Measurement and Analysis of Drug Problems and Drug Control Efforts

by Jonathan P. Caulkins

ABSTRACT

Drug problems are complex, and determining the best combination of drug control interventions is not always intuitive. Hence, there is a need for rigorous, even quantitative analysis of their effectiveness. This essay is a progress report on the state of the still-developing art of quantitative analysis of the effectiveness of drug control interventions.

Some limitations of existing data are first identified and discussed. They include the reliance on self-reports; the indirect relationship between available indicators and the underlying quantities of greatest interest; and an overemphasis on measures of drug use at the expense of other factors, such as externalities associated with drug control efforts. Four encouraging trends are the ongoing expansion of traditional data systems, improving information about drug markets, greater integration across data sources, and better data from other countries.

Although the relevant data are highly imperfect, they have been adequate to support initial efforts to quantify the effectiveness of a range of drug control interventions. Which interventions are most effective depends on what one defines as the objective of drug control. Available evidence concerning one objective—reducing the quantity of drugs consumed—is reviewed and found to contain key insights but

Jonathan P. Caulkins is a Professor of Operations Research and Public Policy at the H. John Heinz III School of Public Policy and Management, Carnegie Mellon University, and is on the staff of RAND's Drug Policy Research Center.

also to be wanting in important respects. There is a need for better information concerning interactions between different drugs and drug markets, interactions with other domains of social policy, how interventions' effectiveness varies over the course of a drug epidemic, and how epidemics emerge and how they can be controlled in their early stages. These limitations are best viewed as a challenge, not as an excuse for basing policy on less formal or ad hoc syntheses of the literature. Drug policy is not alone in demanding creativity in the adaptation and application of quantitative analysis to evaluate effectiveness. Other policy domains in which benefit-cost or cost-effectiveness analysis is now accepted went through a similar, formative stage.

ABSTRACT

Illicit drugs impose significant costs on the United States, on source and transshipment countries and, increasingly, on other industrialized countries to the point that, in Stares' (1996) terms, drugs have become a "global habit." A variety of drug control strategies exist, the drug system is complex, and the best combination of strategies is not intuitively obvious.

When choices have important consequences that are difficult to assess, a natural response is to turn to careful analysis. This paper is, in some sense, a progress report on the status of our collective capacity to think carefully about how best to design the mix of drug control strategies.

That is an ambitious goal, and it is important to state at the outset what will and will not be covered here. The focus will be on outcomes more than on principles or morals. Some people approach drug issues from a moral perspective and believe the best drug policy is the one that advances or is consistent with a particular set of principles regardless of the consequences (cf. Wilson 1990). The focus in this paper instead is on understanding the costs and consequences of pursuing various policies.

For the most part, the discussion concerns aggregate costs and consequences. For someone who represents a particular constituency—whether defined by geographic, demographic, ethnic, or other commonalties—the best way to design drug control strategies might be different.

Likewise, this paper does not address the politics of drug policymaking. There are literally thousands of drug policymakers in the United States who represent a wide variety of interests. Sometimes the best policy from a mythical social planner's perspective is not feasible given the structure of the decisionmaking institutions. But this paper abstracts from such institutional considerations.

Not all careful thinking is quantitative, but this paper focuses on quantitative measures and arguments. Some of that focus is no doubt due to the predilections and training of the author, but there is a more fundamental reason for this bias. Drug-related behavior is sufficiently complex and sufficiently diverse so that it is rarely possible to make unambiguous qualitative statements about the nature of outcomes. If one can think of several reasons why a given policy should have one effect, one can usually think of at least one working in the opposite direction. In such circumstances, one must either be perpetually agnostic (on the one hand it might help, on the other hand it might hurt), or one must argue that one set of effects is larger than another. Comparing the magnitudes of effects is inherently a quantitative undertaking, and a premise of this paper is that if one is going to make quantitative arguments, it is best done explicitly. Furthermore, we are interested not only in the effect but also in the

effect relative to the magnitude of the intervention. That is, cost-effectiveness, not just effectiveness, is important.

Policy analysis comprises equal parts basic and applied science. As in basic science, one wants to measure, describe, and understand a problem. As in applied science, one wants to determine how to ameliorate the problem. Drug policy analysis is, in this regard, no different than other forms of policy analysis, so it makes sense to discuss these perspectives in turn. The next section discusses measuring the drug problem. The section after that examines what is known about the effectiveness of strategies for addressing the drug problem.

Existing data systems are reasonably adequate for **describing** *patterns and trends but generally are incapable of* **explaining** *them, in part because opportunistic instead of random samples and the absence of control groups makes it difficult to tease out causal relationships.*

Measuring the Drug Problem

Understanding the potential and limitations of existing data systems

Richard Hamming said "The purpose of computing is insight, not numbers." The same could be said of data collection. Unfortunately, in the drug policy arena we have an abundance of numbers, but the glass of insight is at best half full.

We know quite a bit about drug offenders within the criminal justice system but much less about their activities on the street. We know quite a bit about how many drug users there are but little about why there are so many. In contrast, we understand why people sell drugs but know little about how many upper level dealers there are, let alone how they operate.

One could be outraged that officials leave these gaps in knowledge unfilled and publish implausible estimates of such basic quantities as the dollar value of global drug trade. (See Reuter's [1998] debunking of the United Nations International Drug Control Programme [1997] estimate of $400 billion per year.) One could also marvel that we know so much about a black market activity that is subject to severe sanctions. Certainly we have better estimates of the number of drug users than we do of the number of prostitutes or ivory traders.

Regardless, it is important to understand what we do know and what we do not. Fortunately, there are many thorough reviews of relevant data systems

(Executive Office of the President, Office of National Drug Control Policy [ONDCP] 1990; Ebener, Feldman, and Fitzgerald 1993; Ebener and Weidmer 1994; Executive Office of the President, ONDCP 1998b), associated estimation techniques (e.g., Hser et al. 1992), and discussions of their policy significance (e.g., Haaga and Reuter 1991; Reuter 1993; Anglin, Caulkins, and Hser 1993; Ebener, Saner, and Anglin 1995).

The goal here is not to provide another data catalogue but to identify and discuss the implications of weaknesses in current data systems. This list of weaknesses is not intended to be comprehensive. Rather, the focus is on less obvious issues that are sometimes overlooked. The existence of published data can lull an observer into thinking better information is available than is actually the case.

For example, we actually know much less about the nature and magnitude of drug control efforts than reading the national drug control budget summary might suggest (Executive Office of the President, ONDCP, 1989, 1997, 1999). This national budget is really only a Federal budget; it excludes State and local spending and, thus, more than half of all drug control spending. Furthermore, the budget is not a budget in the familiar sense of a proactive plan for dividing a pool of available resources. Rather, it is a cross-cut budget, an ex-post accounting of what portion of various agencies' activities further national drug control goals. For the Drug Enforcement Administration (DEA), this apportionment is simple, but deciding what portion of U.S. Customs activity should be attributed to drug control as opposed to interdicting violators of intellectual copyright or crop-threatening foreign insects is another matter (Murphy 1994).

On the other hand, we have a fair idea of how many retail drug sellers there are even though no official data series tracks that number. If one believes retail cocaine sales in the United States are approximately $40 billion per year (Executive Office of the President, ONDCP 1997), that a full-time retail cocaine seller grosses approximately $50,000 per year, and there are approximately three individuals selling for every two full-time equivalent sellers (Reuter, MacCoun, and Murphy 1990), then approximately 1.2 million people sold cocaine in the United States last year. That figure easily could be off by a factor of 2, but it is still useful. Knowing that cities such as San Diego and San Antonio have approximately 5,000 cocaine sellers helps one assess the likely impact of a crackdown that arrests 200 or 300 sellers (cf. Kleiman 1997b).

More generally, existing data systems are reasonably adequate for *describing* patterns and trends but generally are incapable of *explaining* them, in part because opportunistic instead of random samples and the absence of control groups makes it difficult to tease out causal relationships. But discovering and quantifying causal relationships is exactly what is most needed. Policymakers

would like analysts to be able to predict the consequences of various interventions, but doing so requires understanding causal linkages, something that current systems do not do well. For example, we have good descriptions of the correlation between drug use and crime but only rough estimates of how much crime rates would change if drug prices rose enough to drive down use by 10 percent.

Limitations of self-reports

The heavy reliance on self-report measures is a fundamental challenge. The appeal of surveys is obvious. They are a familiar research tool, they hold the prospect of getting a representative sample within some sampling frame, and they allow one to gather related information about categories such as employment or health insurance status. The associated estimates are even accompanied by confidence intervals that create the illusion that potential errors can be neatly bounded. However, respondents have no selfish incentive to give accurate answers and they can have real or imagined reasons not to. Drug users may fear their responses will be used against them or be ashamed of their use. Users and nonusers alike may not give accurate answers to questions such as "What is your household income?" if answering requires substantial effort, e.g., because the household has multiple sources of income or the respondent does not handle the family finances.

Nonresponse bias can be at least as problematic. If a nonrepresentative sample is interviewed, the results could be biased even if everyone interviewed gives accurate answers. For example, if truants are more likely to use drugs than other students, then school-based surveys may underestimate use by youths registered for school. Likewise, if people who travel for their job—whether as truck drivers or management consultants—use more, less, or different drugs than persons who spend more time at their principal residence, household survey findings may be biased. The particular concern with household surveys is that subpopulations that are more difficult to sample—e.g., because their residences are transient or they are suspicious of government data collection efforts—may use at higher than average rates.

A quick glance at the "Drug-Related Data" appendix to the *National Drug Control Strategy* (Executive Office of the President, ONDCP 1999) gives a sense of the magnitude of the problem. Table 2 of the 1999 *Strategy* (p. 114) reports that there were 1.5 million past-month cocaine users in 1995. Table 3 (p. 114) reports that in the same year, 3.6 million people used cocaine weekly and another 3.1 million used cocaine less than weekly. These tables are obviously inconsistent, and the second table's estimates are well outside the 95 percent confidence interval associated with the 1.5 million estimate (U.S.

Department of Health and Human Services 1996). The explanation is that the first is based exclusively on the National Household Survey on Drug Abuse (NHSDA); the second augments NHSDA data with data from the Drug Use Forecasting (DUF) system (now called the Arrestee Drug Abuse Monitoring [ADAM] program). Similarly, NHSDA respondents can account only for approximately one-tenth of the cocaine believed to be consumed based on supply side estimates (Rydell and Everingham 1994). Thus, the only comprehensive survey of drug use in the general population misses the majority of use of the most problematic illicit drug.

Limitations of prominent systems that do not rely on self-reports

Not all data systems depend on self-reports. Notably, DUF/ADAM supplements interviews with urinalysis testing. Because arrestees consume the majority of the "expensive" drugs (cocaine, heroin, and methamphetamines), this makes DUF/ADAM a particularly useful data system. However, DUF/ADAM has limitations. Perhaps the biggest is that samples are not a random or even a representative sample of arrestees. They are not representative in part because of various sampling quotas (e.g., those arrested for drug-law violations have been undersampled in the past). More fundamentally, DUF/ADAM samples only from booked arrestees who are in the booking facility at the time of data collection. Hence, people who are arrested but not booked or not detained after booking are not included, and the probability of an individual being sampled depends on how long he or she stays in the booking facility. The magnitude of the distinction becomes clear when one looks at demographic statistics. More than half of those sampled by DUF/ADAM are black, even though less than one-third of people arrested in the United States are black.

