Purity, price and production: Are drug markets different?

Peter Reuter[1]
Jonathan Caulkins[2]

Introduction

Markets for drugs, prostitution and other prohibited goods and services are just that… markets. The first duty of economists is to show that the tools of conventional economics are applicable for the illegal markets as well. That is easily enough done with respect to demand. Many studies have shown that demand for illicit drugs is downward sloping and has a price elasticity not so different from that for other dependence creating substances (Grossman, 2004). The erroneous belief that drug addicts cannot cut their consumption was once very widely held, so this is no small achievement. Less has been done on the supply side; e.g. there are almost no empirical studies of supply elasticity. Nevertheless, it is clear that drug selling operations can be analyzed as business activities (e.g., Reuter et al., 1990) , and insights obtained from applying economic reasoning to those businesses finances (Levitt and Venkatesh, 2000); for a review, see Caulkins and Nicosia (2010).

There is though a second task that is not so frequently tackled, namely analyzing the distinctive features of illegal drug markets. What are the consequences for the operation of a market of the conversion of the state from an institution aimed at facilitating, or at least not hindering, markets to one that is actively hostile to those markets? How does that affect efficiency, structure, conduct and behavior? How much does the conventional economic framework need to be adapted?

Some differences are obvious and readily explained. For example, retail drug transactions are usually made in round dollar figures ($10, $20), whereas legal prices usually end in nines ($9.99 or $19.99). Standardized purchase units, which have been observed in many countries and over four decades (Wendel and Curtis, 2000), arise because drug sales are often clandestine and hurried to reduce enforcement risks; even

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the act of making change is a luxury that persons seeking to avoid detection cannot afford.

Other empirical regularities are more consequential and more difficult to explain. This paper contributes to the second task, understanding drug markets' distinctive characteristics, by considering a variety of puzzles, observations that are, on their face, counter-intuitive to an economist: Initially we offer four categories:

1. Purity: Heroin regularly travels in large shipments that are substantially impure, even though that increases the risks and costs of smuggling per pure gram of heroin.
2. (Purity-adjusted) price. Within individual markets there is a strong negative correlation between average purity and purity-adjusted price, even though the principal driver of purity adjusted price is enforcement risk; higher enforcement risk should increase the incentives for more compact (i.e. higher purity) cocaine or heroin.
3. Price response to government intervention. The massive increase in enforcement intensity against sellers in the United States has been accompanied by a large and continued decline in the price of both cocaine and heroin.
4. Production. Production of cocaine and heroin is highly concentrated in a small number of countries that represent encompass only a small portion of the arable land suitable for growing those crops.

The paper begins by motivating an interest in the markets for illegal drugs, specifically identifying characteristics of the markets themselves that lead to policy interventions. It then sets out a simple conceptual framework that has been used to explain equilibrium in markets for illegal drugs, emphasizing those features that differ from the model for legal commodities. The third section lists a set of empirical oddities that the standard market model seems to handle poorly. Section four then offers some conjectures that might help account for the puzzles. The final section offers observations about research on drug markets.

Motivation

The markets for illegal drugs constitute an important criminal, economic and social phenomenon, in the United States and around the globe. Collectively these markets were estimated to generate $60 billion in U.S. retail sales in 2000 (and twice that in 1990) (ONDCP, 2001). Globally, the figure may be $150 billion.[3] Drug markets matter both because they generate large criminal earnings and harms as a consequence of their operation (e.g. diverting youth from education, creating disorder and crime around market places) and also because they provide dangerous substances whose use generates violent crime, at least when the drug is a stimulant. According to surveys of arrestees in the United States about half of all arrestees have recently used drugs other than marijuana (National Institute of Justice, 2003; Office of National Drug Control Policy, 2009); the figures for England and Wales and for Australia are not much lower (e.g. Bennett and Sibbit, 2000). In other historical periods illegal gambling and bootlegging of prohibited alcohol have been large and troubling markets in the United States, but the available evidence suggests that illegal drugs are much the largest illegal market now in the U.S. and probably in a number of other Western countries.

Moreover, governments make a large investment of both money and authority in suppressing drug markets. Drug control is probably a $40 billion annual effort in the United States (Walsh, 2005). Reuter and Stevens (2007) estimate UK government expenditures of about $6 billion in 2005; on a per capita basis that is surprisingly close to the U.S. figure though methodological and institutional differences are such that not too much should be made of that. In all countries for which budget estimates have been made, most of the money goes to law enforcement; even in the harm-reduction oriented Netherlands that turns out to be the case (Rigter, 2006).

On any given day in 2005, approximately 500,000 persons were incarcerated in jails and prisons in the United States because of violations of drug prohibitions; the vast

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[3] The UN Office on Drugs and Crime estimates a total of almost $322 billion in retail sales; $94 billion in wholesale revenues; and $13 billion in producer sales (UNODC, 2005: 127). This is likely an overestimate, particularly of the marijuana revenues and of the share going to wholesalers. A more recent and better documented study estimated that the global marijuana market at the retail level was probably only half as large as the figure estimated by the UNODC; it did not attempt a global estimate for cocaine and heroin but for the countries it did consider the figures were generally lower than the UNODC estimates (Kilmer and Pacula, 2009)

majority were involved in drug distribution, although not infrequently in minor roles (Caulkins and Chandler, 2005). Of course the U.S. stands out for its incarceration rates generally, so one hardly expects to find similar figures for drug incarceration for any other nation but again in Britain there has been a sharp increase in drug incarcerations both relatively and absolutely. The number receiving prison sentences for drug offenses rose by nearly 150% between 1993 and 1999, before slightly declining over the next five years; the increases for drugs were much higher than for all other offenses taken together (de Silva, 2005a. 2005b). Beyond being important in its own right, this effort competes with more traditional crime fighting efforts for criminal justice resources (Kuziemko and Levitt 2004; Rasmussen and Benson, 1994).

