6-1-2005

Marijuana Markets: Inferences from Reports by the Household Population

Jonathan P. Caulkins
Carnegie Mellon University

Rosalie Liccardo Pacula
RAND Corporation

Marijuana Markets: Inferences from Reports by the Household Population[a]

Jonathan P. Caulkins, Ph.D.
Heinz School of Public Policy, Carnegie Mellon University

and

Rosalie Liccardo Pacula, Ph.D.
RAND Corporation and National Bureau of Economic Research

Abstract:
Generally more is known about drug use and demand than about markets and supply, in large part because population survey data are available while market data are not. Although the household population represents a relatively small proportion of users of hard drugs, it represents a large proportion of the population using marijuana and participating in marijuana markets. This paper provides a description of marijuana market and acquisition patterns as reported by participants in the 2001 National Household Survey on Drug Abuse. We find that most respondents obtain marijuana indoors (87%), from a friend or relative (89%), and for free (58%). Retail marijuana distribution appears to be embedded in social networks, rather than being dominated by "professional" sellers. Despite these contrasts with stereotypical street markets for cocaine and heroin, there are also similarities, such as evidence of quantity discounts and a minority of users accounting for the majority of purchases. We estimate that there are on the order of 400 million retail marijuana purchases in the U.S. each year and that the average purchase size is small, about 6-7 joints.

Bio Sketches:
Jonathan P. Caulkins, Ph.D., is Professor of Operations Research and Public Policy at Carnegie Mellon University's Heinz School of Public Policy. Dr. Caulkins specializes in mathematical modeling and systems analysis of social policy problems with a focus on issues pertaining to drugs, crime, violence, and prevention.

Rosalie Liccardo Pacula, Ph.D., is a Senior Economist and co-Director of the Drug Policy Research Center at RAND. Dr. Pacula's research has largely focused on evaluating state and local public policies at diminishing youth substance use and abuse and their social costs.

Running Head: Marijuana Markets

Keywords: Marijuana, drugs, illicit markets, market structure, quantity discounts, social networks

Marijuana Markets: Inferences from Reports by the Household Population

Abstract:

Generally more is known about drug use and demand than about markets and supply, in large part because population survey data are available while market data are not. Although the household population represents a relatively small proportion of users of hard drugs, it represents a large proportion of the population using marijuana and participating in marijuana markets. This paper provides a description of marijuana market and acquisition patterns as reported by participants in the 2001 National Household Survey on Drug Abuse. We find that most respondents obtain marijuana indoors (87%), from a friend or relative (89%), and for free (58%). Retail marijuana distribution appears to be embedded in social networks, rather than being dominated by "professional" sellers. Despite these contrasts with stereotypical street markets for cocaine and heroin, there are also similarities, such as evidence of quantity discounts and a minority of users accounting for the majority of purchases. We estimate that there are on the order of 400 million retail marijuana purchases in the U.S. each year and that the average purchase size is small, about 6-7 joints.

Running Head: Marijuana Markets

Keywords: Marijuana, drugs, illicit markets, market structure, quantity discounts, social networks

Introduction

Drug markets have long been a topic of interest (Preble and Casey, 1969), and disrupting them is a center-piece of drug control policy, most notably in the U.S. but also abroad (ONDCP, 2004; UNODC, 2004). There is increasing recognition that drug policies ought to be grounded in research on drug markets (Natarajan and Hough, 2000), and that understanding drug markets is central to understanding and controlling drug related crime (NIJ, 2003). Due to their illicit nature, information on drug markets is not readily available. However, limited information has been gleaned from ethnographic studies and data related to enforcement activities (e.g. STRIDE).

The information we do have suggests that not all drug markets are alike. In particular, marijuana markets differ substantially from the street markets for cocaine and heroin that have been the focus of so much interesting ethnographic research (Bourgois, 1995, 1996; Curtis and Wendel, 2000; Dunlap et al., 1997; Johnson et al., 1995). Ethnographic data suggest that marijuana sellers are more likely to operate independently (than as part of organized operation), sell indoors, and involve acquaintance or referral networks than street markets for cocaine, crack and heroin (ONDCP 2002; ONDCP 2004). These latter two findings are supported by results obtained from survey data of populations with a broad geographic spread, including youth (SAMHSA, 2003) and arrestees (NIJ, 1998).

Although some features of the marijuana market have been highlighted in previous studies, no study to date has looked carefully at the structure and characteristics of U.S. marijuana markets and the individuals who participate in them. This is surprising given that it is the most widely used illicit substance (SAMHSA, 2003) and a major focus of the Bush administration's drug policy. It is also surprising because major population surveys, such as

NIJ's Arrestee Drug Abuse Monitoring Program and SAMHA's National Household Survey on Drug Abuse, have recently included modules that inquire about users' purchasing habits.

Survey data obtained from the household population would not generally be viewed as a reliable source for information about the acquisition of hard drugs because the household population represents such a small proportion of total demand in these markets. However, there is evidence that these data sources may be useful for understanding marijuana markets (ONDCP, 2001). In fact, current evidence suggests that hard to reach populations (prisoners, homeless, criminally-involved dependent users, etc.) account for a much smaller share of the marijuana market than they do of the cocaine or heroin markets (ONDCP, 2001), and hence information collected from the household population is more relevant for understanding marijuana markets. Furthermore, state sanctions for personal use of marijuana are less severe (Chriqui et al, 2002), so traditional concerns about under-reporting may be less troublesome.