DUF/ADAM urinalysis data are also problematic because they, like many drug-related data series, are only an indicator, not a direct or even proportional measure of the phenomena of greatest interest. This point is best illustrated by example. For many reasons, we would like to track changes in the quantity of drugs used by the criminally involved. Sometimes DUF/ADAM data are used for this purpose, but they are fundamentally limited in rather obvious ways. Ideally, if a data series does not directly measure the phenomenon of interest, one would like it at least to be proportional to that phenomenon. When proportionality holds, one can draw inferences such as, "The indicator declined by 10 percent, so a reasonable point estimate is that the underlying behavior declined by 10 percent as well." Proportionality might hold if the behavior in question did not influence the probability of being sampled. But that is clearly violated in the case of DUF/ADAM and drug use by the criminally involved

because drug use affects the probability of being arrested. Indeed, one of the very reasons we are so interested in drug use by the criminally involved is precisely because drug use can have a criminogenic effect.

It is not even clear that drug use and DUF/ADAM data always move in the same direction. Suppose drug prices jumped. Presumably that would reduce drug use, but in the short run, the elasticity of demand may be less (in absolute value) than unity. If so, spending on the drug would go up. In as much as economic-compulsive crime is driven by the amount spent on drugs, this might increase economic-compulsive crime and resulting arrests. If the decline in use takes the form of reduced consumption per use session (e.g., because purity is lower), not less frequent use, then the probability of a drug-involved offender testing positive given arrest might not change appreciably. So, unless the price increase caused a comparable increase in the rate at which nonusers are arrested, this scenario would lead to an increase in the proportion of offenders who test positive, even though the quantity consumed by drug-involved offenders declined.

There are similar problems with the Drug Abuse Warning Network (DAWN), which monitors the number of drug-related emergency room (ER) episodes by retrospectively examining ER records in a sample of non-Federal, general care, short-stay hospitals that operate 24-hour emergency departments. For each recorded episode, DAWN gathers up to four substances of abuse, user demographics, the user's reason for using the drug and visiting the ER, the route of administration, and the source of the substance.

From an analyst's perspective, DAWN has limitations (Caulkins, Ebener, and McCaffrey 1995), such as DAWN's definition of "drug related" not being synonymous with "caused by."[1] It excludes drug-related morbidity associated with HIV and much drug-related violence. Furthermore, if intoxication leads to the assault of a nonuser, a drug user injures a victim in the course of a robbery, or a dealer injures another dealer (who is not a user) in a battle over turf, those injuries are not drug related in the DAWN sense of the term.

Likewise, the number of drug-related episodes is not proportional to the amount of drug use because the number of DAWN mentions per user or per gram can vary. For example, Newmeyer (1999) observes that between 1980 and 1998 the heroin-using population in San Francisco roughly doubled, but DAWN mentions for heroin increased tenfold. Many factors influence whether and how frequently users visit ERs, including mode of administration, use patterns, the user's socioeconomic and demographic characteristics, the location and availability of ERs, ER policy, and availability of alternative sources of care. These factors can vary by location as well as over time. For example,

although roughly 60 percent of injection drug users (IDUs) in New York City are HIV positive, a much smaller proportion in Los Angeles are infected. If IDUs with AIDS may be more likely to visit the ER than are other IDUs, there might be more DAWN episodes per IDU in New York than in Los Angeles. Hence, one must be cautious when interpreting differences in the number of ER episodes across cities as representing differences in the number of users.

Measurement error

One problem with some data systems is that accurate measures are not vital to the individuals involved in the data collection. For example, DEA maintains price information in its System to Retrieve Information from Drug Evidence (STRIDE). As discussed subsequently, knowledge of drug prices and trends is of enormous value to analysts, but STRIDE was not designed primarily to track prices (Frank 1987). This may explain why greater care has not been taken to eliminate outliers.[2]

Likewise, DAWN data are not collected by hospitals in order to give good medical care. ER staff are under enormous time pressure. Determining and accurately recording for subsequent analysis which drugs the patient may have used, why, in what form, and how the drugs were obtained is not always a priority. Perhaps not surprisingly, a variety of studies have found significant inaccuracies and underreporting in DAWN (Ungerleider et al. 1980; Roberts 1996). Brookoff, Campbell, and Shaw (1993) found that not one of the 82 trauma patients studied who tested positive for cocaine was recorded by DAWN—even though the hospital in question had recently been formally audited by DAWN and found to be in complete compliance with DAWN guidelines.[3]

Issues of definition and interpretation

Inconsistencies in definitions and interpretation can also be problematic as estimates of drug-related deaths illustrate. A common source of such estimates is the National Vital Statistics Survey (NVSS); recent figures are in the vicinity of 15,000 deaths per year. This relatively low number is often contrasted with estimates of 100,000 deaths per year due to alcohol and 400,000 deaths per year due to cigarettes, but the figures are not comparable.[4] The alcohol and cigarette figures include chronic effects such as liver disease and lung cancer, whereas the NVSS figures include only acute effects such as overdose and poisoning. Deaths due to ill health resulting from addiction and dependency are not included, nor are deaths from HIV and homicide, two of the principal sources of drug-related mortality.

We know there are several million children living in households with a substance-dependent adult, and child protective services case loads grew along with the growth of the cocaine epidemic. However, drug policy discussions generally give short shrift to the harms borne by family members and friends of the drug abusers.

Comparable issues emerge with estimates of the social cost associated with drug use (e.g., Harwood, Fountain, and Livermore 1998). These numbers provide a sense of magnitude and can have real policy implications. For example, Tragler, Caulkins, and Feichtinger (forthcoming) argue that the preferred level of drug control spending depends on the magnitude of the associated social costs.[5] However, it is important to recognize what these figures are not. For one, they are not the same as budgetary costs. If government interventions succeeded in reducing the social cost of drug use by $10 billion, that would not increase taxes or the gross domestic product or any other identifiable account by $10 billion.

Second, changes over time in the estimates reflect changes in methodology as well as changes in drug use or drug problems. These changes are not repudiations of the earlier analyses. Rather, there has been a gradual improvement in the ability to quantify components of the overall cost. (Compare Harwood, Fountain, and Livermore 1998, and Rice et al. 1990.)

Third, the studies often ascribe dollar values to morbidity and mortality in ways that weight more heavily losses to wealthy people. For example, Harwood, Fountain, and Livermore (1998) use the value of foregone earnings (the human capital approach). Hence, these methods would imply that shifting drug abuse from affluent to impoverished citizens would reduce social costs.

Focus on drug use at the expense of other drug-related problems

Another weakness of existing data is their focus on drug use. That may sound paradoxical, but it is only paradoxical if one equates drug problems with drug use, and a variety of problems stem more directly from drug distribution and drug control than from drug use (MacCoun and Reuter forthcoming). If all aspects of drug problems grew and shrank in direct proportion to the level of use, this would be a distinction without a difference, but that is not the case. Indeed, different measures of use are not always well correlated.[6]

One can speculate about the reasons for this focus. U.S. drug control goals have typically focused on drug use reduction, a point discussed further in a

later section. There has been greater emphasis on research and evaluation of demand reduction programs than of supply control programs (Reuter 1997). Drug users are the ultimate source of all drug-related problems; if no one wanted to use drugs, there would be no drug supply industry or need for drug control efforts.

Whatever the reason, this overemphasis on drug users in data collection is problematic. It focuses attention on the problems of drug users to the exclusion of other issues. We know there are several million children living in households with a substance-dependent adult, and child protective services case loads grew along with the growth of the cocaine epidemic. However, drug policy discussions generally give short shrift to the harms borne by family members and friends of the drug abusers. This deficit may at least in part be explained by the absence of a national database tracking instances of drug-related child abuse or neglect.

We tend to measure what is easy to measure, not just what is important. That is understandable, and one can argue that some information is always better than no information. However, there is a tendency to ascribe zero value to that which is not measured and for tangible but less relevant numbers to drive out consideration of less tangible issues.

Likewise, little attention is paid to the families of the approximately 400,000 people incarcerated for drug offenses. It seems likely that the number of children separated from a parent by this incarceration is in the tens of thousands, but we do not track that number or even think much about whether those separations are good or bad for the children.

More generally, little effort is made to track nondollar costs of drug control efforts. Some are important but difficult to quantify. Drug control efforts in source and transshipment countries affect those countries and our relations with them in ways that are of interest not only for altruistic reasons. The level of drug-related corruption in Mexico and its impact on Mexico's democratic institutions is of considerable importance to the United States, given that Mexico is our third-largest trading partner (in 1997), we share a 1,936-mile border, and many millions of Americans have direct family ties in Mexico. Other costs could be quantified readily, including the number of search warrants served on incorrect addresses, the value of assets seized but ultimately returned because the owner was not found guilty, the number of individuals stopped and searched under suspicion but who were not found to be in possession of any drug or in violation of any law, and so on.

Looking at the "Drug-Related Data" appendix of the *National Drug Control Strategy* illustrates the point (Executive Office of the President, ONDCP 1999). The appendix contains 33 tables of drug-related data distributed across categories as indicated in exhibit 1.

Many aspects of the drug problem are not reflected in these data tables. They say nothing directly about impacts on family members and friends of drug users, drug-related crime or violence, morbidity and mortality caused by drugs (as opposed to that which is merely drug related), the nondollar costs of drug control efforts, and so on. We tend to measure what is easy to measure, not just what is important. That is understandable, and one can argue that some information is always better than no information. However, there is a tendency to ascribe zero value to that which is not measured and for tangible but less relevant numbers to drive out consideration of less tangible issues (Larkey and Caulkins 1991).

Recent developments in drug-related measures

Despite these problems, the existing data systems have strengths. There are multiple systems, which is valuable for triangulation. The systems are well funded. The major systems have been collecting data consistently over time. Many provide data at the local as well as national level. Furthermore, four promising trends portend better data in the future.

(1) Expansion in size, scope, and consistency of mainstream data systems

Many of the traditionally most useful data series are getting better. DAWN was among the first to benefit from this trend. In the late 1980s and early 1990s, the number of metropolitan areas covered was reduced to 21, but a national panel of facilities located throughout the remainder of the United States was added. DAWN was redesigned as a stratified random probability sample that permits calculation of site-specific and national estimates as a weighted sum of the episodes occurring in the region's sampled facilities, where the weights are recomputed each quarter.

The Monitoring the Future (MTF) survey added samples of 8th- and 10th-grade students in 1991. The expanding length of its 12th-grade data series (dating to 1975) is making it increasingly valuable.