The price and conditions under which drugs are sold have important criminal consequences. If heroin were to cost $1 a dose rather than $25, the effects on society would be very different because there might be many more users and certainly much less crime (MacCoun and Reuter, 2001). Not only would the lower prices reduce the needs of dependent users to commit crimes to fund their purchases, but it would also reduce the incentives of sellers to compete violently or to resolve conflicts about transactions through violence. Current prices of illegal drugs are many times higher than would be the corresponding price in legal markets (Moore, 1990; Kilmer et al., 2010). High prices are not simply an automatic consequence of illegality; for example, illegal bookmakers charge roughly the same for their services as do their legal counterparts (Strumpf, 2003).

Similarly, it is important to understand the distribution of earnings in the drug trades: Drug markets would generate much smaller problems if the unskilled manager of a heroin distribution gang earned what the manager of a McDonalds earns. Instead, many senior drug dealers earn as much as a successful lawyer, without the necessity of law school; some, mostly in producer and transshipment countries, earn large fortunes. Any good account of drug markets should explain the very uneven distribution of earnings in the trade.

Finally, it is important to understand how drug markets respond to various kinds of interventions. For example, how will an increased risk of incarceration or more restrictive access to specific inputs (e.g., precursor chemicals for drugs such as

methamphetamines) affect prices, the size of the market and the distribution of returns across groups of participants?

Risks and Prices

Caulkins and MacCoun (2003, p.436) give a good summary of the Reuter and Kleiman (1986) "risks and prices" model of price determination in markets for illegal drugs that has been used in many studies since, particularly studies associated with the RAND Corporation (e.g. Rydell and Everingham, 1994).

- "People sell drugs primarily to make money, not for pathological or ideological reasons.
- There are few barriers to entry because (a) few specialized skills and little capital are needed to be a drug supplier and (b) the domestic distribution "industry" is fragmented, so it is not generally in the interest of individual incumbent supplier organizations to take costly action to prevent others from entering the market[4].
- Hence, people enter the drug distribution business until the returns from doing so are bid down to a level comparable to that derived from other activities, i.e. to the opportunity cost of being a dealer.
- The economic return from dealing is the monetary or accounting profit minus the dollar value of non-monetary risks and costs incurred.
- Conventional costs of production are too small to explain or drive prices."

The risks and prices model identifies two separate sources of risks for participants, the government (arrest, incarceration, seizure of assets and drugs) and other participants (injury or robbery of drugs or money). The conventional market model deals only with the first. In many Western countries the risk of being incarcerated (on an

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[4] We do not take up here the circumstances under which market power becomes possible. Reuter (1983) suggests that corrupt enforcement agencies with a sole franchise may provide a unique opportunity for some form of monopoly in illegal markets.

annual basis) is substantial enough that it is plausible that compensation for those risks is a substantial cost.[5]

Violence seems to us a neglected and critical factor in explaining many aspects of drug markets. In a set of calculations using data from 1988, when drug market violence in the United States was probably near its peak, Caulkins and Reuter (1998) estimated that compensation for physical risks (serious injury or death) accounted for about 40 percent of total costs of delivering cocaine to final users.

For many final market countries outside the United States the second set of risks may be moderate. However violence is not unknown there and can be much greater in certain source and transshipment countries. The enormous increase in drug-related homicides in Mexico, now perhaps close to 30,000 for the period October 2006 to October 2010, is a vivid reminder of how violent such a market can be.Recent data from interviews with incarcerated drug dealers in British prisons (Matrix Consulting, 2007) suggest that few have experienced actual violence in the course of their drug dealing careers, nonetheless, many had carried guns and perceived violence as potentially important in the business. In this respect their careers parallel those of most police officers, who never draw the gun they always carry.[6] Even countries with low homicide rates, such as Australia and Canada have seen outbreaks of drug related violence, often involving biker gangs.

Risks and prices has been extended to dynamic versions (Caulkins and Reuter, in press), though the stories there are more complex. In any of these versions, it is very classical in its assumptions about rationality of the actors.

Some puzzles

Purity Puzzles

Purity is the central driver of product quality for illegal drugs. In legal markets product quality is a minor strategic choice, representing judgments of producers about consumer preferences; frequently a variety of qualities exist in the marketplace, and usually quality

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[5] Illegal drugs increase in value within the U.S. by roughly $50B per year ($60B retail minus roughly $10B in import costs). If the 500,000 people incarcerated for drug law violations demanded an average of $40,000 per year of incarceration, that risk compensation would account for 40% of that $50B mark up.
[6] We thank Martin Bouchard for this observation.

information is transmitted accurately and credibly to the purchaser, who makes an informed choice.[7]   This holds even for the dilutable legal intoxicant alcohol; the alcohol content of beer and whiskey differ, but the alcohol content of different cans of the same beer are essentially identical. The government may even regulate purity ("proof") as for example in the many nations where 60% alcohol content is the legal maximum.

That is not the case for illegal drugs. Though they are natural products, subject only to simple refining, these drugs are "experience goods." Cocaine and heroin labs do not adhere to rigorous quality control standards, and the drugs are further diluted as they move through the distribution system. At the time of purchase the retail customer can assess only imperfectly the quantity being purchased and has even less information about its chemical composition including its purity and hence its psychoactive effect. Imperfect knowledge of quantity stems simply from the drug's extreme potency and hence the tiny quantities involved in retail transactions.

