The War on Drugs: Methamphetamine, Public Health and Crime

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Abstract

This paper examines the impact of an extremely successful government effort to reduce the supply of methamphetamine precursors. The intervention disrupted the methamphetamine market and interrupted a trajectory of steadily increasing usage. In the five months after the intervention, the street price of methamphetamines tripled and purity declined from 90% to less than 20%. In this same period, amphetamine-related hospital and methamphetamine-related drug treatment admissions in California dropped by 50% and 35%, respectively. Methamphetamine use among arrestees in three California cities declined by 55% while felony and misdemeanor drug arrests for methamphetamine-related offenses declined by 50% and 25%, respectively. However, there is no compelling evidence that the intervention reduced property or violent crime. The impact of the intervention on methamphetamine prices, purity, health and drug arrests is largely temporary. The price of methamphetamine returned to its original level within four months. Methamphetamine purity, hospital admissions, drug treatment admissions, and drug arrests recovered more slowly, but within twenty months they had returned to 85% of their original levels.

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I. Introduction

Reducing the consumption of illegal drugs and the health problems and crime 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 $160 billion in 2000. Approximately $15 billion of the loss is attributed to health care costs, $35 billion to crime, and the remainder to productivity loss (ONDCP 2001). Despite substantial efforts to reduce the supply of and demand for illegal drugs, the use of some drugs has continued to increase. Methamphetamine use is of particular concern due to the rapid increase in the number of users. 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 et al. 2004).

The ONDCP (2004) highlights 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 of drug users is intended to reduce the demand for illegal drugs among current users. The bulk of the government efforts, however, are focused on enforcement (ONDCP 2004). Enforcement efforts concentrate on disrupting drug markets with the intention of reducing the supply of illegal drugs. While the efficacy of demand-side interventions can be evaluated experimentally, assessing the effectiveness of enforcement efforts is a more complicated problem. In this paper, we examine the effectiveness of supply reduction strategies by evaluating how a particularly effective intervention in the market for methamphetamine precursors affected the street price and purity of methamphetamine, public health outcomes, 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 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

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1 The budget for 2005 is allocated as follows: 1) $2 billion for prevention, 2) $4 billion for treatment, and 3) $6 billion for market disruption/enforcement.
this type of intervention is increasingly important as state and federal legislators pursue legislation to further restricting the availability of precursors.

Several researchers have noted the 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 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 there is limited evidence of the direct impact of enforcement on public health and crime.

This study advances the literature in four ways. First, the focus on a very large abrupt intervention makes it possible to directly measure the impact of enforcement on public health and crime. Second, we are able to 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 are known. Third, we are able to examine how rapidly supply recovers after a substantial disruption. Fourth, this study addresses the impact of restricting access to legal precursors – an approach which is under consideration in a number of states.

Our approach focuses on two interventions that occurred in May 1995 following the implementation of the Domestic Chemical Diversion Control Act (DCDCA). The DCDCA required the registration of distributors of single entity ephedrine products. Ephedrine is a methamphetamine input (or precursor) that had formerly been readily available due to its many legitimate uses. The DCDCA also allowed the DEA to deny or revoke a company’s registration without proof of criminal intent. The DEA shut down two suppliers of methamphetamine precursors in May 1995 that appear to have been supplying 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 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 were stable and
usage was increasing steadily. We find that the intervention had a substantial though temporary impact on methamphetamine price, methamphetamine purity, adverse health outcomes, and crime. Using the DEA’s STRIDE data, we document the impact on prices and purity. The price of methamphetamine jumped from 30 dollars per gram to 100 dollars per gram in the five months after the interventions. The purity of methamphetamine plummeted from 90% to less than 20%. The price of methamphetamine recovered quickly, returning to its original level of 30 dollars per gram within four months after it peaked. However, after 20 months, the purity of methamphetamine purchased by the DEA had returned to only 75%. Consequently, the purity-adjusted price is still significantly above its pre-intervention levels even 20 months after the intervention. Using administrative data from California hospitals and treatment centers, we also examine the impact of the supply shock on two health outcomes: amphetamine-related hospital admissions and methamphetamine-related drug treatment admissions. In the months following the supply disruption, hospital admissions with a mention of amphetamine and drug treatment admissions for methamphetamine decreased by 50% and 35% respectively. The impact on crime is mixed. We find a 55% reduction in the proportion of arrestees testing positive for methamphetamine use in a non random sample of arrestees in three California cities. Data from the California Department of Justice (CDOJ) show a 50% reduction in felony arrests and a 25% reduction in misdemeanor arrests for the drug offense categories that include methamphetamine possession and sale. We find no evidence of changes in property or violent crime rates.

The impact of the intervention was largely temporary. Prices returned to their original levels within a few months. Methamphetamine purity, hospital admissions, drug treatment admissions and drug-related arrests returned to slightly below their original levels over the 20 months following the intervention. The fairly rapid recovery of the methamphetamine market after the massive intervention in the precursor market suggests that the operators of illicit laboratories were able to find other sources of precursors.

The paper is organized into six sections. Section 2 provides background information on methamphetamine and a brief survey of the literature on supply-side

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2 The hospital discharge data codes do not distinguish methamphetamine from other amphetamines. But California Alcohol and Drug Program data indicate that methamphetamine comprised 95% of amphetamine use in the mid-1990s
interventions. Section 3 provides a description of the legislation targeting methamphetamine precursors and the resulting interventions. Section 4 describes the datasets used in the analysis. In Section 5, we examine the effect of the precursor intervention on methamphetamine markets, public health and crime. Section 6 concludes.

II. Background and Policy Significance

After marijuana, amphetamines are the most widely-abused drug worldwide (Rawson et al. 2002a). The World Health Organization estimates that amphetamine users outnumber both cocaine (2.3 to 1) and heroin users (3.5 to 1). Methamphetamine use is rapidly growing in popularity in the United States. Methamphetamine can be smoked, snorted, injected, or ingested orally generating 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 alertness that can last up to 12 hours. Chronic methamphetamine abuse can lead to psychotic behavior including hallucinations, paranoia and violent rages. Cessation of use can result in depression, fatigue, intense craving for methamphetamine, and aggression (ONDCP 2003). Research indicates that methamphetamine has serious short and long-term impacts on health. Rawson et al. (2002b) find that methamphetamine users experienced hallucinations (30%), paranoia (23%), chest pains (23%), depression (63%), and headaches (39%). A follow-up survey indicated that physical and mental symptoms persisted years later. Simon (2002) also found that methamphetamine use had an impact on cognitive performance similar to cocaine use. The National Institute on Drug Abuse reports that methamphetamine use induces psychotic and violent episodes, mood disturbances, and suicidal thoughts (NIDA 2002).