The DUF/ADAM program is being improved by (1) making sampling procedures more consistent across sites, (2) recording the sampling probability of every

Exhibit 1. Types of data included in the *National Drug Control Strategy's* data appendix

Number of tables	Subject	Data sources
15	Prevalence as measured by the "Big Three" surveys	National Household Survey on Drug Abuse, Monitoring the Future, Drug Use Forecasting/ Arrestee Drug Abuse Monitoring
4	Number of school dropouts, use by dropouts, societal costs of dropping out of school	U.S. Census, Youth Risk Behavior Survey, Mark Cohen's studies (see his chapter in this volume)
2	Drug-related morbidity and mortality	Drug Abuse Warning Network, National Vital Statistics Survey
8	Magnitude of drug control efforts: Numbers of arrests, incarcerations, seizures, and treatments	Uniform Crime Reports, Bureau of Justice Statistics, Drug Enforcement Administration, Federal-wide Drug Seizure System, National Drug Abuse Treatment Utilization Survey, Substance Abuse and Mental Health Services Administration
4	Market aggregates: Global production, drugs available in United States, prices, and drug spending	International Narcotics Control Strategy Report, Drug Enforcement Administration, System to Retrieve Information from Drug Evidence, Office of National Drug Control Policy (Rhodes et al. 1995)

arrestee in the sample, and (3) extending coverage to (in most cases) the county containing the city in question (Rhodes 1998). In addition, the core instrument is under revision and the number of sites is scheduled to increase to 75.

Plans are under way to expand the NHSDA sample. Early NHSDAs surveyed only 4,000 to 9,000 individuals. The sample size increased to approximately 30,000 in 1991 and is expected to grow to 70,000 in 2000, allowing prevalence estimates to be produced at the State level.

(2) Emergence of information about markets

Illicit drugs are, ultimately, consumer goods, and like other goods in modern societies they are provided primarily through markets. The markets for illicit drugs have distinctive characteristics with implications for social welfare and drug policy choices (Kleiman 1992). For example, the markets are characterized by small, short-lived, vertically unintegrated, and technologically unsophisticated sole proprietorships that generate great violence and disorder. Nevertheless, drug markets are, in fact, markets.

A market-clearing equilibrium is characterized by its price and quantity, but price data have only recently been a focus of attention. Studying prices is appealing because price data are relatively abundant and can be disaggregated to the municipal or even neighborhood level (Weatherburn and Lind 1997).

Price data support a number of important observations. Perhaps the most striking is simply that drug prices are extraordinarily high. The cocaine and heroin sold in retail markets in the United States are quite literally 10 to 100 times more valuable per unit weight than gold (Caulkins and Reuter 1998).

Illicit drug prices also vary widely across market levels, between locations, over time, and from transaction to transaction. The simplest expression of the variation across market levels is that there are substantial quantity discounts for a wide variety of illicit drugs. Specifically, price per unit is proportional to transaction size raised to a negative power (Caulkins and Padman 1993).

Quantity discounts exist for many consumer goods, but the discounts are far larger for illicit drugs, and they have important implications. They help us understand how costly drug seizures at different levels are to drug suppliers. They imply most of the accounting profits accrue not to a handful of kingpins but rather are divided among a large number of low-level dealers. They imply that the effectiveness of high-level enforcement depends crucially on the manner in which price increases at one market level are translated into increases at lower levels (a point discussed further later in this chapter). They imply that one cannot estimate the dollar value of the retail market just by multiplying the quantity consumed by the price per gram; one also needs to consider the distribution of retail purchase sizes.

Data on prices also help elucidate characteristics of markets. For example, Caulkins (1995) found that drug prices within the United States increase as one moves away from the drug sources and that prices are lower in larger markets. For cocaine in particular, the data support the notion that cocaine is distributed through an urban hierarchy, in which large cities tend to be leaders, with drugs diffusing down through layers of successively smaller surrounding communities.

Price data also have raised questions not yet answered. For example, exhibit 2 shows how the inflation-adjusted price of cocaine and heroin fell by 75 percent between 1981 and 1988, even though enforcement intensity increased during that period. There are many theories but little agreement concerning why enforcement failed so dramatically to keep prices high.

Prices are not the only new source of information about drug markets. To continue the market analogy, drug suppliers are like businesses. Like business, the more sophisticated supplier organizations keep financial books. Levitt and Venkatesh (1998) used financial records from drug-dealing gangs to draw interesting inferences about their behavior, but on the whole, these records are a promising but largely untapped data resource.

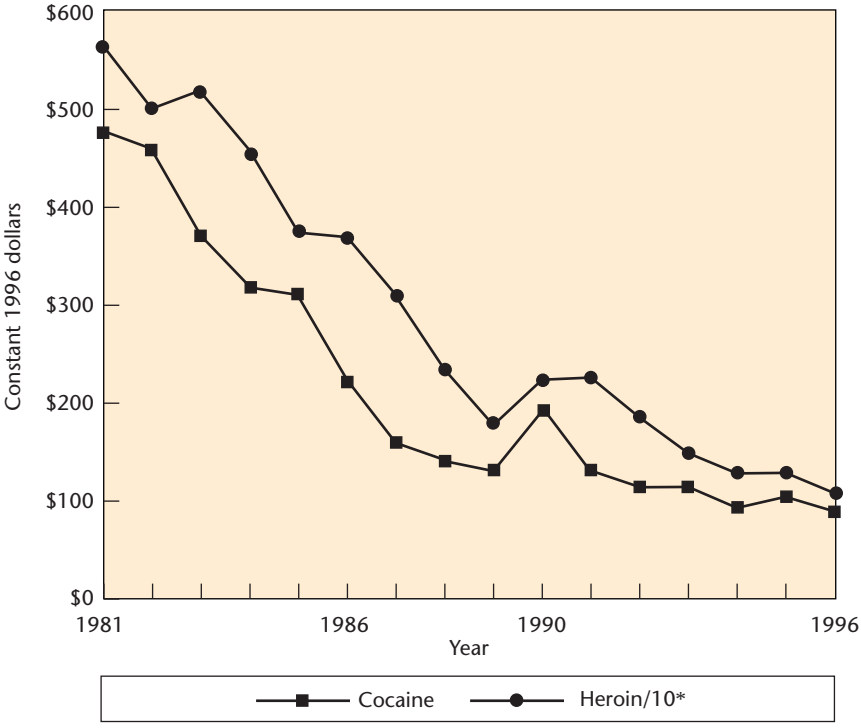
Another source of information about drug markets is ethnographic studies. Traditionally, ethnographic studies focused on drug addicts. Those addicts frequently participated in low-level selling, but selling activity was not central to the investigations. More recently, qualitative researchers (e.g., Johnson et al., 1985, 1991; Maher 1997) have been focusing explicitly on dealers and resulting data are being used in formal analyses of their organizational and business structures (Caulkins et al. 1999; Tita 1999).

(3) Data integration

Drug-related data series have not always been integrated into a coherent systems view. This disconnectedness is problematic for a variety of reasons, including the fact that it foregoes important opportunities to check the validity of numbers. As a result, numbers are repeated, trusted, and used, which are, on closer examination, simply absurd.

Max Singer (1971) was perhaps the first to draw attention to this problem with his article "The Vitality of Mythical Numbers." He noted that conventional wisdom about the number of heroin addicts and the amount of crime committed per addict were incompatible with estimates of the amount of crime that was actually committed. In particular, although it was generally assumed that addicts stole $2 billion to $5 billion per year in New York City, Singer showed that the total amount stolen in the city was about 10 times less, suggesting that estimates of the

Exhibit 2. Retail cocaine and heroin prices per gram



* Heroin prices divided by 10 to fit scale.

number of addicts were seriously in error. As Singer (p. 9) observed, "The main point of this article may well be to illustrate how far one can go in bounding a problem by taking numbers seriously, seeing what they imply, checking various implications against each other and against general knowledge."

Unfortunately, this message has been slow to take hold. Thirteen years later, Peter Reuter (1984) wrote a followup piece ("The [Continued] Vitality of Mythical Numbers"), which showed that the situation had not substantially improved. Only more recently have coherent systems views been constructed (e.g., Homer 1993a, 1993b; Childress 1994a, 1994b; Dombey-Moore, Resetar, and Childress 1994) that allow us to reconcile apparently conflicting trends in indicators (Reuter, Ebener, and McCaffrey 1994) and add up all the costs in the domestic cocaine distribution industry (Caulkins and Reuter 1998). These integrative estimates have not yet banished all mythical or nonsensical numbers, but they do provide a much firmer foundation on which to base subsequent policy analyses.

(4) Expansion of international comparisons and databases

In the past, drug-related data from outside the United States were weak to nonexistent. That was understandable. It costs about the same amount to run a household survey in a country of 27 million people as it does in the United States with its population of 270 million. But the tax base for paying for data collection is obviously larger in a larger country. Also, drug problems in the United States had been much more severe than elsewhere. They remain more severe, but the gap is narrowing (Taylor and Bennett 1999).

Increasing drug use around the world is obviously an undesirable development, but inasmuch as it has spurred greater investment in data collection and reporting abroad, it has a beneficial side effect for the United States. Better data collection abroad is valuable because it provides two types of variation that are helpful for understanding relationships among variables.

First, there is greater variation in drug policy across countries (for example, within Europe) than there is across jurisdictions within the United States. Because the ultimate objective of policy analysis is to estimate the impacts of varying policy, this is of direct value (MacCoun, Reuter, and Schelling 1996; MacCoun and Reuter 1997, and forthcoming).

Second, there are variables that affect drug use, vary over time, and are difficult to control for (e.g., attitudes toward drugs). They make panel datasets much more valuable than simple time series, but, unfortunately, some important data series are not collected at the subnational level. For those, comparisons across countries can be insightful.

The United Nations International Drug Control Programme in Vienna, Austria, has long produced information on different countries' drug problems, and the quality of the data and associated publications has risen dramatically in recent years. Data on seizures, prices, purities, and so on are now available for many countries and multiple years (United Nations International Drug Control Programme 1998).

These four trends do not exhaust the list of promising developments. It is easy to get frustrated about the inadequacies of the data. But given the intrinsic difficulty of gathering information about covert activities, the progress that has been made in the past decade and the progress that can be expected in the next decade are heartening. Furthermore, even if the glass of insight is only half full, there is no reason not to make use of that half.

Solving the Problem

Having addressed the measurement of drug problems, the discussion turns next to the measurement or estimation of the effectiveness of drug control efforts. We open by considering alternative drug control goals and how the choice of goals interacts with the apparent effectiveness of drug control strategies. The bulk of the section reviews what is known about the effectiveness of interventions with respect to a particular goal, namely reducing drug use. The section closes by identifying themes for subsequent research.

Alternative goals of drug policy and their interaction with program effectiveness

To evaluate an intervention, one must first know its objective. A vigorous literature concerning the goals of drug policy has emerged since the passage of the 1988 Anti-Drug Omnibus Control Act. That act requires ONDCP to establish "long-range goals for reducing drug abuse in the United States" and "short-term measurable objectives." There has been an ongoing expansion and evolution in the named goals, culminating in last year's establishment of the national drug control strategy performance measurement system (Executive Office of the President, ONDCP 1998a). Other countries, including the United Kingdom, Canada, and Australia, have also established official national drug policy goals.