Not only is purity not known at the time of purchase, it also may not even be determined accurately after consumption. Some adulterants mimic the drug's physical effects (e.g., numbing), and the user may have only a general notion of how much of the drug he or she actually consumed, since there is variability in response to the drug, depending on, *inter alia*, health status, concomitant use of other intoxicants, time since last ingestion, and "set and setting" or expectation and context (Zinberg, 1984). The user will make an assessment of the quality of the experience, but without certainty. Consumers are thus vulnerable to strategic manipulation by sellers,[8] who can reduce purity by adding diluents and/or adulterants.

These observations characterize retail transactions. At wholesale levels transactions are more likely to take place in protected settings, so there is in principle more opportunity) and more incentive (because of the high dollar value of the transaction) to conduct systematic testing of purity. However it is apparently not difficult

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[7] Even the classic exception to this rule, used cars, has eroded since Akerlof's classic 1970 paper, with statutory warranties in the EU and the Magnuson-Moss warranty act in the U.S., dealer warranties, and ubiquitous vehicle history checks.

[8] "What exactly is in street heroin, how pure it is and what the effects of different cuts are is the subject of much discussion on the street….Assays of street-level heroin in New York City found that among a sample of 40 bags, at least 27 types of adulterants and cuts had been added to produce heroin…" (Wendel and Curtis 2000; citing Strategic Intelligence Section 1996).

to sell bundles of varying purity. Colorimetric assays are readily available, but accurate testing would require a Mass Spectrometer, the purchase of which is not only expensive but also would create substantial risk of disclosure. Testing often appears to be no more sophisticated than having a "taster" snort some to see if the experience is good; that is likely to detect rip-offs, that is bundles of very low purity.[9]

Galenianos, Pacula and Persico (2008) present a model that attempts to explain how a market establishes positive equilibrium purity in face of such uncertainty. That is an important advance in the literature but still leaves us without a theory of what determines purity levels. A particular conundrum is why the purity of international wholesale heroin shipments is so low.

The risk of seizure and apprehension is a decreasing function of purity of the drug; the purer the drug, the smaller the volume and the easier to conceal. Prohibition may affect purity (more correctly potency) in a more fundamental way; it is often claimed that the shift in Pakistan and Thailand from opium to heroin is a function of the Western-inspired implementation of effective prohibition which made the more compact and concealable heroin preferred over traditional opium.

The role of purity is particularly important for large shipments. It is substantially easier to conceal 2 kilos of heroin than 4 kilos, most obviously for "body packers" who swallow the drugs in condoms. Higher purity can lower costs in more subtle ways as well. For example bribes are paid on a raw kilogram basis, not purity adjusted. The corrupt airport official will charge $5,000 per kilo, regardless of whether the kilogram is 50% or 90% pure, if only because the official has no method of testing for purity. Small plane pilots also charge on a weight basis, not value or purity.

How then can one account for the following data from Turkey on the purity of large seizures (Figure 1). Not only does the average never rise much above 50 percent even for seizures of over 10 kilograms (with a value of $100, 000 at that point in the distribution chain) but fewer than 10 percent of the seizures had a purity of 70%. The seizures certainly are not a random sample of shipments and higher purity shipments

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[9] The film *Traffic* portrayed this. Fuentes, having researched Colombian cocaine import organizations in the U.S. (Fuentes 1998) reports not having heard of any systematic testing (personal communication); refunds and replacements were available for bad shipments.

have a lower risk of seizure. However many seizures are related to investigations of individuals rather than generated by border inspections of cargo, so that bias may be slight.
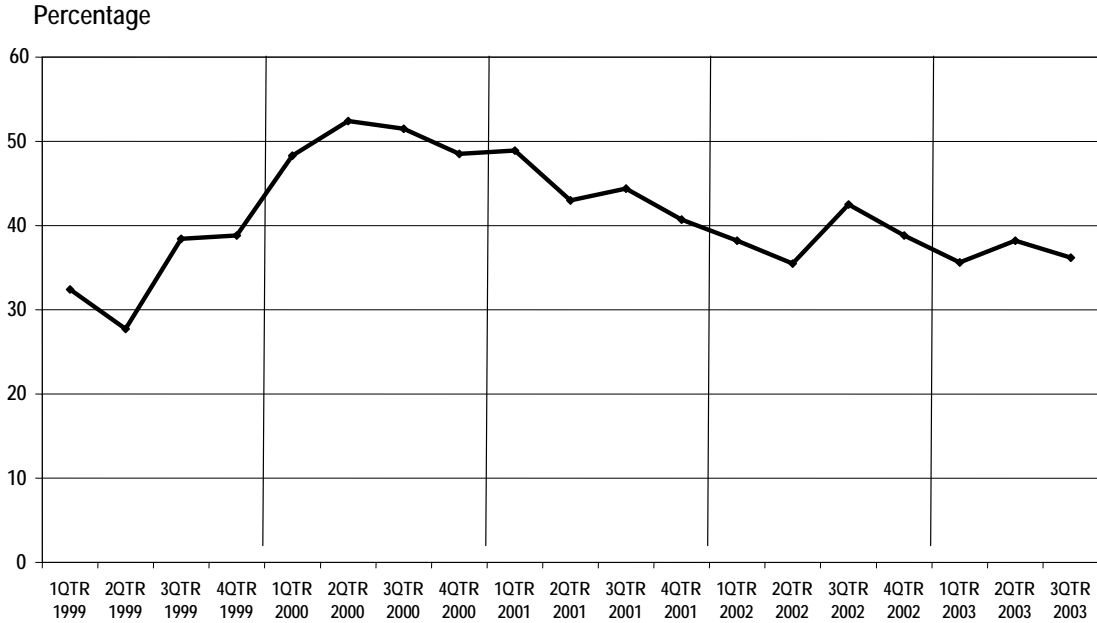
Percentage