This paper summarizes findings regarding the structure and characteristics of U.S. marijuana markets, as reported in the 2001 National Household Survey on Drug Abuse (NHSDA). Aspects evaluated here include information on (a) the most common source of marijuana and location of transactions, (b) the extent to which buyers also sell or informally distribute their marijuana, (c) purchase size, prices, and quantity discounts, and (d) the annual numbers of marijuana purchases in the U.S. This information provides insights concerning retail marijuana markets that have implications for the effectiveness of current enforcement strategies.

Data and Methods

The National Household Survey on Drug Abuse

The National Household Survey on Drug Abuse (since renamed the National Survey of Drug Use and Health) monitors drug use and related behavior among the bulk of the U.S. population. The 2001 survey obtained usable responses from 55,561 respondents who were selected through a national probability sample of the civilian, non-institutionalized population, 12 years old and older, living in the 50 states or the District of Columbia. Selection is not uniform. For example, youths, Blacks, and Hispanics are over-sampled to improve the precision of estimates for these subpopulations.

The purpose of the survey is to collect information on the prevalence of substance use and abuse in the household population as well as provide information on the individual and environmental factors that are correlated with this drug using behavior. Respondents are asked the number of days during the past month (and year) that they used marijuana and a host of other substances. In addition, information is collected on the socioeconomic background of respondents, including their age, income, race/ethnicity, sex, marital status, family structure, educational attainment, and urbanicity.

2001 NHSDA Marijuana Market Survey Questions

The 2001 NHSDA asked the 8,339 survey respondents who reported using marijuana in the past 12 months a schedule of questions concerning their participation in the marijuana market.[1] Not all respondents were asked every question. The skip pattern was driven primarily by responses to a key introductory question: "Now think about the last time you used marijuana. How did you get this marijuana?" As Figure 1 shows, the majority reported obtaining their most recent marijuana for free (57.8%). Only 2 in 5 respondents (39.2%) reported purchasing their

most recent marijuana acquisition. A few reported trading something else for it (2.0%) or growing it (1.0%). (See Figure 1.)

The market survey was designed to focus on purchases, so those whose most recent acquisition was not a purchase were asked, "During the past 12 months, did you buy any marijuana?" Any past year user who had bought in the last year or whose most recent acquisition was a purchase even if it occurred more than a year ago was asked the core set of questions concerning purchases, including amount obtained, price paid, and where the purchase occurred. About 10.8% of those who most recently obtained their marijuana by purchasing reported that the purchase occurred more than 12 months ago.[2] In analyses of purchase price and related characteristics, we focus on purchases made within the last year.[3]

The survey next examined transactions that involved trading things for marijuana. A comparably detailed set of questions concerning these trades was asked of: (1) those whose most recent marijuana acquisition was by trade but who never purchased in the last year and (2) those whose most recent acquisition was a gift or by growing and who traded for but never bought marijuana within the last 12 months. These individuals represented only 2.1% of people responding to the marijuana market questions so they are studied only briefly below.

There were 81 respondents who reported most recently obtaining their marijuana by growing it, but 39 reported purchasing it within the last year and 4 others reported trading for it. Thus, only 38 respondents were given the battery of questions regarding marijuana growing. We devote little time to these respondents given the relatively small sample size.

Of the respondents who most recently obtained marijuana for free, 1,391 reported buying in the last year and so were asked the purchase questions. Another 66 reported trading, but not buying, and so were asked questions about trading. However, that still left 3,588 respondents

whose most recent source was a gift and who had not in the past year purchased or traded for marijuana. These respondents were responsible for only a modest share of self-reported days of past year marijuana use (13.5%), but they represented the plurality of past-year marijuana users (43.3%). Hence, we examine this group in some detail.

Table 1 summarizes the number of respondents who answered each of the four groups of questions pertaining to purchase, trade, growing, or gift.

It should be kept in mind that there are reasons why the survey might not produce a random sample of people acquiring marijuana in the U.S. even though it is a representative sample of the household population. First, certain subpopulations are excluded, including the incarcerated and transient homeless. Second, those that refuse to complete the marijuana acquisition module (approximately 3% of the original sample) might differ in systematic ways from those who did respond. Third, individuals who refused to answer a particular question might differ from those who did respond. Finally, respondents might lie or not remember accurately what they did.[4] These factors' influence on the generalizability of findings obtained from these data cannot be determined given that objective data on marijuana market transactions are not available.[5] However, findings from this population can be compared to those obtained from other sources including relevant populations to assess the reasonableness of results. Where possible, such comparisons are made below.