There is an interesting interplay among the nature of data systems, the types of goals, and the apparent effectiveness of different drug control strategies. Some data systems are more appropriate for certain goals than others. (NHSDA can measure progress on goals pertaining to overall prevalence of drug use, but other systems are better at tracking the number of certain types of heavy users.) Likewise, some data systems are more appropriate for evaluating certain control strategies than others. (City-level data on prices and search times are invaluable for evaluating enforcement interventions; individual-level data from controlled trials are most valuable for evaluating treatment and prevention programs.) Perhaps least appreciated is the interplay between the choice of goals and the apparent effectiveness of control strategies. Some goals inherently favor certain control strategies relative to others, as will be illustrated by considering some possible goals and noting at least one such bias for each.

Reducing prevalence

The first *National Drug Control Strategy* (Executive Office of the President, ONDCP 1989, 8) stressed goals that pertained to the prevalence of drug use among the general population and youths. In particular, 7 of the 10 goals related to NHSDA or MTF measures.

Setting goals in terms of overall prevalence weights all drug users equally. Because it is easier to persuade a light user to quit than it is to persuade an addict to do so, these goals inherently favor interventions that target light use. Drug testing of athletes and workers might convince some light users to quit but would presumably have less impact on unemployed street addicts. Likewise, media campaigns, tough rhetoric, and symbolic actions that stigmatize drug use might convince some recreational users to abstain. They are less likely to convince an addict to quit, and the stigmatization might even hurt addicts. It is perhaps not entirely coincidental that during the late 1980s, the number of drug users in the United States fell sharply, but the number of heavy users increased.

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A case can be made for placing greater emphasis on the smaller number of most problematic users. Such an emphasis favors a different set of tactics. Inasmuch as addiction is a chronic relapsing condition, programs that discourage people from becoming heavy users are appealing. Primary prevention, which discourages initiation into drug use in the first place, is relevant for reducing both the overall prevalence and the prevalence of heavy use, but secondary prevention programs that seek to reduce escalation from light to heavy use are relevant only for the latter.

Reducing the amount of drugs used

Because heavy users consume much more per capita than light users, tracking changes in consumption is not altogether dissimilar from tracking changes in the number of heavy users, but it has the advantage of not entirely ignoring light users. In particular, focusing on consumption effectively assigns a weight to each user proportional to that user's rate of consumption.

There is evidence that treating heavy users is the most cost-effective way to reduce the quantity of cocaine consumed (Rydell and Everingham 1994), but given the high relapse rates (Anglin and Hser 1990a), it is almost certainly not the most cost-effective way to reduce the number of cocaine users. If the goal is to reduce the quantity of drugs consumed, then interrupting an addict's drug use for 3 months is valuable.[7] Indeed, it could well be more valuable than

convincing some light users to quit permanently.[8] But if the goal is to reduce the number of people who are addicted to drugs, short-term interruptions are meaningless.[9]

Reducing the amount spent on drugs

Not all drug-related problems are driven by the amount of drug use. Some are driven by the amount spent on drugs. Consider drug-related crime and violence. Goldstein (1985) categorized drug-related crime and violence as psychopharmacological, economic-compulsive, and systemic. Only the first is driven directly by drug use or withdrawal. Economic-compulsive crime clearly is driven by spending on drugs. Systemic crime may be as well. Caulkins et al. (1997) estimate that about five-sixths of cocaine-related crime is economic-compulsive or systemic. Likewise, the amount of money laundering, corruption, and demoralization of law-abiding citizens by the affluence of dealers may be related more closely to the dollar value of the drug market than to the weight of drugs consumed.

Changing the goal from reducing the quantity of drugs consumed to reducing the dollar value of the drug market favors demandside interventions relative to enforcement programs that reduce use by driving up prices. Indeed, if the (absolute value of the) elasticity of demand were less than one, then, although driving up prices would reduce drug use, it would actually increase the dollar value of drug sales. Note that not all enforcement operates principally by driving up prices. Setting a goal of reducing the dollar value of the black market would penalize high-level enforcement, including interdiction and source country control efforts, more than it would retail enforcement or partnerships with treatment because high-level enforcement reduces use primarily by driving up prices.

Harm reduction versus use reduction objectives

Another goal, one more popular outside the United States, is reducing the total damage done by drugs, not the amount of drugs used. Logically, one would like to call this social utilitarian approach *harm reduction* and contrast it with *use reduction*. The term *harm reduction* will be used in this sense here even though it has been made controversial by being used to mean other things in other contexts.

MacCoun and Reuter (forthcoming) give a useful categorization of drug problems and their relationship to use. The magnitude of the overall drug problem is some agglomeration of intoxication-based functional impairment, numbers of overdoses, amounts of drug-related crime and violence, and so on. These components of the drug problem do not always move in proportion to each other or to consumption.

If the goal is to reduce the harm caused by drugs, not the amount of drugs used, then a variety of interventions merit consideration that otherwise would not be relevant. The most famous (or infamous) is needle exchange. Needle exchanges are unlikely to have much impact on the amount of drug use. Advocates argue that they bring addicts in contact with social services and hence improve treatment outcomes. Critics argue that needle exchanges send the wrong message. But neither effect is likely to be large relative to the impact on the rate of HIV transmission. Because each new case of HIV is very costly (for society as well as the individual), if the goal were to reduce harm, needle exchange at a minimum deserves consideration. And the consensus in the scientific literature seems to be that it can actually succeed in reducing HIV transmission (e.g., Lurie et al. 1993; National Research Council [NRC] 1995).

A less discussed and perhaps less controversial example can also make the point. Inasmuch as IDUs are at risk for becoming infected with HIV and transmitting it to others, distributing condoms to IDUs might plausibly reduce the harm caused by injection drug use. It is hard to argue that doing so would have any substantial impact on the amount of drug use. Because condoms are cheap relative to the cost of treating HIV, distributing condoms to IDUs is probably cost effective if the goal is to reduce harm but worthless if the goal is to reduce use.

Harm reduction itself can be defined in a variety of ways. For example, should harm suffered by adult drug users be included in the sum of harm to be minimized? Some argue the government has neither the responsibility nor the right to protect people from themselves (Friedman and Szasz 1992). Others argue that "drug consumers may be less capable than other consumers of protecting their own interests" (Kleiman 1992). Enforcement makes users worse off by imposing sanctions, raising prices, reducing availability, and increasing variability in potency. In contrast, treatment programs help users break the cycle of addiction and avoid some of the harshest consequences of use. Hence, one is more likely to favor treatment over enforcement if harm experienced by users is part of the harm to be minimized.

MacCoun (1996) distinguishes between *micro*harm reduction that seeks to reduce the average harm users experience and *macro*harm reduction that seeks to minimize aggregate societal harm. A microharm reduction perspective is particularly hostile to enforcement. A macroharm reduction perspective recognizes harm to nonusers. Thus, improving the quality of foster care and property crime control strategies (such as enhancing sanctions for burglary) might be useful from a macroharm reduction perspective, but irrelevant or even counter-productive from a microharm reduction perspective.

If one asks simply whether these various programs are effective at reducing drug use, the answer is in most cases yes. But such an answer is not very informative. Not every program that reduces drug use is worth pursuing, any more than every program that reduces pollution or improves health should be pursued. One has to ask whether the benefits are large enough to justify the costs of undertaking the program.

To summarize, there are a variety of possible goals for drug policy, and the choice of goals affects the apparent desirability of various interventions. Hence, as the discussion turns to a review of estimates of the effectiveness of interventions, it must be explicit about the goals or outcome measures. In most cases, that will be the quantity of consumption averted per program dollar, in part because that is the most common measure in the literature and in part because Rydell, Caulkins, and Everingham (1996) argue it is perhaps the single best scalar measure of the magnitude of drug problems.

Current understanding of the effectiveness of drug control interventions

Evidence concerning the effectiveness of drug control interventions is a study in contrasts. We have great faith in, but little evidence concerning, the effectiveness of prevention programs (Gorman 1995; Moskowitz 1993; Caulkins et al. 1999). In contrast, there is great unease but relatively abundant evidence concerning the efficacy of methadone maintenance (e.g., Ward, Mattick, and Hall 1994), and some evidence but great controversy concerning the effectiveness of other types of treatment (Gerstein et al. 1994; Rydell and Everingham 1994; Institute of Medicine [IOM] 1996; Crane, Rivolo, and Comfort 1997). Paradoxically, there is less evidence about the ability of enforcement programs to control drug use even though they absorb the bulk of drug control resources (Reuter 1997). There are exceptions, including experimental studies of local police interventions (e.g., Weisburd and Green 1995; Tita 1999), model-based analyses of incarceration-oriented efforts (e.g., Caulkins et al. 1997), and model and time series-based analyses of high-level enforcement and interdiction programs (e.g., Crawford et al. 1988; Crane, Rivolo, and Comfort 1997; Yuan and Caulkins 1998). But it is striking how much greater is the ratio of research to program funding for demand control interventions than for supply control interventions.

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informative. Not every program that reduces drug use is worth pursuing, any more than every program that reduces pollution or improves health should be pursued. One has to ask whether the benefits are large enough to justify the costs of undertaking the program.

As Cohen explains elsewhere in this volume, there are at least two ways of thinking about whether the benefits are enough. Benefit-cost analysis seeks to monetize the benefits and compare them with program costs. Cost-effectiveness analysis seeks to compare the benefits per dollar of program cost generated by different programs. Programs that generate the greatest benefit per dollar spent (i.e., that yield the most "bang for the buck") are viewed as being the most cost effective.

Unfortunately, although much has been written about drug control interventions and drug policy, only a tiny fraction of that literature seeks to provide quantitative estimates of programs' effectiveness. Some of the literature is not quantitative at all, and a portion of that which is quantitative examines only process measures. Many studies that quantitatively address program outcomes seek only to establish the statistical significance of an effect or do not translate the magnitude of estimated effects into policy-relevant terms. Finding that a program has a statistically significant effect on some outcome is a necessary, but not sufficient, condition for concluding that the program is effective. And knowing that a $10 million-per-year program reduces drug-related 911 calls for service in a medium-sized city by 5 percent is not enough to determine if it is cost effective. The results need to be translated into measures that allow comparison with other available interventions.

Theoretically, neither benefit-cost nor cost-effectiveness analysis is a good way to inform decisionmaking because both collapse a vector of outcomes into one or two aggregate measures. Ideally, one would leave estimates of the various outcomes disaggregated and apply methods of multicriteria decisionmaking. Realistically, however, this is complicated when there are multiple stakeholders, and it seems that without the discipline of needing to compute some bottom-line assessment, few studies ever even estimate quantitatively the magnitude of the effect of each program on a common and comprehensive set of outcome measures. Hence, the remainder of this section does not seek to review the entire quantitative literature concerning drug control interventions, but rather to focus on the small subset that addresses questions of benefit-cost ratios and cost-effectiveness directly.

Before proceeding, it is useful to specify a framework for categorizing drug control interventions. For present purposes, it is convenient to distinguish among three types of intervention effects:

- Reducing the quantity of drugs consumed.
- Reducing the magnitude of the drug problem per kilogram consumed.
- Displacing the problem from one location, time, or population to another.

One intervention can operate in more than one way. For example, when police shut down an outdoor street market, there might be some reduction in selling and use, some displacement of the selling to another location, and some displacement to more covert forms of dealing that impose fewer harms on neighbors per gram sold.