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Figure 1: Purity of heroin seizures in Turkey, 1999-2003

Purity data from final market countries in Europe reinforce the puzzle. Figure 2 shows purity of heroin seizures in Germany in 2002. Even for seizures greater than 100 grams, worth many thousands of dollars, the majority are of low purity. Indeed, only 41 percent are more than 20 percent pure. We have observed similarly low purity in other European nations.
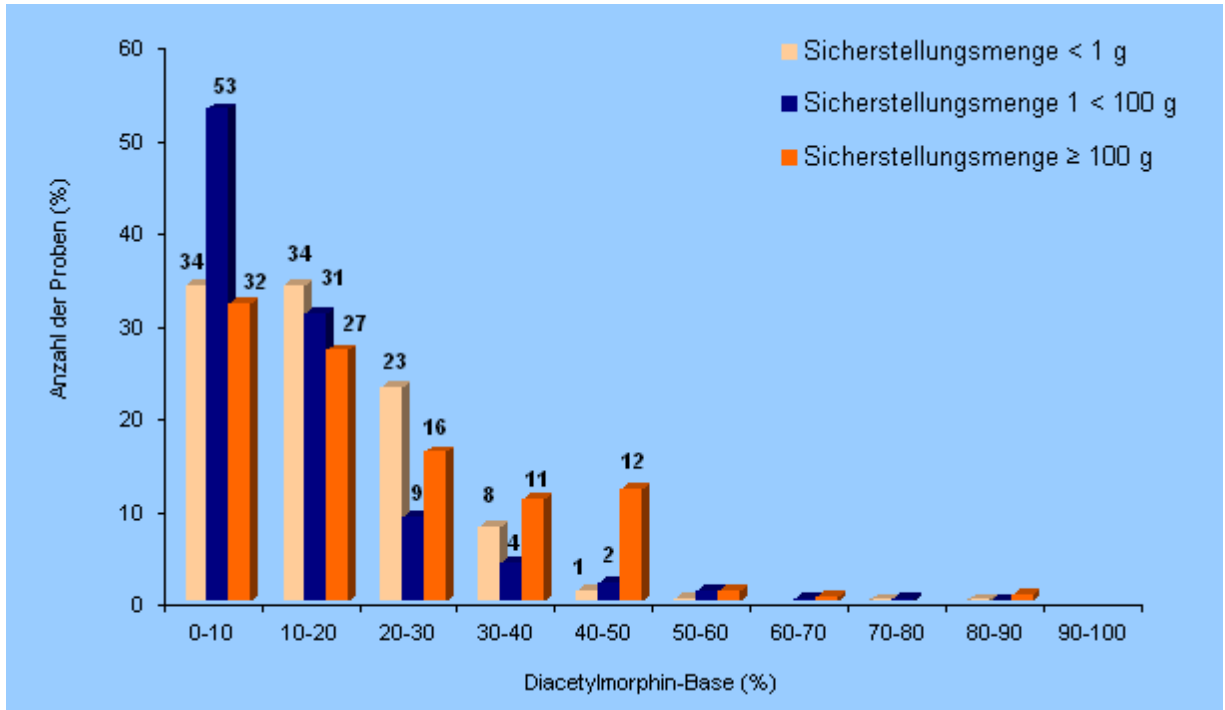
Figure 2. Purity of Heroin Seizures in Germany, by size, 2002

There are purity puzzles not only vertically, up and down the distribution chain, but also horizontally, between cities that occupy parallel positions in the distribution chain. In particular, why should there be such great variation across markets in their average purity at any one time. Figure 3, from Caulkins et al. (2004) shows that not only has purity varied for a given city over time but that there are persistent differences across cities. Perhaps not surprisingly, New York (as the largest single heroin market) has consistently the highest purity. That Chicago is often the lowest purity city is surprising, given that it is the second largest of these cities and one with a very active heroin market.
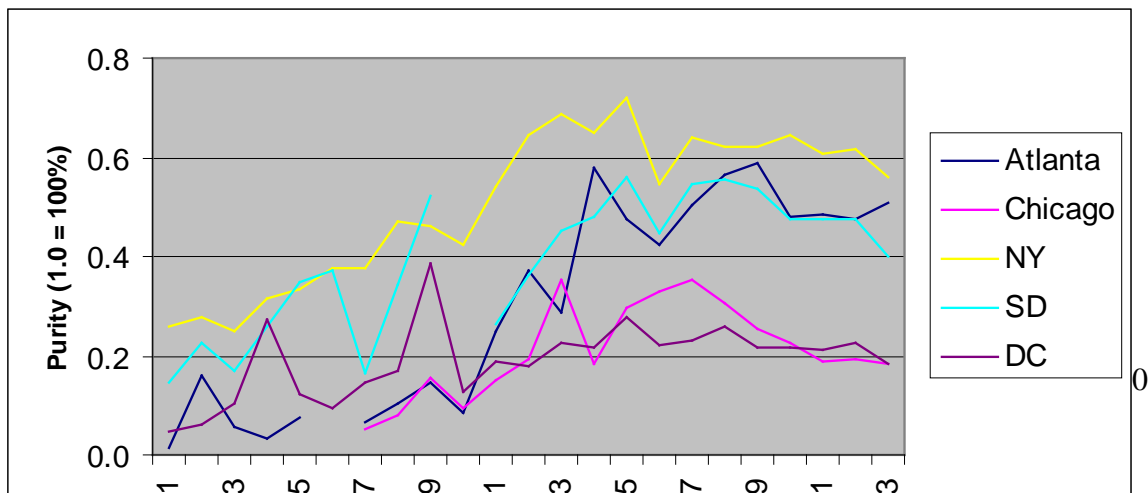
Figure 3. Heroin Purity in 5 U.S. Cities, 1981-2003

There are also large differences reported across countries. In 2001 the German police report an average of 18.5 percent versus a U.K. average of 54 percent. These differences persist over time. It is puzzling that the markets equilibrate at such different levels and points to the need for a theory of purity determination. As Mark Kleiman has oft noted, low expected purity exposes the user to greater risk of fatal overdose; if a user expects 50% purity, at most he might be exposed to twice the anticipated dose. With 20%, the actual dose could be 5 times as high.