Results

Descriptive Statistics

Source and Location of Most Recent Marijuana Acquisition: The Importance of Friends

Those reporting past year marijuana use are asked three questions pertaining to where and from whom marijuana was last acquired.[6] The questions are adapted to the nature of the acquisition. For example, for those who bought, the first question is "The last time you bought marijuana, who did you buy it from?" The possible answers are "a friend", "a relative or family member", and "someone I had just met or didn't know well" (abbreviated below as "stranger"). The second question asks, "The last time you bought marijuana, where were you when you bought it?" with six possible responses. The third question asks, "The last time you bought marijuana, where did you buy it?" with responses limited to "Near where you are now living" and "Somewhere else". The responses, summarized in Table 2, highlight important nuances about the structure and visibility of marijuana transactions.

Almost 90% of the most recent acquisitions are from a friend or relative, with friend being the most frequent source of marijuana. This proportion is highest among those receiving marijuana for free (93%), but it is also high for those who most recently obtained marijuana by purchase (83%) or trade (86%). This suggests that attempts to disrupt marijuana distribution through undercover buys or sales may be fairly ineffective.

It is interesting to compare these results from the 2001 U.S. Household Survey with those from the 2001 Dutch Household Survey (Abraham et al., 2002). The Netherlands has very different policies toward retail marijuana distribution. For example, in the Netherlands marijuana selling in designated coffee shops is tolerated by police, in part to separate cannabis users from sellers of "hard drugs". Not surprisingly, coffee shops are cited often as a place of acquisition by Dutch past year cannabis users (37% of 12-17 year olds and 47% of those over

18). However, the proportions of Dutch survey respondents who report acquiring from relatives, friends, acquaintances, or by growing their own is much lower (49% and 41%, respectively). Hence, obtaining marijuana from someone other than a relative, friend, or acquaintance and outside of coffee shops is actually reported slightly more often in the Dutch Survey than in the U.S. Survey. There are many differences between the Netherlands and the U.S., so direct comparisons can be deceiving. However, it appears that relative to the U.S., the Dutch coffee shops may be substituting for acquisition from friends and relatives, not just for acquisition from hard drug sellers.

Few (13%) recent acquisitions take place outdoors. The majority (57%) is made inside a home, apartment, or dorm. Only about half of those occur near where the respondent lives, suggesting that transactions often occur at the residence of a supplier or a third party. More generally, acquisitions both within and outside of the buyer's neighborhoods are common, consistent with findings reported in other surveys (SAMHSA, 2003; ONDCP, 2002).

Redistributing Marijuana Purchases: The Importance of Gifts

Table 1 already underscored the importance of gifts. Fully 57.8% of past year marijuana users most recently acquired marijuana for free. Only 39% of past-year marijuana users acquired marijuana most recently by purchase. However, they are heavier users, accounting for 63% of the days of use.

Fortunately, the survey asks about distribution activity as well as their acquisitions. Indeed, just two questions are asked of all respondents, regardless of whether the skip pattern directed them to questions about a purchase, trade, gift, or growing. Those questions are: (1)

"Did you sell any of the marijuana you bought [got/grew] this last time?" and (2) "Did you give away or share any of the marijuana you bought [got/grew] this last time?"

Three things are clear from the answers, which are summarized in Table 3. First, the majority (58%) of people who used marijuana in the last year gave away or shared some of their *most recent* acquisition.[7] That stands in dramatic contrast to reports concerning street users of more expensive drugs, such as cocaine and heroin (e.g., Simon and Burns, 1997). Sharing among running partners is certainly reported, but the overall image is one of every user for himself or herself, with users as likely to steal drugs from each other as to share them.

The second observation is that even though most marijuana users are "distributors", most do not report selling marijuana. Small proportions applied to a large number of people still generate a reasonably large number of people, however. The responses suggest that there were 1.1 million past-year marijuana users who had sold a portion of their most recent marijuana acquisition by the time they were surveyed. Interestingly, one in six people who said they had sold some of their most recent marijuana acquisition also report in a separate question that they did not sell any illicit drugs in the past 12 months.[8] This apparent conflict may indicate nothing more than the unreliability of survey data. On the other hand, it might indicate that some respondents do not think of marijuana selling as the selling of an illicit drug.

The third observation from Table 3 is that selling and giving away are not mutually exclusive activities. Indeed, sellers are more likely than non-sellers to give some away or share (78% vs. 57%), and those who gave away or shared are more likely than others to sell (8% vs. 3%).

Overall these responses indicate that there is a great deal of informal distribution in the marijuana market. Buyers do not typically use all of what they buy, and even those involved in

selling frequently give away part of their own supplies. It may be that sellers who give away part of their supplies are providing free samples to potential buyers, but the questions in this survey are insufficient to determine this.

Purchase Size and Cost

Past year purchasers are asked questions regarding the quantity purchased in units of the respondent's choosing. The survey first asks, "Think about the last time you bought marijuana. Did you buy marijuana that had already been rolled into joints or did you buy marijuana in loose form?" Less than five percent (4.8%) report purchasing joints. The vast majority (95.2%) report buying marijuana in loose form. Those who purchased in loose form are asked if they want to report the quantity in grams, ounces, or pounds. The appendix breaks down the possible response categories by units, identifies the proportion of people responding by each, and provides the conversion factors through which these different amounts are translated into a common unit, grams. When responses are provided by pre-specified ranges, the midpoint of the range is used.

