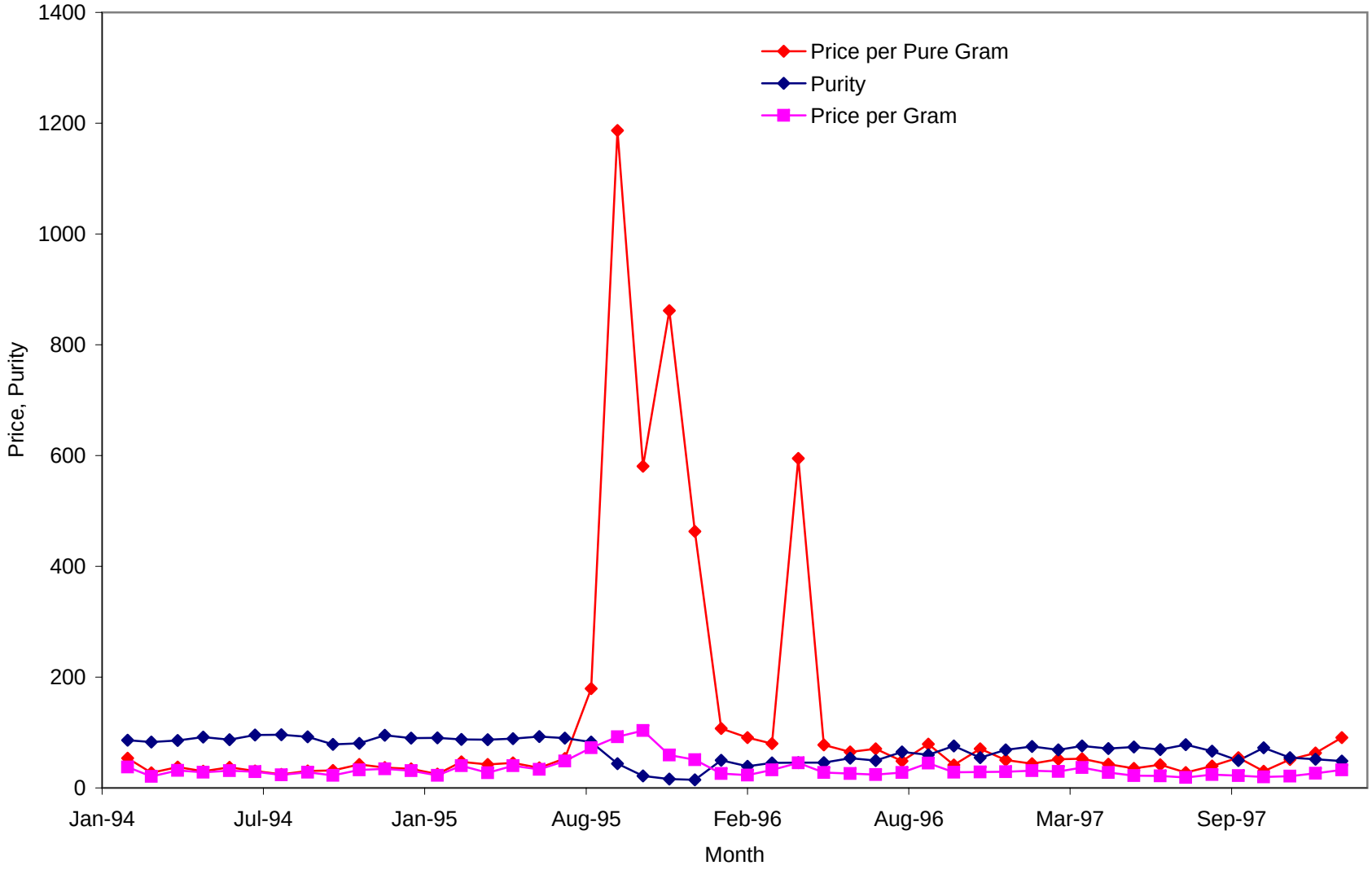
Notes: The dependent variable is the log of the total number of reported crimes in a county in a month. All of the regressions include county fixed effects. Standard errors are in brackets, they are robust and clustered on county. * significant at 5%; ** significant at 1%. The proxy for consumption is the log of the count of amphetamine related hospital admissions in a county in a month + 1. The unit of observation is county by month. The instrument takes on a value of 1 between August 1995 and September 1996 and the estimates are robust to varying the starting and ending date.