The negative relationship between purity and price per pure gram
Average purity and purity adjusted price in a market have a reliable and strong negative correlation. Figure 4, taken from Caulkins et al. (2004) on methamphetamine (retail transactions of less than 10 grams bulk, estimated at 2.5 grams) is chosen from the many available instances because it includes many reversals in prices and is not, as with cocaine or heroin, a tale of almost uniformly declining price.
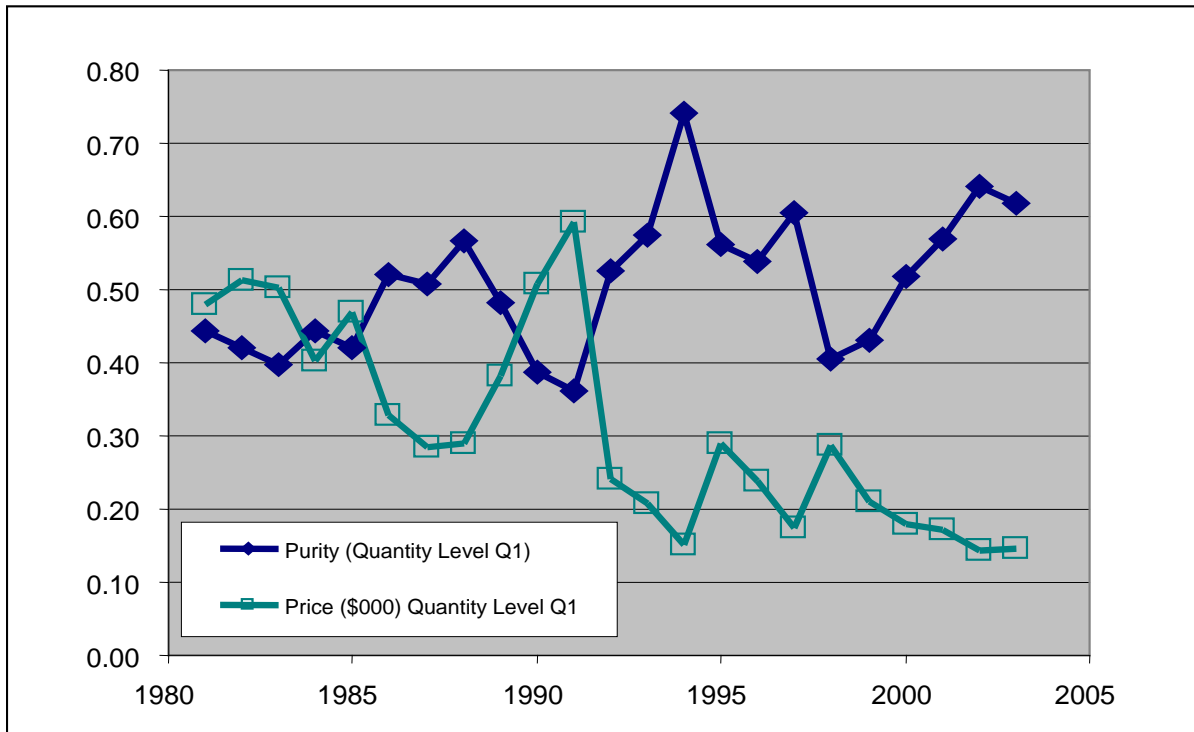
Figure 4. U.S. Methamphetamine Price and Purity

The puzzle here is more subtle. Initially it seems not a puzzle at all but a mathematical tautology. Purity-adjusted prices and purity could be inversely related because shrinking the denominator of a ratio, while holding the numerator constant, makes the ratio larger. However, the inverse relationship exists not just observation to observation, because of random noise, but in expectation across hundreds of observations in each time period. And if one wanted to reduce the pure quantity contained in a $100 bag, why not reduce the weight of drugs in the bag rather than the purity?

The negative relationship can also exist across substances. In the U.S. heroin typically triggers the toughest sanctions, so it is not surprising that it is more expensive, per pure gram, than cocaine, but it is surprising that it is diluted more extensively. As drug selling becomes riskier, either because of longer sentences or higher risk of apprehension, a simple maximization model would predict not only a higher price per

pure gram (shift in supply curve) but also a rise in purity. That latter change reduces the risk associated with a given quantity of the drug; the higher the purity, the lower the quantity of white powder to deliver a given amount of the desired ingredient.

The puzzle is deepened by sentencing practices. In theory one could justify a sentencing structure that worked in terms of the pure drug content, since the harm caused is not a function of the gross weight of white powder but by the amount of active ingredient. However we know of no jurisdiction that follows that procedure; all work in terms of the gross weight of what is sold. Hence there is heightened advantage in selling purer drugs.

Price Puzzles

When monitoring drug market prices one needs to adjust for purity. Purity-adjusted prices can explain very well variation in use-related indicators, such as ambulance call-outs, even when "raw" prices, not adjusted for purity do not (e.g., Moore et al., 2005). A consequence of the buyer's uncertainty about purity is that measurement of purity adjusted drug prices (either by police or researchers) becomes technically difficult, but the methods for dealing with this are by now well established (Caulkins, 2007).