Most reported purchases are small, although the distribution of transaction sizes is highly skewed. Among those buying joints, 40% report buying a single joint, and 81% buy five or fewer. Only 10% buy more than 10. Still the average number of joints purchased is 6 joints (4 for those who do not re-sell; 19 for those who do) because a few people report buying large numbers.

Transaction sizes for purchases of loose marijuana are similarly skewed. Table 4 shows that one-third of all purchase amounts are less than 5 grams, and nearly three-quarters (72%) are less than 10 grams. However, because a few large purchases are reported, the average

transaction amount across all loose purchases is 77 grams, significantly higher than the median of 7.5 grams.

Table 4 also reports the median and average price paid per gram of marijuana for specific quantity levels. The price per gram is constructed by dividing the total amount paid by the total amount reported, after converting into grams.[9] The distribution of prices paid per gram is also highly skewed for all quantity levels; the median price paid is always lower than the average price paid at each of the quantity levels. The average price paid per gram falls dramatically as the quantities purchased rises, supporting the hypothesis of quantity discounts in the marijuana market (Caulkins and Padman, 1993; ONDCP, 2004).

Figure 2 explores whether those who sell tend to buy in larger quantities than other users by examining the cumulative distribution function of purchase sizes for three groups of buyers. The first group (top line) represents everyone who reported purchasing loose marijuana. It demonstrates the same basic idea shown in Table 4. The second line shows the cumulative distribution function for the sub-set of buyers who report selling some of what they bought. The third (bottom) line shows a smaller subset who also report in another part of the survey that they sold drugs three or more times over the last 12 months. A cumulative distribution function plots the proportion of respondents who bought less than or equal to the quantity identified on the horizontal axis. So, groups with a higher curve tended to buy smaller quantities. For example, 86% of all those who buy marijuana loose buy 21.26 grams or less, whereas only 51% of those who re-sell some of what they buy do so. Looking at it the other way, only 14% of people buying loose marijuana purchase more than 21.26 grams, but 49% of those who re-sell some of their purchase do.[10]

There is a substantial difference in average purchase size between those who did re-sell (370 grams) and those who did not (45 grams). A handful of respondents reporting large purchases heavily influence both averages, but there is still a significant gap even among purchases of less than one kilogram (81 grams vs. 20 grams).

Amounts spent are similarly skewed. Nearly forty percent (38.8%) report spending less than $21 on marijuana, and over one-third (35.7%) report spending between $21 and $51. Just 10.3% spend more than $100, and only 4.0% spend more than $250.

One non-result is worth noting. There appear to be few differences in purchase size, location, or source of marijuana between the most recent purchases of people who have bought in the last month and those who have bought in the last year.

Multivariate Analysis of Price Paid Per Gram

The previous analyses provide some interesting descriptive data about the market, but are limited in that they do not clarify what factors are the most important for determining price paid. The literature suggests that a variety of factors may be important, including the familiarity between buyer and seller, the location of the transaction (outdoors versus indoors), time of day, the type of marijuana, the experience of the buyer, demographic differences, and so on (Kleiman, 1989; ONDCP, 2002). The following analysis builds on the previous work by exploring the impact of these factors on the total cost of the transaction and on the reported price per gram. It also considers the issue of quantity discounts, controlling for other factors that influence price.

This section uses responses reporting use and purchase of loose marijuana in the past year (n = 4,524, or 52% of all past-year marijuana users). Quantities reported in ounces and pounds are converted to grams using the conversion factors shown in the appendix. We do not include

purchases of joints because there is no consensus on how to translate quantities in joints to grams. Transaction costs are calculated by assigning the midpoint of the response categories reported. Although using the midpoint reduces the variability in our measure of actual amount paid and introduces some measurement error, any alternative assignment of values would suffer from the same problems. The anticipated impact is fairly small because the response categories are so detailed. Increments are no wider than $10 up to the first $150 (the lowest two categories are $5 increments), and 93% of respondents report paying less than $150. Table 5 presents weighted descriptive statistics of all the independent variables included in our multivariate analyses. Only 3,872 observations are included because some observations have missing data for one or more covariates.[11]

If we let Q_i represent the quantity purchased, C_i be the total cost paid for the purchase, E_i represent a vector of variables capturing characteristics of the exchange (i.e., location, source, and proximity to home), and X_i represent individual characteristics, then we can write the basic model as:

$$(1) \qquad \ln C_i = \alpha + \beta \ln Q_i + \delta E_i + \gamma X_i + \varepsilon_i$$

Preliminary specification tests reveal that the most appropriate specification of this base model is a general linear model (GLM) with a log-link function and non-constant (gamma) variance, so that is the specification we employ.[12]

Unfortunately, no information concerning marijuana potency is collected, so it is not possible to adjust for variation in quality, as has been done with other drugs (ONDCP, 2004; Caulkins, 1994). This is a problem for interpreting results to the extent that this omitted variable (potency) is correlated with other right hand side variables, which is particularly likely in the case of amount purchased (Q_i). For example, when buying high potency marijuana, people may

buy less because less is needed to generate the same level of a high. If this is the case, then the negative correlation between purity and amount purchased would cause β to be biased downward (i.e., toward zero). This is important because β is what we use to determine the extent to which quantity discounts exist in the market.