Despite amphetamines’ prevalence worldwide and its severe health effects, research in the U.S. 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 problem nationwide. From 1992 to

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3 The physical effects became less common over time, but the mental effects remained at initial levels.
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 (ONDCP 2003). In addition, nearly one-third of the 412 state and local agencies in the National Drug Threat Survey now rate methamphetamine as one of the greatest drug threats in their areas (NDIC 2003). 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 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 (2000) find a strong negative correlation between methamphetamine prices and consumption: a 1% price increase reduces consumption by 1.48%. The analysis suggests that methamphetamine use is more price sensitive than cocaine and heroin use. 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. We are only aware of one paper that examines the effect of methamphetamine enforcement on health outcomes. Cunningham and Liu (2003) examine the implementation of legislation aimed at curbing methamphetamine supply and find that three of the four legislative changes are associated with reductions in amphetamine-related hospital admissions. We are unaware of any direct evidence on the relationship between methamphetamine availability and crime. A recent survey of 655 methamphetamine users in Queensland found that a substantial number had committed property and violent

4 Grossman (2004) reviews the literature on price and substance use. He notes that the majority of empirical papers find a substantial negative impact of price. For example, recent evidence suggests approximately a 1% (or less) decline for a 1% price increase for heroin and cocaine (Chaloupka and Pacula 2000). Likewise Weatherburn et al. (2003) also find that heroin demand is price-elastic.

5 Cunningham and Liu examine the legislative changes in 1989, 1995, 1996 and 1997 and find that only the 1996 legislation was not associated with a significant decline in admissions. Why some legislative efforts were effective and others weren’t and the mechanism by which the legislation reduced hospitalizations is not clear.
crimes (Lynch et al. 2003). Surveyed users also reported that their methamphetamine use had caused them to be violent towards partners (35%), close friends (29%), friends/acquaintances (33%), family members (27%), and strangers (29%) at least once. In the U.S., the media have devoted considerable attention to the link between methamphetamine use and crime (Butterfield 2004, Wilgoren 2005). 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 U.S. relies heavily on enforcement, there is considerable debate on 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. DiNardo (1993) finds that enforcement does not have a significant impact on cocaine prices. Contrary to expectations regarding enforcement and drug prices, Yuan and Caulkins (1998) document a negative relationship between seizures and prices. Miron (2003) 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 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, enforcement successes are often correlated with prevalence, which can result in biased estimates. We avoid these problems by focusing on a large abrupt supply shock and using

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6 They offer six potential explanations for the counterintuitive result: 1) monthly 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.
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 interdictions focuses on supply side interventions 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 methamphetamine 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 approximately twenty states seeking to implement legislation targeting methamphetamine precursors, a careful examination of one extremely successful attempt to reduce the availability of inputs could help inform decision makers.

III. Methamphetamine Precursor Regulation and Supply

Methamphetamine production in the United States in the 1980s and early 1990s was dominated by small independent laboratory operators. 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. Despite considerable efforts to control the supply of methamphetamine, the DEA reports 1,847 labs seizures in California alone in 2001. Most of these labs used one of two regulated precursor chemicals, ephedrine or pseudoephedrine, in addition to other readily available chemicals to produce methamphetamine. 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. As a result, they have traditionally been readily available.

In the 1990s, the DEA became aware of diversions of ephedrine produced by

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7 Outlaw motorcycle gangs have traditionally been heavily involved in the manufacture and distribution of methamphetamine in small-scale operations. But large-scale cartels have recently displaced these small-scale operations.
8 Most of the labs are located in California and other Western states during this period.
9 These substances are key ingredients of such over-the-counter drugs as Sudafed and Tylenol Cold.
legitimate pharmaceutical companies to methamphetamine producers. The DEA expends considerable resources to restrict the supply of ephedrine and pseudoephedrine to these clandestine methamphetamine labs. DEA efforts have been facilitated by recent federal legislation that has increased the restrictions on both ephedrine and pseudoephedrine distribution.

There were significant changes in the federal law regulating ephedrine and pseudoephedrine distribution in 1989, 1995, 1996, 1997 and 2000. In October 1989, the Chemical Diversion and Trafficking Act (CDTA) imposed reporting, record keeping, and import/export notification requirements for regulated transactions in bulk ephedrine and pseudoephedrine. However, it did not control tablets or capsules that contain ephedrine and pseudoephedrine. The Domestic Chemical Diversion Control Act (DCDCA) was passed in 1993, became effective in April 1994 and its regulations were implemented in August 1995. This 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 October 1996, the Methamphetamine Control Act (MCA 1996) regulated access to over-the-counter medicines containing ephedrine. In October 1997, the Methamphetamine Control Act (MCA 1997) regulated products containing pseudoephedrine or phenylpropanolamine with or without other active ingredients. Finally, in July 2000, the Methamphetamine Anti-Proliferation Act (MAPA) established thresholds for pseudoephedrine drug products.

This project focuses on two major enforcement efforts made possible by the DCDCA. In May of 1995, the DEA executed a search and seizure warrant at Pennsylvania ephedrine/pseudoephedrine tablet manufacturer Clifton Pharmaceuticals. The seizure netted 25 metric tons of ephedrine and pseudoephedrine – an amount which could yield 16 tons of methamphetamine. In addition, on May 31st, the DEA executed search warrants at the mail order distributor X-Pressive Looks, Inc. (XLI). The DEA

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10 The CDTA amends the Controlled Substances Act (CSA).
11 The maximum conversion rate for ephedrine and pseudoephedrine into methamphetamine is 92%, but typically drug labs convert at a rate of 50% to 75% (DEA 1996). We use the midpoint (62.5%) for this estimation.
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 produce 13 metric tons of methamphetamines. The scale of these two supply disruptions was enormous. By contrast, the STRIDE data indicate that the DEA seized only .76 metric tons of methamphetamine in 1994.12 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.13 The size of the disruptions relative to the market indicates substantial concentration in the supply of precursors.

IV. Data

We use a variety of administrative and survey data sources to examine the impact of the disruption in methamphetamine precursor supply on methamphetamine price, methamphetamine purity, public health, and crime. Most of the data are drawn from detailed administrative datasets that represent a census of events. These data make it possible to compute monthly, county-level measures of events that facilitate the identification of short-lived or local effects.

Estimates of drug price and purity are derived from the DEA’s System to Retrieve Information from Drug Evidence (STRIDE) dataset.14 The dataset includes the purity of seized and purchased methamphetamines, the price of purchased methamphetamines, and the location and date of the purchase or seizure.15

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. The discharge data include information on the cause of admission, other conditions present on admission, month of admission, hospital location, residential location of patient, medical costs and payment source. Amphetamine-related admissions are identified by ICD-9-CM codes: 304.4 (amphetamine and other psychostimulant

13 The size of these interventions suggests that ONDCP may be underestimating methamphetamine consumption.
14 Although the STRIDE data have been criticized (Horowitz 2001), they are one of the only measures of the prices of illegal drugs.
15 STRIDE also contains prices, purity and seizures for other drugs including cocaine and heroin.
dependence), 305.7 (amphetamine or related acting sympathomimetic abuse), 969.7 (psychostimulant poisoning) and E854.2 (accidental psychostimulant poisoning). The second dataset contains drug treatment admission records from California Alcohol and Drug Programs (CADP). These data identify admissions where methamphetamines were the primary, secondary or tertiary cause of admission. The data include frequency of use, month of admission, and patient demographics.

We use two data sources to examine the relationship between methamphetamine availability and crime. The first source is the Arrestee Drug Abuse Monitoring Program, formerly titled the Drug Use Forecasting, (ADAM/DUF) data. These data measure drug use – both self-reported and the results of urine analysis – among persons arrested and booked in 35 U.S. cities. The second source is monthly jurisdiction-level crime data from the California Department of Justice (CDOJ). These data include counts 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, narcotics, dangerous drugs, and other drugs.