The best known price puzzle concerns U.S. price and enforcement trends. Between 1980 and 2005, there was a massive increase in drug-related incarceration in the United States, aimed at making drugs more expensive and harder to get. The purity-adjusted prices of cocaine and heroin, the principal drugs targeted, fell steadily and substantially throughout this period, while availability has remained high.
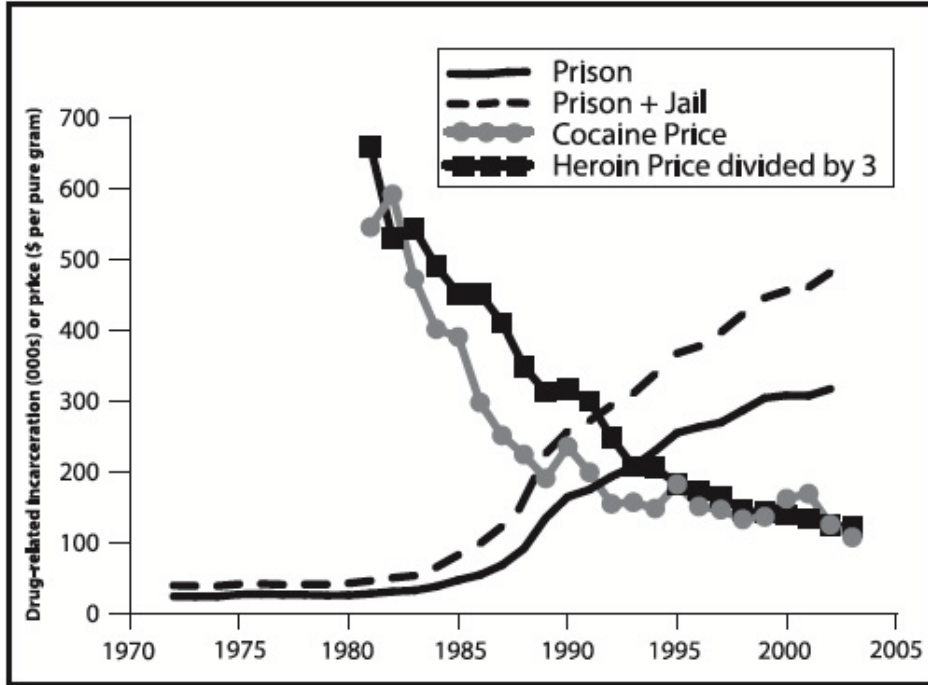
Figure 5. Drug Prices and Total Drug-Related Incarceration, 1980-2005.

Figure 5 provides the most basic series, showing that cocaine and heroin prices fell by about 80% from 1980 to 2000 during which time drug related incarcerations rose ten-fold.

Economic theory predicts that what should drive prices is not the level but rather than intensity of punishment, meaning the punishment per metric ton sold or per seller. We briefly summarize the basis for the claim that drug imprisonments rose not just in absolute numbers but in terms of the risks of incarceration for cocaine and heroin

Converting drug incarcerations to a rate for cocaine and heroin markets requires considerable judgment with respect to both the numerator (number of cocaine and heroin dealers incarcerated) and denominator (number of active dealers). The available data on incarcerations is not drug specific. However Sevigny and Caulkins (2004) use self-report data from a large 1997 survey of federal and state prison inmates to show that over 60% are serving time for cocaine or crack offenses; heroin, marijuana, and methamphetamine each account for about 10% of drug prisoners. There are no analyses available for the 1980s, so we rely on the impressions of observers that the share for cocaine has risen and that for heroin may have fallen somewhat. The total drug incarcerations figure probably

overstates the rise for heroin and understates that for cocaine, but we are sure in both cases that the total has risen substantially.

For the denominator, the number of dealers, we rely on indicators from other studies, such as estimates of the population of frequent users. For the period 1988-2000, series are available for cocaine and heroin (ONDCP, 2001). Both show substantial declines—nearly 50% for cocaine and 30% for heroin. These series have been subject to a number of revisions, but in no version of the data have they shown substantial increases. Earlier research efforts suggest that cocaine demand increased during the period 1980-1988 but for the post 1988 period, during which the incarceration rose most rapidly, we are confident that the number of regular cocaine consumers did not increase. For heroin 1980-1988 data are sparse but there is no evidence of an increase in the user population.

In theory it is possible that the number of dealers per user may have increased, so that a constant user population supported a larger number of dealers. There is no evidence of such a trend, and in any event such a change would have had to be extraordinarily large to change the conclusion that the risk of incarceration for a cocaine dealer or a heroin dealer rose.

The simplest explanations of declining prices are declining demand or increasing production efficiency. Though the prior discussion suggests that for cocaine consumption has ebbed somewhat since 1988, demand was likely increasing in the early to mid 1980s, the period of fastest price declines (Caulkins et al., 2004). There has not been comparable analysis of heroin demand (as opposed to indicators of quantity consumed), but conventional wisdom would be of stable demand in the 1980s and flat demand during the 1990s. While it cannot be dismissed completely, sharply declining demand is not a very plausible explanation for the fall in prices.

Costa Storti and De Grauwe (2008) suggest that globalization may explain the decline in drug prices that has occurred in many Western countries. They identify three different mechanisms: a shift to more competitive market structures, a flow of low cost labor that reduces the risk premium and greater efficiency in international trade generally. These may indeed be important factors in shifting the supply curve but their analysis does not directly confront the paradox of tougher enforcement and lower prices.

Various other explanations have been offered, some of which are reviewed in Caulkins and MacCoun (2003). A more recent one by Caulkins, Reuter and Taylor (2006) offered a model that took account of the role of violence in the formation of prices. Tougher enforcement that focused on more violent individuals would reduce the costs to the marginal supplier, defined by his willingness to incur physical risks. The result was that more enforcement would lower prices. None of these are convincing as identifying all the factors that might be involved.