Table 6 presents results for four versions of the basic model. Model 1 estimates the base model using all observations reported in grams, ounces, and pounds but excluding potentially endogenous variables, such as whether some of the purchase is sold or shared and whether the buyer is a new initiate. Although these variables are likely to be important in determining price, the price the individual faces may partially determine whether the individual wants to share or sell some of the quantity purchased. In the case of new users, other analyses have shown that higher prices deter marijuana initiation (Pacula, et al., 2001). Hence, given the potential for reverse-causality, these variables are excluded from Model 1. Model 2 evaluates how including these potentially endogenous variables affects the relationship between total cost and quantity consumed. Models 3 and 4 are restricted to purchases reported in grams and in ounces, respectively, to assess whether aggregation of these observations leads to any biases.

The Relationship Between Quantity Purchased and Price per Gram.

All the models reported in Table 6 show a positive relationship between ln(amount) and ln(Total Cost), which is to be expected. It costs more to buy more. The interesting question is whether it costs less *per unit* when buying more.[13] That would be the case if the coefficient on ln(amount) is less than unity (Clements, 2004). That is indeed the case; all four models suggest the presence of substantial quantity discounts. For example, Model 1's coefficient on ln(amount) is 0.425, indicating that a 1% increase in transaction size is accompanied by a 0.425% increase in

transaction value. That implies a $1\% - 0.425\% = 0.575\%$ decrease in the cost per unit. Conversely, from the seller's perspective, selling in lot sizes that are 1% smaller allows the seller to charge 0.575% more per unit. Model 2's inclusion of additional covariates has little effect on the quantity-price relationship, so we defer momentarily discussion of those covariates.

It is possible that the omission of potency may be causing us to over-estimate the quantity discount, which could explain the large implied quantity discounts/price markups for this market relative to the cocaine and heroin drug market. Even so, the bias would have to be fairly substantial to cause the general conclusion regarding the existence of quantity discounts to be invalid. Furthermore, perhaps a better test of the finding is to assess whether there are differential quantity discounts across markets. Even if there is bias in estimating the overall quantity discount, there is no reason to believe that omitting potency would differentially bias results across distribution levels. The bias should be proportional.[14] Thus, if we find differences in the relationship between quantity and total cost across different distribution levels, than this would support the hypothesis that quantity discounts exist.

Results from the interaction terms of our log quantity and unit of sale (e.g. ounces, pounds versus grams) in Models 1 and 2 suggest that quantity discounts do indeed exist, but they are smaller for amounts sold at the ounce level than those at the gram level, other factors being constant. This finding is further supported by results presented in Model 3 and 4, which drop the 101 observations measured in pounds and estimate the model separately for observations reported in grams (Model 3) and in ounces (Model 4). The coefficient on ln(amount) in Model 3 is smaller than that for Model 4 (0.421 vs. 0.526) suggesting that the quantity discounts within the gram (sub-ounce) range of transaction sizes are larger than they are for somewhat larger transactions.

Variation in the extent of quantity discounts across market levels has been observed before (Caulkins, 1994; ONDCP, 2004). A fixed cost per transaction, independent of transaction size, could generate greater quantity discounts/price markups at lower market levels since the relationships are measured in percentage terms (from the log-log model structure). Such a fixed cost could also help explain why the quantity discounts observed here are larger than ONDCP (2004) estimates for more expensive drugs such as cocaine, heroin, and methamphetamine. However, we cannot rule out the possibility that it is omission of potency that causes us to estimate such large quantity discounts. Nonetheless, the results suggest at least a 10%-18% difference in quantity discounts across market levels, suggesting that quantity discounts may still be fairly large.

The Relationship Between Total Cost and Other Covariates

We turn now to a discussion of the other covariates. Males appear to pay more, although that result appears to be driven by purchases at the ounce level. Non-Hispanic Whites (the omitted race/ethnicity category) pay more than do Hispanics and, to an even greater extent than Non-Hispanic Blacks particularly for smaller quantities. One might hypothesize that this could be related to urbanicity. If marijuana is less expensive in urban areas and minorities disproportionately live in urban areas, then it might explain their apparent access to lower priced marijuana. Indeed some additional sensitivity analyses reveal that when interaction terms for ethnicity and urbanicity are included, the main Hispanic effect disappears. However, the effect for Non-Hispanic Blacks remains, suggesting that even in urban areas, Non-Hispanic Whites pay more than do Non-Hispanic Blacks. If race correlates with potency, then this might explain the remaining differential, but it cannot be tested with these data.

People with higher incomes pay more. This might reflect quality differences either in the product (higher potency marijuana) or transaction setting (paying a premium for transactions that are made more expensive by extra efforts to avoid police detection). The second story is consistent with the result that a premium is paid for purchases made in private residences compared to more public settings. For Model 3 (gram-denominated observations), an increasing education level of the respondent has similar effects on amount paid as income.

An alternative hypothesis that combines all of these coefficients is that "disadvantaged" areas in terms of these demographic variables might be more likely to have drug markets for cocaine and heroin. If police in areas that do not have such "hard drug" markets place a higher priority on marijuana enforcement, that might tend to drive up marijuana prices relative to marijuana prices in areas with active markets for other drugs.