V. Results

There is abundant evidence that the use of illegal drugs such as methamphetamine result in significant costs to the economy due to adverse health effects and that illegal drug use is associated with criminal behavior. It is less clear how effective enforcement efforts are in reducing these problems. In this section, we examine whether enforcement efforts reduce drug-related adverse health events and crime. We begin by examining the impact of the reduction in precursor availability on the price and purity of methamphetamine. We then examine how the reduction in precursor availability impacted hospital and drug treatment admissions. Finally, we examine the relationship between methamphetamine availability and crime.

The purchase and consumption of drugs may result in increased adverse health events and crime in several ways. First, the drugs can directly cause a spectrum of

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16 The hospital discharge data codes do not distinguish methamphetamine from other amphetamines. But authors’ calculations using the California Alcohol and Drug Programs data indicate that methamphetamines comprised 95% of amphetamine use in the mid-1990s.

17 Unlike the other datasets, the ADAM/DUF data are a selected sample rather than a census.
adverse health effects ranging from dependence to overdose. Second, drug consumption can also result in violent crime committed by abusers who are suffering from drug-induced psychosis.\textsuperscript{18} Third, the high price of drugs may drive users to commit property crime in order to support their drug habit. Fourth, criminal organizations competing over distribution and sales do not have recourse to the legal system and may resort to violence to enforce their property rights.\textsuperscript{19} Fifth, the distribution, sale and possession of methamphetamine are crimes.

Figure 1A shows the price and purity time series for methamphetamine in California constructed from the STRIDE data. The series is the average price and purity for purchases of 1000 grams or less.\textsuperscript{20} The vertical line in the figure indicates the timing of the DEA intervention. Prior to the intervention, methamphetamine prices and purity were stable at 30 dollars for a 90 percent pure gram. The figure reveals that the price jumps from 30 dollars per gram to over 100 dollars per gram in the four months following June 1995. It is worth noting that the price per gram of methamphetamine returns to its original level within four months of its peak. In the same period, we also see a very large decline in purity, which drops from 90 percent to less than 20 percent. Purity recovers much more slowly than price. After one year, purity only recovers to 50 percent - still well below its original level. Purity never fully recovers and takes 18 months to recover to about 85 percent of its original level.

There are several possible causes for the change in purity. One is that dealers or producers cut the product more when they have less available. Another possibility is that there is a change in the production process as clandestine labs are forced to find different, and possibly inferior, sources of methamphetamine precursors. Figure 1B presents the methamphetamine price by size of purchase. Small purchases of 30 grams or less show a dramatic increase in prices that is not evident for large purchases.\textsuperscript{21} Figure 1C shows the purity for purchases of less than or more than 30 grams. We see that the purity starts declining a couple of months earlier for the larger purchases though the overall size of the decline in purity is the same. Since the different size purchases probably represent

\textsuperscript{18} This is of particular concern with methamphetamine.
\textsuperscript{19} Individual drug users may also be more vulnerable to victimization as they may have limited recourse to or faith in the legal system.
\textsuperscript{20} Using alternative cut-offs produced substantively similar results.
\textsuperscript{21} There is a decline in the number of large purchases immediately following the intervention.
different levels in the supply chain, the figure suggests that the change in purity is due to changes in production that take a few months to work their way through the distribution chain rather than street level dealers cutting the methamphetamine in response to a reduction in supply. It is also interesting that the price per gram for larger purchases does not change despite what appears to be a significant methamphetamine shortage.22

The increase in methamphetamine price and the reduction in purity documented in Figure 1A suggest that the DEA’s efforts to shut down the two precursor suppliers resulted in a significant reduction in methamphetamine supply. In Figure 2, we present the monthly count of hospitalizations and drug treatment admissions in California. The hospitalization counts include all patients admitted to California hospitals where amphetamine is mentioned on the admission record.23 The figure reveals an abrupt 50% decline in hospital admissions with amphetamine mentions. The drug treatment counts include all admissions to drug treatment centers where methamphetamine is listed as the primary cause of admission. The figure reveals a rapid 35% drop in the number of methamphetamine-related drug treatment admissions. Figure 2 demonstrates that the timing of the decline in admissions matches the timing of the changes in price and purity seen in Figure 1A. The decline in treatment admissions starts a few months after the decline in hospital admissions. Because individuals typically do not seek treatment until years after starting to use methamphetamine, the decline in treatment admissions is probably the result of users quitting on their own in lieu of treatment. It is worth noting that the patterns of both hospital and drug treatment admissions track purity much better than they track price.

Based on the Diagnoses Related Groups (DRGs), the primary cause of hospital admissions is psychosis, with alcohol and drug detoxification a close second. Surprisingly, more than 11% of the hospital admissions that have a mention of amphetamine use are for pregnant women. This finding is potentially the result of higher detection rates due to the drug screens administered to women in labor. Figure 3A plots

22 There is a significant decline in DEA 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.
23 The amphetamine use is coded based on a toxicity screen that is administered if drug use is suspected. Unfortunately the records do not distinguish methamphetamine from other amphetamines. However, based on data from the CADP, in this period methamphetamine abuse accounts for 95% of amphetamine abuse in California.
the time series of admission by DRG. Admissions for psychosis and detoxification show larger declines in percentage terms than admissions for other reasons.

Figure 3B presents the monthly counts of drug treatment admissions by referral route. All referral categories show some decline, but the immediate and most dramatic decline in admissions occurs among individual referrals. That the decline in treatment admissions is concentrated among individual referrals suggests that some people are reducing or stopping methamphetamine use due to the shortage and no longer seeking treatment. Other referral routes such as court/criminal justice referrals also show a decline, but lag individual referrals. The four month delay in the decline of court referrals may be due to the time it takes the courts to process cases. In Figure 3C, we present monthly drug treatment center admissions by the type of treatment received. There are declines for all treatment types. Not surprisingly, the largest most abrupt decline is for detoxification. The decline in treatment center admissions for day programs and treatment and recovery start a few months after the decline in detoxification programs.

The figures above reveal that the intervention in the precursor market resulted in a substantial decline in adverse health events due to methamphetamine use. However, some of this decline may be offset by users switching to other drugs such as cocaine and heroin.24 Because it is not possible to check for substitution directly, we look for evidence of an increase in the demand for cocaine and heroin. It is possible that an increase in demand for cocaine and heroin, if it is occurring, will result in an increase in price or a decline in purity. Analysis of the STRIDE data indicates that there is little change in the price of cocaine and heroin at the time of the intervention, but the purity of cocaine drops from 80 percent to 60 percent (not shown). This change is confined to the Western region of the United States. Unlike the Western region, the other three regions had very few methamphetamine users during this period. The fact that the three Census regions with little methamphetamine use show no evidence of a similar change in cocaine purity suggests that the decrease in purity may be the result of increased demand for cocaine by methamphetamine users in California. A more direct check of substitution to cocaine and heroin is an examination of the patterns of hospital and treatment admissions.