As mentioned, this review focuses on effectiveness at reducing drug use. Interventions can reduce consumption by reducing demand, constraining supply, or driving a wedge between supply and demand.

Demand can be suppressed by preventing people from initiating or escalating use or by treating current users, with or without assistance from enforcement. A wedge between supply and demand exists to the extent that the costs users pay to obtain and consume drugs exceed the dollar price paid to the dealer. The most-discussed example is that users expend time and effort (search time) locating a dealer and completing a transaction. Presumably, raising these nondollar costs discourages use to some extent.

Interventions can affect supply in two ways. Unanticipated interventions can disrupt supplier operations in ways that upset the market equilibrium. A market is not in equilibrium if (1) supply does not meet demand in the sense that there is a physical shortage, (2) demand does not meet supply in the sense that there is a physical surplus of goods that cannot be disposed of, or (3) the market clears but the market clearing price is changing rapidly. In the absence of ongoing exogenous shocks, one expects this situation to last only until the market has time to adjust. Ideally, the disruption takes the form of physical shortage and the market does not regenerate so the new equilibrium has no drug sales or use, but that is not the norm.

Treatment is the most thoroughly evaluated drug control intervention, and it is usually found to be cost effective.

Enforcement can also affect supply even if the intervention is fully anticipated. For example, if smugglers knew that about one-quarter of all shipments would be seized, they would ship more than they would if they thought none would be seized. So quantity seized is not a direct measure of enforcement's impact on consumption. However, presumably the smugglers would charge more per kilogram landed to make up for the losses. The higher prices

represent a shift in supply that affects retail prices and, hence, consumption. These two distinct aspects of enforcement's effect on supply are referred to here as disequilibrium and equilibrium effects.

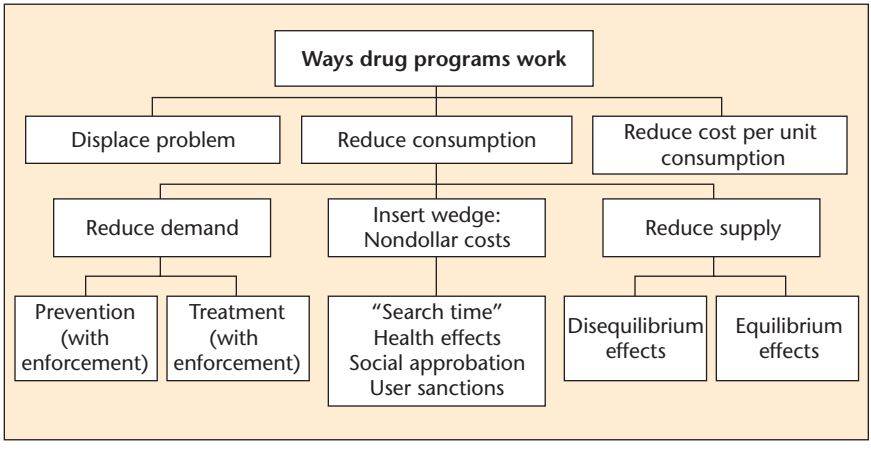
This framework for understanding drug control interventions is summarized in exhibit 3. The discussion of effectiveness uses the framework as a schematic outline.

Reducing demand through prevention

There is great confidence that drug prevention is effective and cost effective. For example, the latest national strategy (Executive Office of the President, ONDCP 1999, 54) states unequivocally, "The simplest and most cost-effective way to lower the human and societal costs of drug abuse is to prevent it in the first place."

Such a monolithic view is simplistic. There is enormous heterogeneity in programs, ranging from school-based curricula to adventure camps to community-wide events to physical fitness-based programs. Some are more effective than others (Sherman et al. 1997). Likewise, some school-based programs have been shown unambiguously to decrease illicit drug use (Ellickson and Bell 1990; Botvin et al. 1995). Yet the evidence concerning the most popular school-based program, D.A.R.E.®, is less positive. D.A.R.E.® has not been shown to have any material effect on marijuana use at followup (Tobler 1997).

Exhibit 3. Framework for understanding drug control programs' effectiveness



There are only a handful of studies that actually estimate cost-effectiveness. For example, in a 1998 National Institute on Drug Abuse Monograph entitled *Cost-Benefit/Cost-Effectiveness Research of Drug Abuse Prevention: Implications for Programming and Policy* (1998), only one of the nine articles produces a specific estimate. In that article, Pentz estimates the drug-related costs averted per dollar spent on the Midwest Prevention Project. Marijuana is the only illicit drug for which she estimates outcomes and she estimates 3-year net reductions of 3.5 percent in heavy marijuana use, tapering off to 2.5-percent reductions at 5-year followup. These reductions, combined with reductions in alcohol and cigarette use and the modest cost of the intervention "indicate that comprehensive drug prevention programs, such as a multi-component community-based drug prevention program, are highly cost-beneficial and cost-effective" (p. 125).

Caulkins et al. (1999) consider a generic "best practice," school-based prevention program modeled on the evaluation data for Project ALERT and the Life Skills Program (Ellickson and Bell 1990; Botvin et al. 1995). They find there is considerable uncertainty concerning prevention's cost-effectiveness, but the range of estimates for cocaine is comparable to that previously estimated for a variety of types of drug enforcement (7 to 60 kilograms of cocaine consumption averted per $1 million).

I am not aware of any comparable estimate for media-based prevention programs such as those at the centerpiece of the ONDCP prevention campaign launched in summer 1998. Related media-based campaigns, such as those designed to promote the use of designated drivers, have been shown to have an effect (Winsten 1999). ONDCP reports a correlation between media exposure and changes in attitudes, but there is no evidence yet concerning effects on drug use (McCaffrey 1999).

Reducing demand through treatment

Treatment is the most thoroughly evaluated drug control intervention, and it is usually found to be cost effective (e.g., Rydell and Everingham 1994; Gerstein et al. 1994). IOM (1996, 192) summarized the literature by saying "Research has shown that drug abuse treatment is both effective and cost-effective in reducing not only drug consumption but also the associated health and social consequences."

Treatment does not achieve this status by convincing most of those who enter treatment to abstain from all subsequent use. Quite the contrary. Relapse rates are very high. Indeed, many who begin treatment do not even complete the course of treatment. At first glance these observations might seem contradictory,

but Rydell and Everingham's (1994) pioneering systems analysis reconciles them by making several points.

First, focusing on relapse rates ignores the benefits of reduced use while patients are in treatment (an incapacitation effect). Rydell and Everingham show that even if every entrant to a typical cocaine treatment program relapses to heavy use and some (20 percent) use during treatment, treatment can still be cost effective on the strength of the in-treatment effect alone.

Second, the fact that many people drop out of treatment quickly increases relapse rates, but it has only a modest effect on treatment's cost-effectiveness because not many resources are consumed by patients who only stay for a day or two.

Third, careers of heavy drug use are long and costly, so even infrequent long-term successes are sufficient to make a program cost effective. There is uncertainty about specific parameter values, but suppose that the average admission to treatment costs $2,000, the average heavy user consumes 125 grams per year, the social cost per gram of consumption is $100, and the net present value of the residual career length for a typical entrant to treatment is 8 years. If the treatment program leads even 1 in 50 entrants to give up heavy use, the program is cost justified.[10] Exactly what figures should be used in these calculations is not known, but the structural points discovered by Rydell and Everingham are clear. A treatment program can be cost effective even if it performs miserably on conventional metrics such as the proportion of entrants who are abstinent 18 months after entry.

At the same time, Rydell and Everingham provide a cautionary note. If most people relapse, then unless those individuals can be re-enrolled rapidly, there is a limit to how quickly treatment can ameliorate the drug problem. In Rydell and Everingham's model (which assumed that 13.2 percent of treatment entrants left heavy use because of that treatment), even if every heavy cocaine user received treatment once a year, cocaine use would still be cut only in half over 15 years.[11] Highly imperfect treatment programs, no matter how cost effective, cannot quickly eliminate an endemic drug problem.

These are very general observations. As mentioned, the treatment evaluation literature is large, so it contains many more insights than can be covered here. There are a number of excellent summaries of the treatment literature (e.g., Hubbard et al. 1989; Anglin and Hser 1990a; Gerstein and Harwood 1990; Cartwright and Kaple 1991; IOM 1996, ch. 8; McLellan et al. 1996). Indeed, the literature is so large there is even a bibliography of literature reviews of drug abuse treatment effectiveness (Prendergast, Podus, and McCormack 1998).

Complementing traditional demand reduction with the stick of enforcement

It is common to view demand reduction generally, and treatment in particular, as an alternative to enforcement programs. Indeed, simple schema such as exhibit 3 encourage such an either-or, if not competitive, view. The reality is much more complicated. Enforcement plays an important role in prevention and treatment (Moore 1990). Conversely, prevention and treatment can enhance the effectiveness of enforcement by shrinking enforcement's target, allowing it to take advantage of inherent increasing returns to intensity (cf. Caulkins et al. 1999).

One important interaction between enforcement and demand control is the use of coercive enforcement to compel people into treatment, to keep people in treatment, and/or to create additional incentives for performing well while in treatment (Anglin and Hser 1990b). The general finding in the literature is that paternalistic treatment that combines the carrot and stick is more effective than either the carrot or stick in isolation (Valliant 1997).

Civil commitment is one of the oldest forms of this cooperation between coercive and therapeutic elements. Not all civil commitment programs performed well, but some did (McGlothlin, Anglin, and Wilson 1977; Anglin and McGlothlin, 1984). As Anglin and Hser (1990a, 425) note, "Although the program results were not spectacular, outcomes at the time were as good as or better than those of other interventions for drug dependence."

Treatment in prison is another vehicle for partnership (Hiller, Knight, and Simpson 1999). There are two undeniable appeals to treating prisoners. First, they are serious offenders. Second, the State is already obligated to pay their room and board, so the marginal cost of delivering some treatment modalities (e.g., therapeutic communities) is less than it is outside of prison.

Treatment Alternatives to Street Crime (TASC) is another longstanding example. Approximately 300 programs in the United States use diversionary dispositions (deferred prosecution, community sentencing, pretrial intervention) to direct offenders into treatment (Inciardi and McBride 1991). TASC programs vary from State to State, but in at least some States, they have beneficial effects on the amount of treatment services received, rates of drug use, and HIV risk behaviors (Anglin, Longshore, and Turner 1999).

Among the better known of the carrot-and-stick partnerships are so-called drug courts, which were developed in Miami and Oakland but now exist in approximately 250 jurisdictions throughout the country. Drug courts are like TASC in the sense of suspending normal criminal justice sanctions if, and as long as,

the offender is attending and progressing through treatment. Most evaluations have been process evaluations published as reports, not in peer-reviewed academic journals, but the consensus seems to be that they can be effective at least in providing relatively close community supervision, improving treatment retention, and reducing recidivism.

The most dramatic variation on the carrot-and-stick approach is coerced (or more generally incentivized) abstinence. It suggests that what really matters is not the authority of the judge's robes but rather the incentives given for recovery, particularly the certainty and swiftness of the punishment. Indeed, replacing the judge with a clear and unbending set of rules that mandate punishment for violations could actually improve outcomes by enhancing the certainty of punishment. A variety of clinical evaluations show that frequent testing associated with immediate incentives enhances treatment success (e.g., McCarthy and Borders 1985; Higgins et al. 1993, 1994; Silverman et al. 1996).