Surprisingly, the coefficients on dummy variables reflecting the relationship of the buyer to the seller are not statistically significant. Apparently, friends and family do not give discounts relative to what strangers charge. However, these results might be influenced by the omitted potency variable.

Recall that Model 1 omits several covariates that were potentially endogenous. Including them (Model 2) has minimal effect on the covariates just discussed, but their coefficients are provocative in their own right. For example, Model 2 suggests that individuals who re-sell some of the marijuana they purchase pay more after adjusting for quantity purchased and other covariates. At first this seems surprising. One would expect "dealers" who sell drugs for profit to aggressively seek out low-cost suppliers. Recall, however, that most of these marijuana sellers appear to be distributing to friends, not selling "professionally". So the positive relationship may reflect causality running in the opposite direction. Perhaps where marijuana is

cheap, people are willing to share it for free. Where it is more expensive, they may want to be compensated monetarily, at least for their own out of pocket costs. Or, in the extreme, where marijuana is very expensive, frequent users might seek to sell for profit, as do heroin "jugglers". Alternately, dealers may provide higher quality (more potent) forms of marijuana that costs more for a given quantity.

Model 2 also finds that new initiates pay less not more for a given amount of marijuana than do more experienced users. Again there are potential explanations related both to the omission of potency and the potential for reverse causality. First, new initiates may be purchasing poorer quality marijuana at a lower cost than are experienced users. Second, new initiates may be less likely to purchase their own marijuana unless the price is really low, whereas long-time users may purchase even when prices are high. This is partially supported by the fact that the result is larger for and only statistically significant for Model 3 (gram-denominated purchases) not Model 4 (ounce-denominated purchases). Besides this "differential elasticity of demand" story, reverse causality could also appear if people share marijuana with new initiates when prices are low but charge them for their marijuana when the drug is more expensive.

(Absence of) Differences for Recent Initiates

Most of the preceding analyses were replicated, breaking respondents down by calendar year of marijuana initiation: before 1999, in 1999, in 2000, or in 2001. Since the survey was conducted in 2001, the last category is fairly small (583 respondents representing about 920,000 people), but quite a few people who are past-year marijuana smokers in 2001 initiated in 1999 or

2000 (1.5 million and 1.7 million, respectively). Of course, the largest number of individuals (over 16 million) initiated before 1999.

In short, marijuana acquisition patterns of those who initiated recently differ only modestly but in interesting ways from the acquisition patterns of people using longer. Some apparent differences stem from demographic differences. For example, recent initiates are much more likely to report selling some of their most recent acquisition. However, that is essentially because recent marijuana initiates are younger than long-time users, and 12-18 year old past-year marijuana users are more than twice as likely as others to report re-selling some of their most recent acquisition.

For the same reason recent initiates also appear to be more likely to get their marijuana in school or on school grounds, although not all of that difference can be accounted for by age. Even after controlling for age, recent initiates appear to be somewhat more likely to have marijuana sources at school.

A number of differences are notable with or without controlling for age. For example, recent initiates report using on far fewer days in the past 12 months. Recent initiates are also less likely to obtain marijuana by purchase and are more likely to receive it for free, particularly for 19-23 years old respondents. Friends dominate as a source of both purchased and free marijuana regardless of time since initiation.

What is striking is the comparatively small differences in proportions of people who report giving away some of their most recent acquisition. Recent initiates are somewhat less likely to give away or share, but the differences are not overwhelming. The practice of giving and sharing of marijuana seems to develop relatively soon after initiation.

Aggregate Market Quantities

The analysis above focuses on the most recent marijuana acquisition of someone who acquired marijuana in the last 12 months. It reflects a sample of people who acquire, not a sample of acquisitions. Hence one cannot, for example, assume that the average value of a transaction reported in the marijuana market module is even a first-order approximation of the average value of a marijuana transaction in the U.S. Any correlation across purchasers between number of purchases and size of the most recent purchase could skew the result.

That is an important limitation because there are questions one would like to address about the population of marijuana purchases. Fortunately, there is one marijuana purchase module question that can be used, along with some complementary information, to draw inferences about aggregate marijuana purchasing by people in the NHSDA survey frame.

Everyone who reports purchasing marijuana within the last month is asked "During the past 30 days, that is, since [DATE FILL], on how many days did you buy marijuana?"[15] Responses suggest there are 5.7 million past-month purchasers who made 33.4 million past-month purchases. That averages about six purchases per purchaser per month, but the distribution is skewed. Almost half (46%) report making just one or two purchases. Conversely, the 26% who purchase most often (6+ times per month) make 71% of the purchases. (See Table 7.) That skew is reminiscent of Everingham & Rydell's (1994) finding for cocaine that the heaviest 22% of cocaine users in the household population accounted for 70% of reported consumption. Indeed, it is even more dramatic when one recognizes that those frequent past-*month* purchasers account for only about 15% of past-*year* purchasers.

Multiplying the 33.4 million past-month purchases by 12 months suggests a minimum of 401 million past-year purchases. However, this number ignores purchases made by the 4.5

million past-year purchasers who did not answer the question, and so should be viewed as a lower bound estimate. . The ONDCP (2001) estimates total U.S. marijuana consumption (based primarily on the NHSDA) in 2000 to be 2.7 billion joints.[16] If most of the 400 or so million past-year marijuana purchases were final purchases, that suggests an average purchase size of 6 to7 joints, or about 2.5 grams if one accepts the ONDCP (2001) presumption of 0.0136 ounces per joint.