24 Graphs for marijuana and alcohol treatment admissions (not shown) indicate no evidence of substitution from methamphetamine during this period.
Figure 4 presents the hospital and treatment admissions for cocaine and heroin. There is no evidence of an abrupt change in either hospital or drug treatment admissions for heroin. There is, however, some evidence of a small decline in hospitalizations and treatment admissions for cocaine. This decline may be due to the reduction in purity or it may be due to each consumer getting slightly less cocaine. The changes in cocaine-related hospital and treatment admissions – along with the slight decline in cocaine purity – are consistent with a small demand shock in the cocaine market.

According to the ONDCP, the cost to society of drug-related crime is more than twice the cost due to drug-related health problems. Despite significant expenditures on drug control, there is no compelling evidence that reducing drug availability reduces 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 the general population. In the 1995-1997 National Surveys on Drug Abuse, only 0.5% of the adult respondents in the general population reported using methamphetamine in the last year. The rates of cocaine use and heroin use were 1.85% and 0.23% respectively. These numbers are probably lower bounds due to reporting bias. In contrast, 15% of California arrestees in the ADAM/DUF dataset reported using methamphetamine in the last month.

Table 1 presents the results from drug testing of individuals arrested for various offenses in California. 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 in the three to five days after use. Methamphetamine use is common among arrestees with about 17% of arrestees testing positive immediately after they are arrested. The proportion of arrestees using methamphetamine varies significantly across crime categories ranging from 12% for violent crimes to 32% for drug arrests. The table reveals significant evidence that arrestees are underreporting 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, where possible, we will use the test results rather than the less reliable self-reports of drug use.

25 Self-reports of drug use often understate actual use. We see considerable evidence of this in the ADAM data.
Figure 5A presents evidence on how the supply shock affected methamphetamine consumption among arrestees in California. The ADAM/DUF dataset contains very few observations from the third month of each quarter so all the figures derived from this dataset have been smoothed using a moving average that weights the current month by .5 and the leading and lagging months by .25. Figure 5A shows that the proportion testing positive for methamphetamine declines by more than 50%. The decline and the recovery in positive tests track the recovery of methamphetamine purity from Figure 1A. Figure 5A also presents the proportion of arrestees that test positive for methamphetamine by the type of crime that they are arrested for. The figure reveals that all three arrestee groups experience a reduction in positive tests of about 50% even though those arrested for drug possession or sale are much more likely to test positive for methamphetamine than those arrested for violent crime or property crime. The ADAM data also include self-reports of the number of times methamphetamine was used per month among arrestees reporting use. Average self-reported use declines from 13 times per month to about 9 times per month after this intervention (figure not shown).

Figure 5B presents the proportion of arrestees in each crime category that report ever having used methamphetamine. This figure reveals a decline that begins 4 to 6 months after the supply shock. This is consistent with methamphetamine users reducing criminal activity as they slowly stop using drugs. However, it may also reflect a reduction in the number of individuals initiating methamphetamine use, decay in recall, or a reduction in the probability of getting caught as this population reduces drug use. However, if it is a result of individuals reducing their criminal activity, then these figures suggest we might see a significant reduction in drug crime rates, a smaller reduction in violent crime rates, and little or no reduction in property crime rates.

The ADAM/DUF dataset also makes it possible to examine the possibility that criminals react to the reduction in methamphetamine availability by switching to other drugs. If this is the case, substitution could significantly reduce the expected impact of the intervention on crime rates. There is substantial poly drug use among arrestees. Among those who reported ever using methamphetamine, 97% had used marijuana, 72%

\[26\] Similar declines are evident in self-reports of recent use in the past 72 hours and past 30 days (not shown). Five months after the intervention, there is also a decline in the proportion of arrestees that report ever using methamphetamine (not shown).
cocaine and 26% opioids. The pattern of poly drug use is similar for self-reports of use during the past 30 days. Figure 5C shows the results of drug tests for the subsample of arrestees who reported ever using methamphetamine. This figure reveals an increase in the proportion testing positive for cocaine and heroin with the peak in positive tests for these two drugs occurring when the methamphetamine use rates are bottoming out. However, the increases only partially offset the decline in methamphetamine use in this population.27

Now that we have documented the prevalence of methamphetamine use among arrestees and the reduction in use that occurred due to the precursor intervention, we turn to examining the impact of the reduced availability of methamphetamine on crime. The arrestee data cannot be used to examine the impact of the intervention on crime rates because it is a small nonrandom sample of the universe of arrests. For this reason, we turn to examining reported property and violent crimes and drug arrests.

We organize the different crimes into three categories: property crimes, violent crimes and drug crimes. Property crimes include larceny, motor vehicle theft, burglary and robbery. The violent crimes include rapes, assaults and homicides. The drug crime category includes drug sales and possession.

The reduction in methamphetamine availability that resulted from the precursor intervention may have different effects on different types of crime. Reduced availability might result in a decrease in problems associated with the pharmacological effects of methamphetamine. This suggests we may see fewer violent crimes committed by drug abusers suffering from drug-induced psychosis. The impact of the reduced availability of methamphetamine on property crime depends on the short-run price elasticity of methamphetamine consumption. When faced with a substantial increase in the price of methamphetamine, do users cease drug use, substitute to another drug, or simply pay higher prices? If users quit, either due to 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.

27 This may be the reason it is only six months after the intervention that we see a reduction in the proportion of people arrested for drug possession or sale that report ever using methamphetamine.
among more dependent users who are unwilling or unable to reduce their consumption.\textsuperscript{28} Violence resulting from enforcement of property rights is likely to drop, if it changes at all, as there are fewer dealers to compete over territory. Arrests for drug possession and sale are likely to decline as there are fewer transactions conducted when the market shrinks.

We examine reported property crime, violent crime and drug arrests separately. We focus on \textit{reported crimes} for property and violent offenses, while for drug crimes we focus on \textit{arrests}.\textsuperscript{29} Figure 6 presents the monthly counts of reported property crimes from the California Department of Justice. There is some graphical evidence of a slight increase in the number of robberies in the period when methamphetamine prices are increasing, but no evidence of large changes in the other types of property crimes. Figure 7 presents monthly counts of reported violent crimes. The increase in all three types of violent crime observed in the figure immediately after the intervention is due to the seasonality of violent crimes.\textsuperscript{30} Similar increases can be seen in August of 1994, 1996 and 1997, though the increase in homicides in August 1995 is greater than in the other years. An examination of the time series of crime rates by the quartile of the methamphetamine hospitalization rate in the county revealed that the increase in robberies and homicides is occurring primarily in counties where methamphetamine use is relatively rare (not shown).

Figure 8A presents the monthly counts of felony drug arrests. There is an abrupt decline of about 50\% in arrests for felony dangerous drugs. This is the arrest category that includes methamphetamine-related offenses. Felony narcotics arrests, which include arrests for the sale and possession of heroin and cocaine, increase in the months when the methamphetamine arrests and hospitalizations have bottomed out.\textsuperscript{31} This may be the result of methamphetamine users and dealers switching to cocaine and heroin or it could be the result of police shifting resources to the cocaine and heroin trade when the

\textsuperscript{28} In particular, if the more severely dependent are more likely to commit crime and less likely to reduce their consumption we may actually observe an increase in property crime even if demand for the \textit{average} consumer is price elastic.