Kleiman (1997a) argues that coerced abstinence might plausibly yield substantial reductions in consumption. He observes that the majority of cocaine used in the United States is consumed by people who are nominally under criminal justice supervision (e.g., free on probation or parole). If frequent testing with automatic and immediate sanctions could cut their use by even two-thirds, that would cut national consumption by approximately 40 percent. No other program offers the hope of such dramatic and rapid reductions in cocaine use.[12]

Driving a wedge between supply and demand

The second broad way of reducing drug use is to create a wedge between the demand and supply curves by imposing nondollar costs on users. Raising nondollar costs is appealing because it can discourage use without increasing revenues per unit sold by dealers. There are at least four categories of nondollar costs: the inconvenience of obtaining the drug, adverse physical reactions to the drug, social approbation from individuals and organizations other than the state, and punishment of users by the state. The first has received the most attention.

The search time argument was originally advanced by Moore (1973) and has been refined and applied by Kleiman (e.g., Kleiman and Smith 1990). It recognizes that users expend time and effort to locate a dealer and complete a transaction. For many years the concept was largely unevaluated, in no small part because there were no data on search times. Kleiman (1988) reported that the extreme case of effectively eliminating street markets in a city had beneficial effects, but it was not clear whether incremental expansion in enforcement could have an appreciable effect on quantities consumed.

Rocheleau and Boyum (1994) achieved a substantial breakthrough by showing that data could be collected on retail purchasing patterns generally and on search times in particular. Furthermore, they showed that even experienced heroin users expend substantial effort obtaining their supplies (an average of 35 minutes per purchase), raising hopes that search time costs were large and, hence, driving them up might be a practical way of suppressing use.

However, Caulkins (1998) argued that because the average purchase totaled approximately $25, unless these addicts placed a high value on their time, the search time costs were still small compared with the dollar costs. Furthermore, because heavy users may know 10 to 20 alternative suppliers and new dealers can be located relatively easily (Riley 1997), it is doubtful that arresting one or even several would greatly increase search time. Quantifying these observations is highly speculative, but Caulkins (1998) estimates that arresting retail dealers of established, mass-market drugs reduces consumption by experienced users through increased search times by less than one-tenth as much as it could reduce consumption through the "risks and prices" mechanism described later in this chapter. The ratio may be even lower for enforcement directed at targets further up the distribution chain.

There are a variety of ways in which one might drive a wedge between the demand and supply for a drug. All have the considerable theoretical appeal of suppressing consumption without increasing dollar prices. None have been studied satisfactorily, and few have been studied in a quantitative way at all.

This does not mean that increasing search times is never effective. It is more likely to be effective in smaller towns, "thinner" markets, and/or with newer users who have not established alternative sources of supply. Such individuals are presently responsible for only a small portion of consumption, but if increased search times can suppress initiation, in the long run it might have a greater effect.

Another and perhaps larger nondollar cost that users pay is the physical or health costs of addiction and adverse reactions to the drugs or impurities mixed with the drugs. Theoretically, the government could seek to make drugs more dangerous, and, if reactions to the 1970s paraquat scare are any indication, doing so might reduce use. However, except for the voluntary taking of an antagonist such as naltrexone, such interventions are at best questionable ethically. Indeed, when a batch of particularly dangerous drugs hits the streets, the usual response is to warn users in order to reduce adverse physical reactions.

Social approbation and informal social controls are a third form of nondollar cost. It is generally recognized that people are constrained from committing most criminal acts not so much by the fear of criminal sanction but rather by informal social controls. Probably the most common punishments for being caught with illicit drugs are shame, ostracization, loss of trust, and so on, not arrest, because the individuals who do the catching are more likely to be parents, spouses, or children than police officers.

With the exception of encouraging the widespread use of drug testing, e.g., of athletes and employees (NRC 1994; Lemmens 1997), it is not clear whether official policy has much control over these nondollar costs of drug use. Taking a tough line on drugs (Partnership for a Drug-Free America ads, government resistance to needle exchange, draconian sentences for drug sellers, and so on) might stiffen the resolve of parents and spouses to deal "severely" with infractions. (Severely is in quotes because even the more severe informal sanctions do not appear severe when compared with the official sanctions for drug selling.) However, there is little empirical evidence concerning this conjecture.

User sanctions are the fourth category of wedges between supply and demand. Little effort has been devoted to estimating the effectiveness or cost-effectiveness of user sanctions. I once produced a rough estimate (unpublished) of the cost-effectiveness of incarcerating heavy cocaine users. The estimate was much more favorable than I had anticipated but still inferior to the results of comparable calculations for domestic enforcement and treatment.

Incarceration is not, however, the only or likely the most efficient form of user sanction. Theoretically, fines should be very cost effective because they are just a transfer, imposing no net cost on society. Realistically, collecting fines is an expensive and uncertain prospect. I am not aware of any study that quantifies how effective fines are at controlling drug use in practice or of parallel estimates for imposing community service or seizing users' cars or other assets.

In summary, there are a variety of ways in which one might drive a wedge between the demand and supply for a drug. All have the considerable theoretical appeal of suppressing consumption without increasing dollar prices. None have been studied satisfactorily, and few have been studied in a quantitative way at all. Perhaps such investigations are an unintended casualty of the predilection toward simplistic partitions of drug policy into supply and demand control programs, with minimal attention devoted to those that do not fall neatly into one box or the other.

Reducing supply through disequilibrium effects

Supply side interventions are most likely to have disequilibrium effects if they quickly affect a large proportion of supply and/or the supply chain. Because the drug supply sector in the United States for most drugs is populated by many vertically disaggregated firms, it is difficult for enforcement to remove a large proportion of the capacity of the domestic distribution network at any one time. In the language of reliability studies, the network is robust because of its many lateral linkages, independent paths, and ability to expand quickly the capacity of individual arcs. The greatest potential for disruption may exist for less common drugs and/or smaller markets. The number of suppliers of LSD is much smaller than the number of cocaine suppliers, so it might be more feasible for a moderate number of strategically coordinated enforcement operations to create a shortage of LSD than of cocaine. Likewise, it should be easier for a given level of enforcement effort to generate a shortage of cocaine in a small, isolated city (Boise) than in a large city (New York) or a small city that is close to a large city (Hartford, Connecticut).

There is sometimes greater potential with interventions in source countries because there is greater market concentration there. Perhaps the greatest success was when the combination of the Turkish opium ban, the breaking of the "French Connection" case, and Mexican opium eradication efforts substantially drove up purity-adjusted heroin prices during the mid- to late 1970s before Asian heroin filled the gap (Reuter 1985). The greatest success with cocaine was the result of a combination of U.S. efforts and the war between the Colombian government and the Medellin-based traffickers in 1989 that led to a sharp (50 to 100 percent at its peak) but short-lived (about 18-month) increase in cocaine prices (Caulkins 1994). More recently, in 1995, Peruvian interdiction of the air bridge to Colombia led to a smaller but identifiable increase in cocaine prices (Crane, Rivolo, and Comfort 1997).

These transient price increases can have meaningful effects. The heroin scarcity in the 1970s is temporally correlated with the ebbing of the heroin epidemic. ER and medical examiner mentions declined in parallel with higher cocaine prices in 1989–90 (Executive Office of the President, ONDCP 1992), and there was a one-period decline in emergency mentions in late 1995 (U.S. Department of Health and Human Services 1998). The price increases and associated benefits do not last, however, because suppliers react to market disruptions by modifying their tactics and operations (Reuter 1988). At one time or another over the past 25 years, four different regions have been the principal supplier of heroin to the United States (Mexico, South America, Southwest Asia, and Southeast Asia). Similarly, Colombia quickly replaced Mexico as the principal

supplier of marijuana to the United States in response to paraquat spraying and fears of adverse health-effects of using sprayed marijuana (Kleiman 1992).

It is important to ask whether short-term disruptions in drug markets are desirable. Moore (1990) argues that it is beneficial to create shortages that last long enough for a birth cohort to mature through its "window of vulnerability" to initiation during periods of relative scarcity. Shortages might also drive experienced users into treatment. However, short-term price spikes can increase sellers' revenues and, perhaps, drug-related crime. (Even if the long-run price elasticity of demand is larger, in absolute value, than –1, it is unlikely that the short-run elasticity is so large.) Boyum (1992) argues that periodic shortages interspersed with times of relative availability could lead to greater use than would stable supplies if the demand curve is "kinked" in the sense of having an asymmetric response to price increases and decreases.

Unfortunately, the literature quantifying the magnitude of the benefits of these short-term disruptions relative to the cost of creating them is meager.

Reducing supply in the long-run equilibrium

It is believed that enforcement against suppliers can reduce consumption by driving up the price of drugs in equilibrium. This theory is embodied in so-called "risks and prices" calculations of the sort pioneered by Reuter and Kleiman (1986). The risks-and-prices paradigm recognizes that increasing enforcement risks for dealers raises their cost of doing business. Dealers could simply absorb those costs but presumably prefer to pass them along to users in the form of higher retail prices. Drug users, like consumers of other goods, respond to higher prices by reducing consumption (Caulkins and Reuter 1998).

The literature on risks and prices calculations for cocaine generates a number of insights. First, expanding domestic enforcement is probably less cost effective at reducing cocaine use and associated problems than is expanding even modestly effective treatment programs for heavy users (Rydell and Everingham 1994).

Second, some types of domestic enforcement generate greater effects through the risks-and-prices mechanism than do other types. In particular, mandatory long sentences are less cost effective than conventional sentences, and enforcement against dealers such as those prosecuted at the Federal level is more cost effective than is enforcement directed at typical dealers (Caulkins et al. 1997). (Retail enforcement may, however, be more effective at controlling the problems associated with markets.)

Third, because retail prices are much greater than those at higher market levels, the ability of enforcement directed at higher market levels to raise retail prices crucially depends on how price increases at one level are transmitted to lower levels. The additive model predicts that increasing high-level prices by $1/gram will increase the retail price by about $1/gram. The multiplicative model predicts that increasing high-level prices by 1 percent will increase the retail price by 1 percent (Caulkins 1990; Boyum 1992).

To illustrate why these two models have vastly different implications for the efficacy of interdiction, suppose the import and retail prices are initially X and 10X, respectively. Would a control program that drove the import price up to 2X significantly reduce consumption? According to the additive model, the retail price will rise by the same amount as the import price, so it will rise only from 10X to 11X—a modest increase.[13] According to the multiplicative model, if import prices double, retail prices will double, from 10X to 20X, a large enough increase to appreciably affect consumption.

Hence, a necessary condition for high-level enforcement to suppress consumption substantially by driving up retail prices in equilibrium is for the multiplicative model to hold. Caulkins (1990, 1994) and Boyum (1992) analyze historical price data that are more consistent with the multiplicative than the additive model, but they do not test the multiplicative model directly and their data are primarily from kilogram-level transactions and below. Near the origins of the distribution chain the multiplicative model does not seem plausible because there are considerable variations in coca leaf prices that are not paralleled (even with a lag) by retail prices. No analyses have been done for intermediate market levels (between export from Colombia and the kilogram level within the United States) because of insufficient data.