ONDCP (2001) converts quantities into expenditures by multiplying by $284 per ounce or approximately $10 per gram. That suggests an average purchase value of about $25.[17] That $25 figure is fairly similar to the average retail transaction for more expensive drugs, such as cocaine and heroin. However, the typical purchase of marijuana (6 to 7 joints) represents more doses, or days of use, than does the expenditure-equivalent purchase of cocaine or heroin. ONDCP's $284 per ounce figure is predicated on an assumption of purchases typically involving 1/3 of an ounce or about 9.5 grams. Assuming that the dramatic quantity discounts observed above are real, the price per gram for purchases of 2.5 grams could be considerably higher, raising questions about ONDCP's (2001) estimate that the total value of marijuana sales was $10.5B in that year.

Converting from total quantity to total expenditures using a factor that reflects both quantity discounts and the distribution of purchase sizes is important (Caulkins, 1994). Unfortunately the survey's information about the *distribution* of purchases sizes pertains to the most recent purchases (effectively sampling on users) not the distribution of purchase sizes overall.

It is interesting to compare the estimate of 400 million purchases to the number of arrests for marijuana offenses. In 2000 there were 1.58 million drug arrests, 46% of which were for

marijuana (Maguire and Pastore, 2001, Tables 4.1 and 4.29). Even if all marijuana arrests were associated with transactions (as opposed to possession between transactions), that implies that the probability of an arrest per marijuana sale is only about $1.58 * 0.46 / 400 = 0.18\%$, or less than one chance in 500. To put that figure in perspective, it is about one-tenth the annual risk of a licensed driver in the US being injured in a motor vehicle accident and about ten times the annual risk of being killed in such an accident.

Of course not all marijuana transactions are associated with the same risk of arrest. If few marijuana arrests are associated with purchase from a friend or family member, the arrest risk per purchase from a stranger could conceivably be substantially greater than 1 in 500.

Who makes these roughly 400 million marijuana purchases per year? Not surprisingly, the proportions of purchases accounted for by various subpopulations are similar to the corresponding proportions of past year days of use. Most marijuana purchases are made by males (74%), and few are by immigrants born outside the U.S. (3%). About 60% of purchases are made by past-year users of an illicit drug other than marijuana, but only about one in eight (12.8%) are made by people who report being in drug or alcohol treatment in the last 12 months. That suggests that either many dependent marijuana users are not receiving treatment or that people in need of treatment are not the dominant driver of marijuana demand. Almost 40% of purchases are made by people enrolled in a school (with about 15% being 18-22 year olds enrolled in college).

There are, however, subpopulations whose share of reported past-month purchases differs non-trivially from their share of reported past-year days of use. Married users account for almost one in five reported days of use (19.6%) but only one in ten (10.2%) purchases. Likewise, people 35 years old and older account for 26.6% of days of use but just 15.5% of purchases.

Conversely, Non-Hispanic Blacks report 12% of days of use but 22% of purchases, and Hispanics report 9% of days of use and 12% of purchases. (This does not appear to be a consequence of urbanicity.) Finally, people who were coded as being dependent on marijuana account for 21% of the days of marijuana use but 31% of the purchases.

Discussion

Marijuana is the most widely used illicit drug in the U.S., so it is natural to want to understand how users acquire it. Until recently, there was little systematic data concerning marijuana acquisition among the general population, as opposed to certain subpopulations such as students or people living in a particular area.

The NHSDA data suggest that marijuana acquisition is almost the antithesis of the images of anonymous, drive-through street markets for cocaine or heroin that play a prominent role in media depictions of drug selling. Most respondents report that their most recent marijuana acquisition occurred indoors (87%), from a friend or relative (89%), and for free (58%). Marijuana distribution appears to be embedded in social networks, not dominated by transactions with "professional" sellers. This is consistent with findings from Europe (e.g., Abraham et al., 2002; Parker, 2000; Decorte, 2001). Furthermore, although it is possible for friends and family members to participate in arms-length transactions, that may not be the norm for marijuana distribution For example, most (78%) people who reported selling some of their last acquisition also reported giving some of it away.

These observations are relevant to various policy considerations. For example, aggressive undercover enforcement to reduce availability to users might be hard to justify if most users get their marijuana from friends. On the other hand, notions that marijuana should be

decriminalized in order to drive a wedge between marijuana users and professional sellers of hard-drugs also appear inconsistent with the results of this survey.

The results also complicate certain efforts to apply "economic analysis" to marijuana markets in ways parallel to cocaine and heroin markets. For example, official marijuana price series are derived from the Drug Enforcement Administration's (DEA's) System to Retrieve Information from Drug Evidence (STRIDE) database (ONDCP, 2004). STRIDE's price observations come primarily from purchases made by undercover agents and confidential informants. Presumably those observations primarily reflect transactions between strangers, which appear to represent a small proportion of all transactions. The multivariate analysis did not detect systematic differences by source (friend, family member, or stranger), but further efforts to explore possible differences in prices between "STRIDE-like" and "social network embedded" transactions would be warranted.