\textsuperscript{29} Reported crimes are probably a better estimate of actual crime rates than arrests except for drug crimes (drug possession and drug sales) which for obvious reasons are unlikely to be reported.

\textsuperscript{30} This seasonality may also be the cause of the increase in robberies.

\textsuperscript{31} Cocaine is included in this category, though it is not a narcotic in the medical sense, because that is how it was classified in the Controlled Substances Act.
methamphetamine market shrunk. That there is no evidence of a large change in felony arrests for marijuana suggests that the increase in narcotics arrests is not due purely to changes in police behavior. In Figure 8B, we show the time series of misdemeanor drug arrests. For misdemeanor arrests, the methamphetamine-related offenses are included in the “Other Drug Laws” category. This category decreases by 25%.

The large reductions in arrests for methamphetamine possession and sale after the DEA interdiction stand in stark contrast to the lack of large changes in either property or violent crime. One limitation of the graphical approach above is that small regional changes in crime rates may be obscured by the aggregation to the state level. To obtain more precise estimates of the relationship between methamphetamine prevalence and crime, we take advantage of the variation in methamphetamine prevalence across counties and across time in a regression context. The price and purity series are too sparse to generate county level estimates and there are no surveys large enough to generate monthly, county-level measures of methamphetamine prevalence. For this reason, we use the rate of hospitalizations with an amphetamine mention as a proxy for methamphetamine consumption in a county. The regression analysis takes advantage of the considerable variation in amphetamine hospitalization rates across counties and across time. All the regressions are estimated using monthly county-level rates from January 1994 to December 1997.

Tables 2A and 2B show the results of the pooled cross-sectional regression of crime rates on hospital admissions with a mention of amphetamines. These regressions include year dummies, month dummies as well as the percent black, percent Hispanic, and the percent in different age cells. We use hospital admission rates among 15 to 44 year olds as a proxy for methamphetamine, cocaine and opioid (i.e., heroin) prevalence. The dependent variable is the number of reported crimes or arrests per month per 10,000 residents age 15 to 44.

The pooled cross-sectional regression results in Table 2A reveal that methamphetamines are associated with both property and violent crime. The estimates indicate that methamphetamine prevalence, as proxied by hospital admission rates, is strongly positively correlated with burglary, larceny, motor vehicle thefts, rapes and assaults. Table 2B shows the same specification for drug arrests. There is a significant
relationship between amphetamine-related admissions and felony dangerous drug arrests, but there is no statistically significant relationship with misdemeanor other drug laws. This lack of statistical significance is surprising given the decline in the statewide time series of misdemeanor arrests in the “Other Drug Laws” category. The point estimates for felony dangerous drugs and misdemeanor other drugs also fail to match the size of the changes shown in Figures 8A and 8B. The point estimates from the regressions suggest a 50% decline in amphetamine-related hospitalizations will be associated with a 20% and a 6% decline in felony and misdemeanor arrests, respectively.32 This is significantly below the 50% and 25% declines in felony and misdemeanor drug arrests we observe in the figures. It is possible that correlations described above are the result of unobserved differences across counties such as the poverty rate. This suggests county level fixed effect regressions that difference out time invariant county characteristics may generate more credible estimates.

The fixed effects regressions in Tables 3A and 3B have the same specification as the cross-sectional specifications in Tables 2A and 2B, but also include county fixed effects to control for county-level, time-invariant unobservable characteristics. In the property and violent crime regressions, only larcenies are statistically significantly correlated with the amphetamine-related hospitalization rates.33 Of the drug arrest categories in Table 3B, felony dangerous drug arrests and misdemeanor other drug laws are very strongly associated with the rate of hospital admissions.34 We find no evidence of an impact on other drug categories except for a negative impact on misdemeanor marijuana, which may be due to chance or may be the result of the fact that only the most serious offense is recorded on the arrest record, so a person in possession of both methamphetamine and marijuana will be coded as arrested for methamphetamine possession. The point estimates from the fixed effect regressions imply a 50% decline in hospital admissions will be associated with a 9% decline in felony methamphetamine arrests and a 6% decline in misdemeanor methamphetamine arrests. This is still well below the 50% and 25% declines in felony and misdemeanor drug arrests we observe in

32 The mean rate of hospitalizations for amphetamine before the intervention is .725. The mean rate of methamphetamine felony and misdemeanor arrests in the period before the intervention are 2.94 and 3.57 respectively.
33 Motor vehicle thefts are significant only at the 10% level.
34 This category also includes amphetamine-related penal codes.
the figures. This suggests that even with fixed effects we are not recovering the effect of the intervention we observe in the figure.

Tables 4A and 4B repeat the fixed effects specifications from Tables 3A and 3B, but use the intervention as an instrument. The instrument takes on a value of 1 during the peak effect of the intervention between September 1995 and June 1996. Table 4A reveals no statistically significant relationship between the hospitalization rate and any of the property or violent crimes though we cannot preclude practically significant changes due to the imprecision of our estimates. Table 4B reveals a very strong relationship between the hospitalization rate and drug arrests for felony dangerous drugs and misdemeanor other drug laws. The estimates from the regression imply that a 50% decline in hospitalizations will be associated with a 59% decline in the felony arrests and a 23% decline in the misdemeanor arrests. This is very close to the 50% and 25% declines we observe in the figures. The decrease in amphetamine-related hospitalizations is also associated with an increase in misdemeanor and felony marijuana arrests. This may reflect actual changes in either consumption or enforcement or it may merely reflect the high level of poly drug use and the fact that the arrest dataset only codes the most serious offense.

VI. Conclusion

The DEA’s efforts to shut down two very large ephedrine and pseudoephedrine suppliers in mid-1995 significantly disrupted the supply of methamphetamine. The evidence suggests that in California, at the peak of the shortage, supply was reduced by over 50%. During the five 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 nearly 20 to recover to 85% of its original level.

This reduction in methamphetamine supply had a substantial, though largely temporary, effect on amphetamine-related hospitalizations and methamphetamine-related

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35 Varying the time period when the instrument is turned “on” produces qualitatively similar (and slightly larger) estimates.
36 This may be due in part to the significantly lower precision of the IV estimates.
drug treatment admissions. The precursor supply disruption also reduced methamphetamine use among arrestees. There is clear evidence of large reductions 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 in either kind of crime. This is surprising given the very strong association between methamphetamine use and crime and the substantial reduction in methamphetamine use among people 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 that either 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 rates may be partially due to substitution into other drugs. The regional decrease in the purity of cocaine, the increase in the number of narcotics arrests, and the increase in positive cocaine and heroin urine tests among arrestees that reported ever having used methamphetamines suggest that some methamphetamine users are switching to other illicit drugs. However, the evidence suggests that the substitution into other drugs offsets only part of the reduction in methamphetamine use making the lack of a finding on property or violent crime surprising.

Hospital admissions, drug treatment admissions, arrestee drug use, and drug arrests all track methamphetamine purity far better than they track price indicating that purity is of interest independent of price. Price is almost uncorrelated with the rates of adverse outcomes except in the period immediately after the intervention. That the health measures track purity could be due to a reduction in the pharmacological effect of methamphetamine people are consuming. However, the fact that use among arrestees and drug arrests also track purity suggests that in this period methamphetamine purity is highly correlated with methamphetamine prevalence. This finding advocates that the results from papers estimating purity-adjusted price elasticities should be interpreted with caution.