A production puzzle

Francisco Thoumi (2003) has articulated a central issue for understanding global drug markets. Production of cocaine and heroin is concentrated in a very small number of countries, even though many nations can, and have, produced these drugs. Only three nations produce cocaine for the illegal market: Bolivia, Colombia and Peru. Yet commercial production has been located in Java (under Dutch colonial control), Formosa (Japanese control) and Bengal (British control). There is no doubt that coca can be grown in Venezuela and Ecuador. There may well be many other countries that can produce it as well.

Opium is a slightly more complicated story (Paoli, Greenfield and Reuter, 2009). It has historically been grown in many nations, such as Iran, Macedonia and Uzbekistan. Seven countries currently produce for the licit market, subject to regulation by the International Control Board; they include Australia and France, as well as the long-term producer, India. Yet illegal production is found in few countries and has been concentrated in two countries for most of the modern era of mass illegal heroin markets. Afghanistan and Burma have accounted for over 85 percent of global production since systematic measurement began in the mid-1980s. Since the late 1990s Afghanistan has come to dominate the global market; in the *2008 World Drug Report* Afghanistan accounted for 93 percent of global production.

Thoumi's account for why nations become active in the production of illegal drugs emphasizes the role of a weak state and tolerance for criminal activities, rather than conventional economic factors, such as factor endowment or prices. That is helpful but still leaves a large question. There are many weak states with tolerance for organized

criminal activities; why do only a few end up dominating the market? One simple model emphasizes the declining marginal costs associated with corruption; having been paid to allow the growth of one hundred hectares, an authority may as cheaply protect one thousand hectares.

Participant characteristics, market outcomes, and policy

The preceding section amply demonstrates that there is much we do not understand about drug markets. Some such ignorance can be chalked up to poor data. However, the more interesting observation is that quite a few empirical regularities shine through the fog of imperfect data which are puzzlingly inconsistent with deductive conjectures based on standard models for how one might expect these markets to operate.

One possibility is that each little oddity has its own idiosyncratic explanation, but Occam 's razor suggests looking instead for a unified explanation. We tentatively propose as a candidate conjecture that the extreme physical and enforcement risks in these markets not only drive up prices, but also create strong sorting or selection effects. The resulting population of people engaged in supplying drugs is thus highly unrepresentative of the population as a whole. So general economic theories designed to apply to markets populated by typical people may sometimes fail to explain successfully puzzling aspects of drug market behavior.

We hasten to add two caveats. First, we are not, at present, going to invoke moral selection arguments. It is not implausible, on its face, that a conscience that makes it easy to break one set of laws (those against drug distribution) may also reduce the personal psychosocial cost of breaking other laws (e.g., against assault) whose violation can be a common correlate of illegal market activity. But we set aside such ideas for the moment. Second, we would not expect this principle to apply to parts of the industry that are not subject to great legal or moral sanction, such as sharing marijuana with friends or growing drug crops in regions where that is commonplace behavior. Rather, it would pertain primarily to international drug trafficking and domestic distribution of substances subject to stringent enforcement.

Our conjecture departs substantially from the economic literature on drug markets which pays little systematic attention to the characteristics of participants, in particular

dealers. In some respects this reflects admirable egalitarianism. Ethnic and racial minorities are disproportionately represented in official statistics on drug distribution, but this is studied only as a consequence of racism or other social forces, not as a cause of distinctive market behavior. However, in other respects it may also reflect a troubling lack of inquisitiveness. Males are even more disproportionately represented among those arrested for drug distribution, and whether biological or sociological, there are systematic differences in male vs. female conflict resolution tactics, notably with respect to proclivity for resorting to violence, which is one of the most salient and troubling characteristics of drug markets.

Gender of course is easily observed and regularly tracked, so we are far from the first to make that connection. But gender may merely be a correlate of other, less easily observed individual attributes on which drug markets select and sort, such as tolerance for risk, optimism bias, and impulsivity. And perhaps a market populated by people who are strongly atypical on such dimensions that affect preferences and decision making might operate in ways that are materially different than classical models would predict.

Behavioral economics studies how typical people may depart from classical economic models. In a related way, we are contemplating what might happen if a market's distinctive institutional characteristics selected on certain attributes often addressed in that literature (such as optimism bias), producing a highly atypical subset of people to populate those markets, and also how that selection could feedback to further accentuate the market's distinctive institutions in a reinforcing cycle.

It is beyond the scope of this paper to connect this conjecture to all of the puzzles above. Instead, we content ourselves with demonstrating the principle with respect to some familiar and uncontroversial characteristics of drug markets, and then close by suggesting how it may matter in a normative sense for how these market respond to policy interventions.

Some consequences of participant characteristics for market behavior

The following examples are written from a good knowledge of U.S. markets and a working knowledge about those in Western Europe and Australia and much less about transshipment countries such as Mexico and Tajikistan. The focus will be on cocaine and

heroin, about which more is known; we suspect similar observations may hold for methamphetamine but presumably not for drugs such as Ecstasy and marijuana, whose markets are quite different.

Drug markets attract individuals with distinctive tastes and skills, both because of a strict prohibition regime and the characteristics of the drugs themselves. The institutions that form around illegal markets, including the enterprises themselves and the relations among them, both reflect and interact with these distinctive participant characteristics.