Fourth, examining the cost structure of the drug distribution industry suggests that only one-quarter to one-third of the economic (not just dollar) cost of distributing drugs is directly attributable to enforcement (Caulkins and Reuter 1998). This lends empirical support to Reuter's (1983) conjecture that there are substantial structural consequences to product illegality. That is, illegality plus a modicum of enforcement is sufficient to make prices much higher than they would be if legal. Additional increments in enforcement have smaller incremental effects on price. MacCoun and Reuter (forthcoming) also find evidence for this proposition of diminishing returns to increasing enforcement intensity in their review of historical and cross-cultural analogies to the drug problem in the United States.

Assessment of the very primitive state of quantitative assessments of effectiveness

The review in the previous section is sobering. When it comes to quantitative estimates of drug control interventions' ability to reduce drug use, much more is unknown than known, and much of what is known is predicated on models and theories that are plausible but not empirically validated. With respect to the other two ways interventions operate (displacing the problem and reducing the magnitude of the problem per unit of use), even less is known. It would be easy to look at this situation and conclude that quantitative assessment of drug control interventions is a quixotic undertaking that is best abandoned.

There are two strong arguments for viewing the inadequacy of past efforts as a challenge, not a warning. First, policy decisions will be made. The choice is to have them informed by partial analysis or no analysis, and flying blind is not appealing.

Second, there are other policy arenas in which quantitative assessments seemed impossible at first but which, over time, were refined to the point of being useful and widely employed. Benefit-cost textbooks point to dams and other water projects as classic examples of problems that are amenable to benefit-cost analysis, but before the first such analysis was done, the analysis certainly would have seemed anything but routine.

Perhaps medical interventions are a closer analogy. There now is a standard approach to doing cost-utility analysis (CUA) of medical interventions (see Kamlet 1992; Gold et al. 1996), but that is a recent development. Twenty years ago, it would have been hard to imagine that such analyses would be either possible or accepted.

The medical CUA example is also instructive because it was not clear at the outset what the measure of effectiveness should be. Possibilities included cost per life saved, cost per life-year saved, and measures of social value saved per dollar spent (i.e., benefit-cost ratios). All have merits, but a consensus has emerged around cost per quality-adjusted-life-year (QALY) saved.

Similarly, there are many possible goals of drug policy and, hence, many possible measures of effectiveness. Work to date has focused on consumption averted per $1 million spent, but that choice should be seen as a point of departure, not as the only possibility.

Emerging themes and gaps in the current literature

Over the past 10 years, significant understanding has accumulated concerning the effectiveness of drug control interventions. However, as Goethe observed, "Doubt grows with knowledge." We now know enough to know that there is a great deal we do not know. This section identifies four key areas that need further research.

(1) Interdrug effects

Polydrug use and "double-breasted selling" are common, and there are any number of reasons why interactions between drugs might modulate the effectiveness of drug control interventions. However, current understanding of these effects is rudimentary at best.

Perhaps the most basic question is whether different drugs are complements or substitutes. The classical notion of complements and substitutes pertains to cross-price-elasticities of demand.[14] That is, does increasing the price of one drug increase or decrease consumption of another? If increasing the price of one drug increases consumption of a second drug, the drugs are called substitutes; otherwise they are complements.

If one thinks of different drugs as being different ways to achieve an altered state of consciousness, one might expect them to be substitutes. Evidence from earlier studies seemed to support this view among at least some pairs of psychoactive substances. DiNardo and Lemieux (1992), Model (1993), and Thies and Register (1993) found evidence that marijuana and alcohol were substitutes. Thies and Register also found some evidence that marijuana and cocaine were substitutes but had inconsistent results with respect to alcohol and cocaine. However, all of the marijuana findings arise from variables reflecting marijuana's criminalized/decriminalized state, not its price.

More recent evidence suggests that drugs are at least as likely to be complements. Saffer and Chaloupka (1995, 1999) found this for various pairings of alcohol, cocaine, and marijuana, except for marijuana and alcohol. (Heroin results were inconclusive.) Chaloupka and Laixuthai (1997) and Pacula (1998b) confirmed this finding and extended it to include marijuana and alcohol. Pacula (1998a), Chaloupka et al. (1999), and Farrelly et al. (1999) found complementarity among beer, cigarettes, and marijuana. These studies just skim the surface, however, because of weaknesses in measures of both price (particularly for marijuana) and consumption (overreliance on past-month prevalence instead of actual rates of consumption).

As MacCoun, Reuter, and Schelling (1996) point out, use of one substance can increase demand for consumption of another substance through a variety of mechanisms, not all of which are pharmacological (cf. DeSimone 1998). For example, regular use of one substance may expose one to sellers of another substance or to a peer subculture that has pro-use attitudes. It may well be the case that drugs may be short-run substitutes, particularly for those who are already established polydrug users, and long-run complements, with complementary effects dominating when one focuses on initiation.

At any rate, understanding these linkages is of the utmost importance. As Rydell, Caulkins, and Everingham (1996) note, if drugs are substitutes, it would undercut the appeal of drug control efforts that operate by driving up prices. Driving up prices might reduce use of the drug in question, but if it leads to wholesale substitution into other drugs, then overall harm could go up or down depending on the amount of substitution and the relative dangers of the different substances.

Likewise, Kleiman (1992) argues that whether one thinks relaxing marijuana enforcement is a good or a bad idea depends in no small part on one's beliefs about how it would affect the use of other drugs. An optimist might hope that alcohol and marijuana were strong substitutes, so marijuana decriminalization might reduce alcohol use and its social costs, perhaps leading to a net reduction in drug-related harm.[15] A pessimist might fear that the historical correlation between the use of marijuana and other substances is causal. If so, then marijuana decriminalization might lead to substantial increases in the use of all drugs.

Interdrug effects are not confined to issues of demand. The size and nature of the market for one substance can influence the development of the market for another. There is a notion that marijuana growing in Appalachia has built on a tradition of moonshining that dates at least to the alcohol prohibition of the 1930s (Weisheit 1990). Likewise, some cocaine smugglers (e.g., Carlos Lehder) apparently got their start smuggling marijuana. The benign description of the relationship is that smuggling expertise developed with one product helped smugglers move other products. The pessimistic description is that when the United States stepped up interdiction efforts in the early 1980s, they were differentially effective against marijuana, which is bulkier and easier to detect than cocaine. Inasmuch as drug markets and drug market participants are known to adapt to variation in enforcement pressure, it is at least plausible that there was a causal connection between increased interdiction effort and the growth of cocaine smuggling.

If one analyzed each drug market in isolation, a result that increased enforcement caused increased trafficking would seem perverse. But if one recognizes the interactions across markets, it is a plausible story that can be told at various market levels. In 1973, the Knapp Commission exposed widespread police corruption in drug investigations (primarily heroin, at the time). The New York City Police Department responded by directing officers not to arrest street-level drug sellers (Kelling and Coles 1996). Over the next 10 years, New York City witnessed an explosion in street selling of cocaine and marijuana,[16] although the connection may or may not be causal.

Similar stories can be told with respect to prevention and treatment. In the 1960s, overreliance on fear-arousal tactics directed at marijuana may have undercut the credibility of government warnings concerning the dangers of other substances, including heroin. Cocaine abuse by methadone maintenance patients is a problem that is almost as old as methadone maintenance itself (Chambers, Taylor, and Moffett 1972). The optimistic interpretation is that this merely reflects preexisting patterns of use. The pessimistic interpretation is that some individuals respond to methadone maintenance by switching from heroin use to cocaine use, with no net reduction in the aggregate use of expensive drugs.

It is easy to generate examples of the effectiveness of policy interventions dependent on interdrug effects. They all have the same character. It is plausible that the program is beneficial, and it is plausible that the program has no or greatly reduced effects. Which is correct depends on interdrug effects, and sufficient empirical evidence to be confident of which story is more accurate simply does not exist. Clearly, interdrug effects are a worthy topic for further research, both in the narrow sense of estimating cross-elasticities of demand and in the more general sense of improving understanding of how drug markets and control programs directed at one market interact with those of other drugs.

(2) Variation in drug control policy over time[17]

Musto (1999) notes that historically there have been alternating periods of greater and lesser drug use. In particular, a cycle of quiescence, rapid escalation, plateau, and gradual decline has been observed for a number of drugs including crack (Golub and Johnson 1997). These cycles are often referred to as drug "epidemics," and the epidemic metaphor is appropriate because the rapid escalation involves "contagious transmission" of drug use from one person to another.

Because drug problems evolve over time, it seems plausible that drug control policy should as well. However, it is rare to hear someone say we should follow one policy or another now because it would be particularly effective at this

point in the epidemic or to argue that a policy once was effective but now should be scaled back. Instead, most such opinions are voiced without explicit qualification about the times for which the policy is sensible.

Initial efforts to enrich understanding on this dimension have taken the form of rather abstract modeling exercises. One thread in the literature has emphasized interventions with local street markets. Based on a variety of empirical reports (e.g., Kleiman 1988), Caulkins (1990, 1993) developed a dynamic model that describes how a local drug market might respond to intensive enforcement operations. The model generates suggestions for how such crackdowns should be managed, but the model itself is purely descriptive. Baveja et al. (1993, 1997), Naik and colleagues (1996), and Kort et al. (1998) extended it by adopting a prescriptive approach. The general finding is that the simple strategy of either accommodating a market or using the maximum available enforcement until the market has collapsed is optimal in most instances. However, this line of research considers only a single type of drug control—namely local crackdowns—and its effects on a specific local market.

A second, distinct thread has sought to address what might be called strategic policy questions from a national perspective. These questions include determining the best division of resources among competing drug control programs (such as prevention, treatment, and various types of enforcement) and whether enforcement should be directed at users or sellers.

Again the early work was primarily descriptive, addressing effectiveness indirectly (Schlenger 1973; Levin, Roberts, and Hirsch 1975; Gardiner and Shreckengost 1987; Homer 1993). The first explicit efforts to develop prescriptive models were made by Rydell (1997) and a group of researchers at Austria's Vienna University of Technology (e.g., Dawid and Feichtinger, 1996; Gragnani, Rinaldi, and Feichtinger 1997).

The image of a mature market is one in which the density of market participants is great enough to support "professional" transactions. In contrast, in a social network market, most sales are transacted between individuals who have reasons for contact other than consummating the transaction. For example, the seller and buyer may be friends, coworkers, neighbors, or schoolmates who share the same routine activities. Street markets in which buyers and sellers may not even know each other are clearly mature markets.

Tragler, Caulkins, and Feichtinger (forthcoming) consider an intertemporal decision model where the government wants to minimize the sum of social costs caused by drug use and expenditures on two controls: price-raising enforcement against dealers and treatment. According to this model, it is usually best to rely primarily on enforcement at first in order to keep prices high and suppress initiation. Enforcement spending should increase as the number of users grows, but not nearly as fast in percentage terms as treatment spending. Hence, treatment should receive a larger share of control resources when a drug problem is mature than when it is first growing.