The similar sized declines in hospital admissions, use among arrestees, and felony
drug arrests in the category dominated by methamphetamine penal codes suggest that the intervention resulted in a decline in methamphetamine availability of at least 50%.37 This is quite possibly the DEA’s largest success in disrupting the supply of a major illegal substance. Interestingly, the DEA does not appear to be fully aware of the scale of their success. The focus on disrupting the supply of inputs rather than of the 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 disruption of the methamphetamine market resulted in only a temporary reduction in both adverse health events and drug arrests and resulted in no discernable effect on property or violent crime is disappointing, though perhaps not surprising.

37 The effect of the interdiction appears to be national. Hospital data from other states we examined including Iowa, Arizona and Washington showed declines in amphetamine related hospitalizations rates on the order of 50%
VIII. References


Notes: These figures are the price and purity of methamphetamine purchases in California from the STRIDE data. There are an average of 14.2 observations per month for the entire period but only 9.1 observations per month between 8/1995 and 3/1996.
Notes: There are an average of 7.35 purchases per month under 30 grams and 6.89 purchases per gram over 30 grams. For the 8/1995 and 3/1996 period there are an average of 6.5 purchases per month under 30 grams and 3 over 30 grams.
Notes: There are no purchases over 30 grams in month of October 1995. See the notes from Figure 1B.
The hospital admissions are counts per month of hospital admissions with a mention of amphetamine on the hospital record. The drug treatment admissions are counts of admissions per month to drug treatment centers for methamphetamine use.

Notes: The hospital admissions are counts per month of hospital admissions with a mention of amphetamine on the hospital record. The drug treatment admissions are counts of admissions per month to drug treatment centers for methamphetamine use.
Figure 3A: California Hospital Admissions with Amphetamine Mentioned on 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.
Note: These are the monthly counts of admissions to drug treatment centers in California by the referral route of the patient.
Figure 3C: Drug Treatment Admissions in California by Treatment Type

Note: These are the monthly counts of admissions to drug treatment centers in California by the type of treatment the patient is seeking.
Notes: The correlation in the hospitalization counts and some of the variance is due to the different number of days and the different number of weekends and holidays that occur in each month.
Notes: Due to the sampling frame of the ADAM data it is necessary to smooth the data using a moving average with weight .25 on the month before and the month after the observation. This is why the change in positive tests precedes the intervention.
Notes: See notes from Figure 5A. Unlike reported lifetime use reported methamphetamine use in the last 72 hours and in the last month track the urine tests well though the levels are lower.
Notes: See notes from Figures 5A and 5B. These are the proportion of arrestees who report ever having used methamphetamine that test positive for methamphetamine, cocaine or heroin.
Notes: These are monthly counts of reported crimes in California. The correlation between the series is due to the different number of days, holidays and weekends.
Figure 7: Reported Violent Crimes in California

Note: See notes from Figure 6.
Figure 8A: Felony Drug Arrests in California

Note: These are counts of monthly arrests in California. For an individual arrested for multiple crimes only the most serious crime is included in the total counts.
Figure 8B: Misdemeanor Drug Arrests in California

Note: See notes from Figure 8A
<table>
<thead>
<tr>
<th>Drug Testing Revealed</th>
<th>All Arrests</th>
<th>Property Crime</th>
<th>Violent Crime</th>
<th>Drug Arrests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marijuana</td>
<td>0.34</td>
<td>0.36</td>
<td>0.32</td>
<td>0.36</td>
</tr>
<tr>
<td>Cocaine</td>
<td>0.26</td>
<td>0.29</td>
<td>0.17</td>
<td>0.41</td>
</tr>
<tr>
<td>Opiates</td>
<td>0.07</td>
<td>0.08</td>
<td>0.03</td>
<td>0.10</td>
</tr>
<tr>
<td>Methamphetamine</td>
<td>0.17</td>
<td>0.14</td>
<td>0.12</td>
<td>0.32</td>
</tr>
</tbody>
</table>

**Survey Reported Methamphetamine Use**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Last 72 Hours</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.20</td>
</tr>
<tr>
<td>Last 30 Days</td>
<td>0.15</td>
<td>0.12</td>
<td>0.10</td>
<td>0.28</td>
</tr>
<tr>
<td>Have used ever</td>
<td>0.30</td>
<td>0.26</td>
<td>0.23</td>
<td>0.44</td>
</tr>
<tr>
<td>Times in Last Month if &gt; 0</td>
<td>11.03</td>
<td>11.31</td>
<td>9.04</td>
<td>12.54</td>
</tr>
</tbody>
</table>

**Spent Some Money on Drugs in Last Month**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Under Influence of Drugs or Alcohol</td>
<td>0.28</td>
<td>0.23</td>
<td>0.27</td>
<td>0.36</td>
</tr>
<tr>
<td>Need Drugs or Alcohol</td>
<td>0.08</td>
<td>0.09</td>
<td>0.04</td>
<td>0.12</td>
</tr>
</tbody>
</table>

**Monthly Income and Spending**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Reporting Legal Income</td>
<td>0.73</td>
<td>0.71</td>
<td>0.81</td>
<td>0.79</td>
</tr>
<tr>
<td>Percent Reporting Illegal Income</td>
<td>0.15</td>
<td>0.19</td>
<td>0.07</td>
<td>0.22</td>
</tr>
<tr>
<td>Legal Income</td>
<td>771</td>
<td>647</td>
<td>1,073</td>
<td>696</td>
</tr>
<tr>
<td>Illegal Income</td>
<td>275</td>
<td>343</td>
<td>123</td>
<td>416</td>
</tr>
<tr>
<td>Money Spent on Drugs</td>
<td>124</td>
<td>167</td>
<td>53</td>
<td>152</td>
</tr>
</tbody>
</table>

**Observations**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16,584</td>
<td>6,231</td>
<td>3,838</td>
<td>2,998</td>
</tr>
</tbody>
</table>

**Table 1: Drug Use and Income by Type of Crime in San Diego, Los Angeles and San Jose 1994-1997**

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.
<table>
<thead>
<tr>
<th></th>
<th>Burglary</th>
<th>Larceny</th>
<th>MV Theft</th>
<th>Robbery</th>
<th>Rape</th>
<th>Homicide</th>
<th>Assaults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate Amphetamine Admissions</td>
<td>2.270</td>
<td>4.327</td>
<td>2.714</td>
<td>0.226</td>
<td>0.070</td>
<td>0.005</td>
<td>0.979</td>
</tr>
<tr>
<td>Rate Cocaine Admissions</td>
<td>[0.782]</td>
<td>[2.101]</td>
<td>[1.042]</td>
<td>[0.214]</td>
<td>[0.030]</td>
<td>[0.007]</td>
<td>[0.371]</td>
</tr>
<tr>
<td>Rate Opioid Admissions</td>
<td>-0.830</td>
<td>-7.403</td>
<td>0.764</td>
<td>1.828</td>
<td>-0.040</td>
<td>0.048</td>
<td>1.866</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.957]</td>
<td>[4.240]</td>
<td>[1.681]</td>
<td>[0.517]</td>
<td>[0.055]</td>
<td>[0.021]</td>
<td>[0.789]</td>
</tr>
<tr>
<td>Observations</td>
<td>3.655</td>
<td>14.135</td>
<td>1.484</td>
<td>1.424</td>
<td>0.053</td>
<td>0.016</td>
<td>-0.283</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.720</td>
<td>0.570</td>
<td>0.530</td>
<td>0.860</td>
<td>0.260</td>
<td>0.460</td>
<td>0.540</td>
</tr>
<tr>
<td>Dep. Var. Mean</td>
<td>16.065</td>
<td>39.326</td>
<td>12.857</td>
<td>4.581</td>
<td>0.449</td>
<td>0.149</td>
<td>7.957</td>
</tr>
</tbody>
</table>