For example, consider the fact that heroin and cocaine addicts in the United States typically purchase from many suppliers (Riley et al., 1997). Superficially this is odd. All other being equal, conducting illegal transactions with a larger number of people increases the risk of detection. However, two factors may combine to override that consideration. One is that retailers are unreliable, because they are subject to sudden arrest or injury and, mostly being addicts themselves, are from time to time not operationally competent. The second is that buyers of addictive drugs have urgent needs and poor impulse control. They manage the latter by buying frequently, even though there are very large quantity discounts. But when they wish to purchase they want immediate delivery, so to speak; having many suppliers when individual suppliers are unreliable, is critical.

As a second example, consider the observation that many if not most persons selling cocaine and heroin are dependent users of those drugs. Dependence is conceptually distinct from intoxication; it involves systematic and lasting changes in neuroreceptors and reward pathways. The architecture underpinning tastes and choices has been altered. In particular, dependence primes individuals to experience powerful cravings for the drug and to be prone to binges. In other words, the sales force is singularly inept at holding inventory responsibly.

Why do such participants drive out others and not vice versa? As Moore (1990) observed, drug using sellers are advantaged over abstinent sellers in that they receive part of their compensation in the form of discounted drugs, which they presumably value at some price between wholesale and retail; non-users must incur the risks of selling all of their drugs in order to obtain the full return. Since the markets have a reputation for

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involving physical risk, those who require less compensation for that risk will enter before others with similar skills. This has other consequences; if attitudes toward physical risk are correlated with risk-taking more generally, we can expect a market primarily of risk lovers. An additional source of transaction risk is that participants are subject to random removal from the market through arrest or injury. That contracts are unenforceable in courts may add further to risks.

Some consequences of participant characteristics for policy

Drug enforcement does not work primarily through incapacitation or rehabilitation; most dealers who are incarcerated or reformed can be replaced easily. Rather, drug enforcement works via deterrence. In particular, drug enforcement deters people from selling drugs at a low price, convincing the sellers collectively to provide the drug only for a higher profit at a higher price.

All deterrence, both the conventional form applicable to non-consensual crimes and the "risks and prices" version applicable to black market distribution, depends on the object of the deterrent threat perceiving and responding to incentives. Since Becker's (1968) seminal work it has been common to presume that criminals respond to those incentives rationally, but many living things respond to their environment in non-rational ways. Even plants stems grow up toward light (phototropism) and roots grow down (geotropism). If drug sellers are systematically different, might their response to deterrent sanctions also be systematically different than would be predicted by conventional economic models?

Caulkins and MacCoun (2003) have developed a model of bounded rationality which aims "to show that even modest departures from the classical model of decision-making are sufficient to break the link between drug enforcement and drug prices. To the extent that in reality the decision to sell drugs is even more spontaneous, emotional, and idiosyncratic than we describe, then the conclusion holds with even greater force" (p.439). As suggested already, we believe that there is ample evidence that the assumption of consistent and rational behavior is particularly strained in these markets.

This may also be a set of participants who are hard to deter in that they do not interpret signals from the criminal justice system well. In this respect they are not

different from other chronic violent and property crime offenders as a population. For a review of that literature, see Nagin (1998). However the nature of the potential response is different; rather than a decision about whether to desist from the criminal activity or reduce intensity in face of increased sanction severity or risk of apprehension, they make price decisions, even if only through manipulation of purity. Pricing decisions seem inherently more complex.

One important factor influencing (lack of) exit from dealing is a little-noted observation by Boyum (1992) about profits in illegal markets. Even if a drug dealing business is operating at an economic loss, when one takes into account risk compensation, it will be showing a positive cash flow, indeed probably a very positive one. The entrepreneur will have to pay agents at levels that reflect their valuation of the risks they face but there are no accounting books that record the entrepreneur's own estimate of risk. Moreover there is a growing body of interviews with dealers that suggest they systematically underestimate the length of sentences they face (e.g. Decker, 2008).

The market is also characterized by extremely weak feedback about quality. The chain from heroin refiner in Afghanistan to final consumer in London may have eight links: sales to traffickers in Afghanistan, Iran and then Turkey; sale to an importer in Britain (10 kilograms) and then three more sales to dealers within the U.K. (1 kilo, 100 grams, 10 grams). Each link in the chain knows only the ones immediately above and below. Only the final user knows whether the purity was less than expected and he does not know which party is responsible for higher than expected dilution.

The links of the chain get broken randomly; the chain that delivered a particular bundle may not be fully operational three months later because one participant was arrested or killed. Information about unexpectedly low purity will be transmitted back up the chain slowly and imperfectly.

Concluding Comments

This paper aims more to encourage a line of inquiry than to provide a resolution of the specific puzzles that motivated its writing. The focus on participant characteristics

surely will not explain all the differences, but it points to a set of variables that might play a prominent role in the analysis.

If economists are to contribute usefully to an understanding of drug markets, they will have to invest in learning about the distinctive characteristics of the participants that they attract and the environment in which they operate. Our conjecture is that these markets will turn out to have distinct features and that the puzzles above (and many others) will be resolved not by turning drug dealers into simply another group of tough risk takers but by learning about decision making in the face of chronic dependence, massive uncertainty about the product and high risks of nearly catastrophic events such as incarceration, injury and impoverishment.

A recent paper by Cook et al (2007) on gun markets in Chicago offers a model of this kind of research. Working with an ethnographer and a criminologist, two well known economists (Philip Cook and Jens Ludwig) showed that a combination of illegality, infrequent transactions and ignorant buyers created a market that worked poorly. The relative strength of the drug market had an effect as well; leaders of the drug dealing organizations that had many competitive advantages in supplying illegal guns chose to stay away from that business because of the lengthy sentences faced for gun offenses that would imperil their drug selling.

Most of the economics literature on drug markets has aimed at finding clever theoretical solutions to problems that trouble academic economists, without investing in an understanding of how the markets operate or what makes them distinctive. We believe that investment is essential.

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