Behrens et al. (1999, forthcoming) is a complementary effort that focuses on prevention and treatment. They extend Everingham and Rydell's (1994) model of cocaine use to make initiation increasing in the number of light users and decreasing in the number of heavy users. The insights suggested by this model include:

- Prevention is most appropriate when there are relatively few heavy users, e.g. in the beginning of an epidemic. Treatment is more effective later.
- The transition period when it is optimal to use both prevention and treatment is very brief.
- Total social costs increase dramatically if control is delayed.

These studies are just initial efforts. In some, certain controls are not treated, and all of them use crude aggregations that disguise prevailing heterogeneities. Hence, these modeling efforts need to be refined and extended, and they need to be complemented by both more empirical and more qualitative studies.

(3) Detection and control of an emerging market

One finding of the foregoing modeling is that detecting the onset of a drug epidemic quickly is valuable. This stresses the importance of having a good understanding of the early stages of drug epidemics. Likewise, the European Monitoring Centre for Drugs and Drug-Addiction (EMCDDA) has identified that a better understanding of initiation into drug use is one of its priority questions. However, little is known about how to describe and analyze the initiation of a drug epidemic compared with what is known about how to analyze mature markets of illicit drugs. The lack of understanding is easy to explain. Mature markets (such as the cocaine market in the United States) are easier to observe and study than are markets that are embedded in social networks (such as the cocaine market in some European cities and MDMA [Ecstasy] markets in the United States). Likewise, aggregate models in which market participants are

not individually distinguished are easier to analyze than models that explicitly recognize the structure of social networks. These models are just beginning to be applied to drug distribution (cf. Carley 1990 and Zeggelink 1995).

The image of a mature market is one in which the density of market participants (both sellers and buyers) is great enough to support "professional" transactions. In contrast, in a social network market, most sales are transacted between individuals who have reasons for contact other than consummating the transaction. For example, the seller and buyer may be friends, coworkers, neighbors, or schoolmates who share the same routine activities. Street markets in which buyers and sellers may not even know each other are clearly mature markets. So are typical crack house and beeper sales.

The term mature reflects a hypothesis that drug use initially spreads within social networks and only emerges into professional markets when the market reaches some critical size.[18] It is an empirical question whether the majority of drug epidemics is characterized by a transition from a social network to a mature market. What is beyond question, though, is that we have very limited capacity to predict epidemics early enough to take action to prevent the rapid spread of use during the infectious stage of the epidemic. For example, the United States fully appreciated that cocaine was a severe problem around 1984, but by then, initiation had already grown from an average of 40,000 per year in the mid-1960s to an average of 1.4 million per year in the 6 years preceding 1984 (Johnson et al. 1996). Likewise, we know little about how the effectiveness of different interventions depends on the character of the market. It seems plausible that efforts to drive up search time would be more effective in the early stages of market development, but this remains a conjecture.

(4) Interaction with other policy areas

Drug policy is often construed as being either self-contained or a subset of crime control policy. An alternative view is that drug policy should be a subset of medical or public health policy. It is not clear that any of these is accurate inasmuch as they underappreciate the extent to which drug policy affects outcomes in other policy areas and, conversely, policies and outcomes in other areas affect drug-related problems (Boyum and Reuter, forthcoming).

Perhaps the most concrete example comes from prevention. There is a literature on drug prevention, but it recognizes that programs designed or funded to prevent one type of delinquent behavior often affect an array of such behaviors (Karoly et al. 1998), including violence, gang participation, teen pregnancy, and dropping out of school.

As another example, drug enforcement has civil rights implications, the implicit if not explicit use of profiling being just one concern. Racial disproportionality in incarceration is most severe for drug offenses (Blumstein 1993) and the rapid expansion in incarceration for drug offenses has played an important role in the expansion in incarceration generally, particularly for minorities. This expansion has implications for everything from labor force participation to voting rates to demographic outcomes, including family structure.

Likewise, source and transit zone interdiction activities interact with foreign policy. The interaction with efforts to counter insurgencies and build democratic institutions has long been recognized. (See, for example, Steinitz 1985, Garcia Arganaras 1997.) Historically, the lament was that drug control objectives were subordinated to other foreign policy objectives (a notorious example being the Air America operations in Southeast Asia). More recently, the tables have been turned. For example, the certification process created by the Anti-Drug Abuse Act of 1986 requires the administration to identify foreign countries as cooperating or not in drug control. Although the sanction provisions have rarely had a direct effect on U.S. foreign assistance, the entire process clearly has implications (largely negative) for U.S. foreign relations (Falco 1995; Drug Strategies 1998).

Conversely, phenomena outside drug policy can affect drug use and drug control efforts. For example, the movement toward managed care and the growth in the population with no health insurance has affected financing for drug treatment. Likewise, Stares (1996) argues that globalization of commerce and transportation have substantially enhanced smugglers' ability to deliver drugs, the North American Free Trade Agreement being a particularly relevant example for the United States. The spread of HIV among IDUs has affected drug use (Caulkins and Kaplan 1991), and (especially outside the United States) HIV/AIDS policy has affected drug policy.

Among the most complicated intersections of drug and social policy are questions of actions the government does or does not take to help the more vulnerable individuals in our society. Parental substance abuse is involved in a large proportion of cases of child abuse and neglect. Very often, alcohol is involved, but often, illicit substances are involved as well. Impulses toward zero-tolerance and family preservation are not the only things that conflict in such complicated situations.

The question of providing income support to substance users, particularly the substance dependent, is another example. This issue came to the fore when the number of Supplemental Security Income (SSI) recipients qualifying because of drug addiction or alcoholism (DA&A) grew sharply in the early 1990s.[19] On

the one hand, addiction is clearly a condition that can restrict income, and SSI is specifically intended to provide income to the needy and disabled. On the other hand, there were reports that taxpayer money was being wasted on drug purchases (Wright 1995) and evidence this use was manifesting in adverse health outcomes (Shaner et al. 1995; Satel 1995; Satel et al. 1997). As an added complication, at least in theory, providing income support to addicts might reduce economic-compulsive crime even if it increased their use, and the bits of available evidence Reuter and MacCoun (1996) review are consistent with that hypothesis.

It is not hard to develop a list of interactions between drug use and drug policy and outcomes and policies in other domains that are of first- not second-order importance. Yet there is only the most limited capacity to quantify these interactions. To develop coherent and effective policy, more than a mere laundry list of potential issues is necessary.

Conclusions

When it comes to measuring and analyzing the extent of drug problems and the effectiveness of drug control efforts, there is an abundance of numbers, but the glass of insight is at best half full. The gaps in insight are understandable; it is difficult to study covert activities. But some of the gaps can be closed. Four encouraging trends discussed here are the expansion of traditional data systems, improved modeling of drug prices and drug markets, better integration of data systems, and improvements in data systems in other countries.

Analysts do not need to wait, however, until all possible information is available before beginning to assess the effectiveness and cost-effectiveness of drug control interventions. Indeed they cannot; those determined to wait for perfect information are determined to be irrelevant.

Pioneering work has begun to evaluate a variety of interventions' ability to control drug use. Much needs to be done to refine these estimates. Yet some of the most interesting, emerging questions pertain to complex interactions across borders, across policy domains, between substances, and over time. The cutting edge of research needs not only to refine existing estimates and improve precision but also to identify new perspectives and link previously self-contained analyses.

This has implications for data collection and analysis. There will be a premium on integrating databases, innovative one-time studies, and collecting evidence that directly informs decisions, not merely monitoring the size of the problem. In short, existing monitoring systems need to be complemented by analysis that

turns them into decision support systems in order to have the greatest and most beneficial impact on policy.

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Notes

1. The DAWN recording manual lists four criteria for determining whether an ER episode is drug related (U.S. Department of Health and Human Services, National Institute on Drug Abuse 1992): (1) The patient must be treated in the hospital's emergency department. (2) The patient's presenting problem(s) must be induced by or related to drug abuse. (3) The case must involve the nonmedical use of a legal drug or any use of an illegal drug. (4) The reason for taking the substance was for psychic effects, dependence, or a suicide attempt or gesture.

2. For example, in earlier analysis (Caulkins 1994, 47–49), I found that on the order of 1–2 percent of STRIDE's price observations were implausible. The most egregious included payments of one-tenth of 1 cent for 23 grams of 84-percent pure cocaine (San Diego, December 12, 1987) and $6,800 for 1 milligram of cocaine (Albany, February 2, 1987).

3. This is, of course, not proof of measurement error. It may be that DAWN's definition of "drug related" excluded every instance in which a patient had cocaine in his or her system. If so, however, it would suggest that gross differences between DAWN counts and the number of cocaine users seeking emergency medical treatment are systemic and not merely confined to facilities with unusual reporting practices.

4. I owe this point to Mark Kleiman.

5. For a dissenting opinion on the importance of these numbers, see Reuter (1999).

6. For example, annual prevalence of cocaine use fell during the 1980s even as the prevalence of heavy use grew (Everingham and Rydell 1994).

7. Consider an addict who consumes 120 (pure) grams of cocaine per year. If the average social cost per gram of cocaine consumed is $100, then a 3-month interruption in that career might be worth on the order of $3,000 to society. That is more than the average admission to treatment costs (Rydell and Everingham 1994).

8. Consider a light user who spends $20 per week on cocaine. That is roughly $1,000 per year. At $100 per (pure) gram, that is the equivalent of consuming 10 (pure) grams a year. If the light user in question would not have persisted in use for more than 3 years, then

completely eliminating that subsequent career of use would avert less consumption that would imposing a 3-month interruption on a typical heavy user who consumes at a rate of 120 pure grams per year.

9. The interruption is meaningless if one views being addicted as determined by an accumulated history of use, not current intoxication. That is, if people who are in recovery are still addicted, then an addict who has been abstinent for 3 months is in that sense still addicted.

10. The cost per unit of consumption and length of the residual career of heavy use in this example are more representative of cocaine and heroin than of marijuana.

11. Furthermore, Rydell and Everingham's analysis did not consider the possibility that such an expansion in treatment might have an adverse feedback effect on initiation (cf. Behrens et al. forthcoming). On the other hand, two-thirds of the exits from heavy use took the form of deescalation to light use.

12. Widespread availability of a substitute such as methadone is probably the only other program that can make a comparable claim concerning heroin.

13. An increase to 11X is implied by a very literal interpretation of the additive model. Those who have employed the spirit of the additive model in the past (e.g., Reuter and Kleiman 1986) have recognized that the increase would likely be slightly greater because there are additional inventory carrying costs incurred by those who purchase the more expensive drugs for resale.

14. Rosalie Pacula contributed substantially to this section.

15. Harwood, Fountain, and Livermore (1998) estimate that the social costs associated with alcohol substantially exceed those associated with all illicit drugs combined, let alone marijuana by itself.

16. I owe this observation to Bruce Johnson.

17. This section draws heavily on joint work of Gustav Feichtinger, Doris Behrens, Gernot Tragler, and others at the Vienna University of Technology in Austria.

18. Number and value of transactions may be more relevant measures of size than the number of users, given the nature of marijuana markets.

19. Reuter and MacCoun (1996) cite an increase from 20,000 in 1990 to 80,000 in 1994, or 250,000 if one includes those with DA&A as a secondary diagnosis.

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