Notes: All regressions are at the county level by month. The regressions include year effects, month dummies, proportion black and Hispanic in county and the proportion of the population in various age categories. The regressions are weighted by county population age 15 to 44. The regressions include all California counties between 1994 and 1997. The mean amphetamine admission rate is 0.7246. The means of the dependent variables are calculated from January 1994 - June 1995.

<table>
<thead>
<tr>
<th></th>
<th>Felony Narcotics</th>
<th>Felony Dangerous Drugs</th>
<th>Felony Other Drugs</th>
<th>Felony MJ</th>
<th>Misdemeanor Dangerous Drugs</th>
<th>Misdemeanor Laws</th>
<th>Misdemeanor Glue Sniffing</th>
<th>Misdemeanor Marijuana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate Amphetamine Admissions</td>
<td>0.028</td>
<td>1.693</td>
<td>0.071</td>
<td>0.105</td>
<td>-0.050</td>
<td>0.562</td>
<td>-0.038</td>
<td>-0.054</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.138]</td>
<td>[0.201]</td>
<td>[0.042]</td>
<td>[0.066]</td>
<td>[0.040]</td>
<td>[0.339]</td>
<td>[0.021]</td>
<td>[0.180]</td>
</tr>
<tr>
<td>Rate Cocaine Admissions</td>
<td>1.332</td>
<td>-1.187</td>
<td>-0.139</td>
<td>-0.098</td>
<td>-0.079</td>
<td>-0.950</td>
<td>-0.050</td>
<td>-0.227</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.297]</td>
<td>[0.344]</td>
<td>[0.107]</td>
<td>[0.122]</td>
<td>[0.077]</td>
<td>[0.549]</td>
<td>[0.033]</td>
<td>[0.279]</td>
</tr>
<tr>
<td>Rate Opioid Admissions</td>
<td>2.063</td>
<td>-0.001</td>
<td>0.151</td>
<td>0.536</td>
<td>0.168</td>
<td>0.330</td>
<td>0.022</td>
<td>-0.016</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.366]</td>
<td>[0.200]</td>
<td>[0.076]</td>
<td>[0.131]</td>
<td>[0.071]</td>
<td>[0.460]</td>
<td>[0.032]</td>
<td>[0.209]</td>
</tr>
<tr>
<td>Observations</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.830</td>
<td>0.710</td>
<td>0.250</td>
<td>0.410</td>
<td>0.310</td>
<td>0.320</td>
<td>0.130</td>
<td>0.320</td>
</tr>
<tr>
<td>Dep. Var. Mean</td>
<td>2.939</td>
<td>2.943</td>
<td>0.118</td>
<td>0.615</td>
<td>0.104</td>
<td>3.575</td>
<td>0.062</td>
<td>1.382</td>
</tr>
</tbody>
</table>

Notes: All regressions are at the county level by month. The regressions include year effects, month dummies, proportion black and Hispanic in county and the proportion of the population in various age categories. The regressions are weighted by county population age 15 to 44. The regressions include all California counties between 1994 and 1997. The mean amphetamine admission rate is 0.7246. The means of the dependent variables are calculated from January 1994 - June 1995.
### Table 3A: County Level Fixed Effect Regressions of Reported Crime Rates on County Level Hospital Amphetamine Admissions Rates

<table>
<thead>
<tr>
<th>Rate Amphetamine</th>
<th>Burglary</th>
<th>Larceny</th>
<th>MV Theft</th>
<th>Robbery</th>
<th>Rape</th>
<th>Homicide</th>
<th>Assaults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions</td>
<td>0.379</td>
<td>1.095</td>
<td>0.402</td>
<td>-0.032</td>
<td>-0.008</td>
<td>0.008</td>
<td>-0.071</td>
</tr>
<tr>
<td>[0.244]</td>
<td>[0.518]</td>
<td>[0.212]</td>
<td>[0.077]</td>
<td>[0.016]</td>
<td>[0.005]</td>
<td>[0.179]</td>
<td></td>
</tr>
<tr>
<td>Rate Cocaine</td>
<td>-0.291</td>
<td>-1.391</td>
<td>0.113</td>
<td>-0.064</td>
<td>0.006</td>
<td>-0.002</td>
<td>0.059</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.311]</td>
<td>[0.996]</td>
<td>[0.401]</td>
<td>[0.191]</td>
<td>[0.031]</td>
<td>[0.011]</td>
<td>[0.183]</td>
</tr>
<tr>
<td>Rate Opioid</td>
<td>0.057</td>
<td>-0.752</td>
<td>-0.245</td>
<td>-0.001</td>
<td>0.008</td>
<td>-0.011</td>
<td>-0.022</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.376]</td>
<td>[0.457]</td>
<td>[0.391]</td>
<td>[0.076]</td>
<td>[0.021]</td>
<td>[0.007]</td>
<td>[0.144]</td>
</tr>
<tr>
<td>Observations</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.91</td>
<td>0.93</td>
<td>0.90</td>
<td>0.96</td>
<td>0.44</td>
<td>0.57</td>
<td>0.84</td>
</tr>
<tr>
<td>Dep. Var. Mean</td>
<td>16.065</td>
<td>39.326</td>
<td>12.857</td>
<td>4.581</td>
<td>0.449</td>
<td>0.149</td>
<td>7.957</td>
</tr>
</tbody>
</table>

Notes: All regressions are at the county level by month. The regressions include county fixed effects, year effects, month dummies, proportion black and Hispanic in county and the proportion in various age categories. The regressions are weighted by county population age 15 to 44. The regressions include all California counties between 1994 and 1997. The mean amphetamine admission rate is 0.7246. The means of the dependent variables are calculated from January 1994 - June 1995.