Table 6: Instrumental Variables Estimates of the Relationship Between Methamphetamine Consumption and Arrests for Drug Possession and Sale

	Log Felony Narcotics	Log Felony Dangerous Drugs	Log Felony Other Drugs	Log Felony Marijuana	Log Misdemeanor Dangerous Drugs	Log Misdemeanor Other Drug Laws	Log Misdemeanor Marijuana
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log Amphetamine Hospitalizations	0.100	1.038	-0.095	-0.346	0.050	0.335	-0.283
	[0.079]	[0.100]**	[0.157]	[0.094]**	[0.446]	[0.106]**	[0.067]**
Proportion Black	-45.750	-5.569	208.243	144.893	204.390	47.821	23.555
	[35.976]	[40.732]	[75.852]**	[39.300]**	[80.358]*	[30.999]	[29.371]
Proportion Hispanic	-9.104	12.212	45.123	-2.685	-69.780	5.482	-36.613
	[9.023]	[10.703]	[20.038]*	[13.466]	[27.150]*	[8.228]	[13.588]**
Proportion Age 15-19	-45.320	61.051	15.413	-222.143	-61.681	-20.425	-85.778
	[66.348]	[70.091]	[111.144]	[64.193]**	[112.440]	[44.904]	[35.080]*
Proportion Age 20-24	-29.420	19.149	-38.405	-245.745	-169.195	-56.911	-58.233
	[61.815]	[62.287]	[107.054]	[61.643]**	[74.804]*	[40.640]	[30.921]
Proportion Age 25-29	37.969	81.468	-280.625	-344.305	-241.407	-85.297	-105.045
	[82.956]	[99.502]	[166.103]	[82.871]**	[122.839]	[64.072]	[48.871]*
Proportion Age 30-34	-35.530	37.914	-87.176	-144.767	-56.503	-25.078	-27.417
	[47.599]	[40.347]	[64.403]	[38.085]**	[79.055]	[31.782]	[26.160]
Proportion Age 34-39	9.829	25.443	51.517	-389.504	-164.879	-128.437	-36.145
	[85.484]	[131.006]	[210.865]	[108.358]**	[160.823]	[75.756]	[70.670]
Log Cocaine Hospitalizations	-0.001	-0.136	0.083	0.048	-0.060	-0.029	0.044
	[0.030]	[0.033]**	[0.072]	[0.031]	[0.133]	[0.025]	[0.026]
Log Opioid Hospitalizations	0.002	-0.028	0.045	0.085	-0.096	-0.002	0.038
	[0.026]	[0.029]	[0.060]	[0.031]**	[0.053]	[0.021]	[0.025]
Log Cannabis Hospitalizations	-0.035	-0.226	0.051	0.106	-0.051	-0.072	0.084
	[0.030]	[0.042]**	[0.065]	[0.035]**	[0.120]	[0.026]**	[0.025]**
Log Alcohol Hospitalizations	-0.057	-0.214	-0.157	0.052	-0.161	-0.140	-0.094
	[0.041]	[0.049]**	[0.088]	[0.054]	[0.083]	[0.035]**	[0.036]*
Constant	24.487	-35.675	14.517	207.298	109.649	50.925	62.219
	[50.092]	[60.614]	[97.530]	[52.545]**	[68.857]	[36.058]	[27.255]*
Year and Month Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2784	2784	2784	2784	2784	2784	2784
R-squared	0.98	0.96	0.89	0.96	0.83	0.98	0.98

Notes: The dependent variable is the log of the total number of arrests in a county in a month. All of the regressions include county fixed effects. Standard errors are in brackets, they are robust and clustered on county. * significant at 5%; ** significant at 1%. The proxy for consumption is the log of the count of amphetamine related hospital admissions in a county in a month + 1. The unit of observation is county by month. The instrument takes on a value of 1 between August 1995 and September 1996 and the estimates are robust to varying the starting and ending date.

Figure A.1: Methamphetamine Price and Purity in California



Note: The spike in purity adjusted price in April of 1996 is due to a 1/2 gram purchase with a very high price but a purity of only 2%.