### Table 3B: County Level Fixed Effect Regressions of Drug Arrest Rates on County Level Hospital Amphetamine Admissions Rates

<table>
<thead>
<tr>
<th>Rate Amphetamine</th>
<th>Felony Narcotics</th>
<th>Felony Drugs</th>
<th>Felony Dangerous</th>
<th>Felony Other Drugs</th>
<th>Felony MJ Drugs</th>
<th>Misdemeanor Dangerous</th>
<th>Misdemeanor Other Drug</th>
<th>Misdemeanor Laws</th>
<th>Misdemeanor Glue Sniffing</th>
<th>Misdemeanor Marijuana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions</td>
<td>0.019</td>
<td>0.740</td>
<td>-0.010</td>
<td>-0.020</td>
<td>-0.007</td>
<td>0.554</td>
<td>-0.023</td>
<td>-0.102</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[0.051]</td>
<td>[0.102]</td>
<td>[0.020]</td>
<td>[0.028]</td>
<td>[0.012]</td>
<td>[0.131]</td>
<td>[0.015]</td>
<td>[0.042]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate Cocaine</td>
<td>0.339</td>
<td>-0.055</td>
<td>0.081</td>
<td>-0.061</td>
<td>-0.043</td>
<td>0.133</td>
<td>0.007</td>
<td>-0.046</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.184]</td>
<td>[0.136]</td>
<td>[0.038]</td>
<td>[0.037]</td>
<td>[0.048]</td>
<td>[0.210]</td>
<td>[0.017]</td>
<td>[0.059]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate Opioid</td>
<td>0.023</td>
<td>-0.146</td>
<td>0.018</td>
<td>0.096</td>
<td>-0.005</td>
<td>-0.140</td>
<td>-0.022</td>
<td>0.073</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.107]</td>
<td>[0.125]</td>
<td>[0.025]</td>
<td>[0.036]</td>
<td>[0.014]</td>
<td>[0.126]</td>
<td>[0.020]</td>
<td>[0.067]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.91</td>
<td>0.84</td>
<td>0.71</td>
<td>0.68</td>
<td>0.65</td>
<td>0.80</td>
<td>0.45</td>
<td>0.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dep. Var. Mean</td>
<td>2.939</td>
<td>2.943</td>
<td>0.118</td>
<td>0.615</td>
<td>0.104</td>
<td>3.575</td>
<td>0.062</td>
<td>1.382</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: All regressions are at the county level by month. The regressions include county fixed effects, year effects, month dummies, proportion black and Hispanic in county and the proportion in various age categories. The regressions are weighted by county population age 15 to 44. The regressions include all California counties between 1994 and 1997. The mean amphetamine admission rate is 0.7246. The means of the dependent variables are calculated from January 1994 - June 1995.
### Table 4A: IV Regressions of County Level Crime Rates Regressed on County Level Hospital Amphetamine Admissions Rates

<table>
<thead>
<tr>
<th></th>
<th>Burglary</th>
<th>Larceny</th>
<th>MV Theft</th>
<th>Robbery</th>
<th>Rape</th>
<th>Homicide</th>
<th>Assaults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate Amphetamine</td>
<td>-0.880</td>
<td>2.273</td>
<td>1.199</td>
<td>-1.199</td>
<td>-0.118</td>
<td>-0.048</td>
<td>-2.063</td>
</tr>
<tr>
<td>Admissions</td>
<td>[2.298]</td>
<td>[3.549]</td>
<td>[1.976]</td>
<td>[0.720]</td>
<td>[0.119]</td>
<td>[0.050]</td>
<td>[1.415]</td>
</tr>
<tr>
<td>Rate Cocaine</td>
<td>0.019</td>
<td>-1.680</td>
<td>-0.083</td>
<td>0.223</td>
<td>0.033</td>
<td>0.011</td>
<td>0.549</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.584]</td>
<td>[1.310]</td>
<td>[0.638]</td>
<td>[0.231]</td>
<td>[0.036]</td>
<td>[0.015]</td>
<td>[0.327]</td>
</tr>
<tr>
<td>Rate Opioid</td>
<td>0.183</td>
<td>-0.870</td>
<td>-0.325</td>
<td>0.116</td>
<td>0.019</td>
<td>-0.006</td>
<td>0.177</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.436]</td>
<td>[0.635]</td>
<td>[0.483]</td>
<td>[0.110]</td>
<td>[0.024]</td>
<td>[0.009]</td>
<td>[0.194]</td>
</tr>
<tr>
<td>Observations</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.91</td>
<td>0.93</td>
<td>0.9</td>
<td>0.96</td>
<td>0.43</td>
<td>0.56</td>
<td>0.82</td>
</tr>
</tbody>
</table>

#### Notes: All regressions are at the county level by month. The regressions include county fixed effects, year effects, month dummies, proportion black and Hispanic in county and the proportion in various age categories. The regressions are weighted by county population age 15 to 44. The instrument takes on a value of 1 between September 1995 and June 1996. The mean amphetamine admission rate is 0.7246. The means of the dependent variables are calculated from January 1994 - June 1995.

### Table 4B: IV Regressions of County Level Crime Rates Regressed on County Level Hospital Amphetamine Admissions Rates

<table>
<thead>
<tr>
<th></th>
<th>Felony Narcotics</th>
<th>Dangerous Drugs</th>
<th>Felony Other Drugs</th>
<th>Felony MJ</th>
<th>Dangerous Drugs</th>
<th>Other Drug Laws</th>
<th>Misdemeanor Glue Sniffing</th>
<th>Misdemeanor Marijuana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate Amphetamine</td>
<td>1.305</td>
<td>4.805</td>
<td>0.047</td>
<td>-0.488</td>
<td>-0.040</td>
<td>2.276</td>
<td>-0.038</td>
<td>-0.610</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.827]</td>
<td>[0.795]</td>
<td>[0.106]</td>
<td>[0.129]</td>
<td>[0.089]</td>
<td>[0.829]</td>
<td>[0.064]</td>
<td>[0.304]</td>
</tr>
<tr>
<td>Rate Cocaine</td>
<td>0.022</td>
<td>-1.054</td>
<td>0.067</td>
<td>0.054</td>
<td>-0.035</td>
<td>-0.291</td>
<td>0.011</td>
<td>0.079</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.271]</td>
<td>[0.316]</td>
<td>[0.046]</td>
<td>[0.054]</td>
<td>[0.053]</td>
<td>[0.288]</td>
<td>[0.026]</td>
<td>[0.102]</td>
</tr>
<tr>
<td>Rate Opioid</td>
<td>-0.106</td>
<td>-0.553</td>
<td>0.012</td>
<td>0.143</td>
<td>-0.002</td>
<td>-0.313</td>
<td>-0.020</td>
<td>0.123</td>
</tr>
<tr>
<td>Admissions</td>
<td>[0.107]</td>
<td>[0.172]</td>
<td>[0.028]</td>
<td>[0.040]</td>
<td>[0.019]</td>
<td>[0.165]</td>
<td>[0.022]</td>
<td>[0.078]</td>
</tr>
<tr>
<td>Observations</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
<td>2.784</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.89</td>
<td>0.59</td>
<td>0.71</td>
<td>0.64</td>
<td>0.65</td>
<td>0.75</td>
<td>0.45</td>
<td>0.57</td>
</tr>
<tr>
<td>Dep. Var. Mean</td>
<td>2.939</td>
<td>2.943</td>
<td>2.943</td>
<td>2.943</td>
<td>2.943</td>
<td>2.943</td>
<td>2.943</td>
<td>2.943</td>
</tr>
</tbody>
</table>

#### Notes: All regressions are at the county level by month. The regressions include county fixed effects, year effects, month dummies, proportion black and Hispanic in county and the proportion in various age categories. The regressions are weighted by county population age 15 to 44. The instrument takes on a value of 1 between September 1995 and June 1996. The mean amphetamine admission rate is 0.7246. The means of the dependent variables are calculated from January 1994 - June 1995.