One intriguing possibility raised by the multivariate analysis is that the dollar price to a potential initiate may not be equal to or even vary proportionately with the dollar price paid by current users. There are hints that when marijuana is cheap to existing users, it may be given to new initiates for free, whereas when marijuana is more expensive the new users may be expected to pay for what they use. This possibility might be investigated by asking questions about how marijuana was first acquired, not just about how it was most recently acquired. It is important because moving from a regime in which marijuana initiation involves politely accepting a gesture from a friend to one that requires actually purchasing something could introduce a psychological barrier to initiation whose impact exceeds that suggested by a simple change in the average price paid by current users.

Another issue pertains to the relationship between the total weight or quantity of marijuana consumed in the country and the amount spent by users purchasing that marijuana. If all retail purchases were cash transactions for precisely some specified weight (e.g., 1 gram), then the relationship would be trivial. Quantity consumed in grams times price per gram would equal total amount spent. The existence of quantity discounts complicates the relationship because the ratio of the amount spent to the quantity purchased and consumed would depend on how many transactions were for one gram as opposed to one ounce or some other quantity. Indeed, what we see is a highly skewed distribution of purchase sizes. Most reported purchases are small, but the relatively fewer large transactions account for a significant share of the total weight and dollar value of all reported purchases.

This issue is further complicated to the extent that lower-level distribution is often done without renumeration or is done "at cost" vs. "for profit" (meaning no markup). Official estimates of the relationship between aggregate national spending and national consumption recognize this and make some modest adjustments (ONDCP, 2001). The modest adjustments may be adequate for the cocaine and heroin markets, but the size of the quantity discounts estimated here and the frequency of informal distribution suggest that more extensive efforts may be warranted in the case of marijuana.

As a final observation along these lines, the basic framework for thinking about how increasing drug enforcement affects equilibrium prices and, hence, consumption is the so-called "Risks and Prices" model (Reuter and Kleiman, 1986). It is predicated on a vision of drug sellers as rational actors who in an expected-value sense balance non-monetary risks (notably of enforcement and physical violence) with the accounting profits that can be made by drug selling. The glimpse of marijuana selling revealed by the NHSDA suggests that risks and prices model

may not apply to marijuana distribution at lower market levels. For one, the arrest risk per transaction is so low as to be in the range where human beings both have difficulty judging probabilities accurately and also process those probabilities in ways that depart from that implied by a classical expected utility model (Kahneman and Tversky, 1979; Prelec, 2000). More fundamentally, marijuana distribution often takes place among friends or family members who enjoy an ongoing relationship that transcends the drug transaction. So some "payment" for "free" marijuana may take a very abstract form, such as the beneficiary simply being a friend of the supplier.

Marijuana distribution is undoubtedly an economic activity at some levels. It is a roughly a $10B per year market comprised of upwards of 400 million cash transactions per year. Prices even as reported in this household survey obey sensible regularities. So these comments are by no means a call for retreat from considering the role of price on behavior. On the contrary, they suggest that more information is needed to better understand the circumstances under which marijuana is received for free or traded.

As is so often the case in science, new data answer some questions and raise others. What does seem clear, however, is that asking market-related questions as part of the NHSDA is a useful complement to its traditional focus on use.

References:

Abraham, Manja D., Hendrien L. Kaal, & Peter D.A. Cohen.

2002   *Licit and illicit drug use in the Netherlands 2001*. Amsterdam: CEDRO/Mets en Schilt.

Blincoe, Lawrence J.

1995   The Economic Cost of Motor Vehicle Crashes, 1994. NHTSA Technical Report

        available at http://www.nhtsa.dot.gov/people/economic/ecomvc1994.html#table4.

Bourgois, Phillipe

1996   In Search of Respect: Selling Crack in El Barrio. New York: Cambridge University Press

Caulkins, Jonathan P.

1994 What is the Average Price of an Illicit Drug? Addiction. 89(7): 815-819

Chriqui, JF; Pacula, RL; McBride, DC; Reichmann DA; VanderWaal CJ and Y Terry-McElrath

2002   Illicit drug policies: Selected laws from the 50 states and the District of Columbia.

        Berrien Springs, MI: Andrews University.

Clements, Kenneth W.

2004   Pricing and Packaging: The Case of Marijuana. Mimeo.

Curtis, Ric and Travis Wendel.

2000   Toward the development of a typology of illegal drug markets. In Illegal Drug Markets:

        From Research to Prevention Policy, Mangai Natarajan and Mike Hough (eds.) Monsey,

        NY: Criminal Justice Press.

Deb, P., Manning W., and E Norton

    2003   Modeling Health Care Costs and Counts, Pre-conference workshop held before

        the *International Health Economics Association* 2003 Meeting (San Francisco, CA).

Decorte, Tom

2001   Quality Control by Cocaine Users: Underdeveloped Harm Reduction Strategies.

      European Addiction Research 7:161-175.

Dunlap-Eloise, Johnson-Bruce-D, and Maher-Lisa

1997   Female Crack Sellers in New York City: Who They Are and What They Do. Women and

      Criminal Justice 8(4).

Everingham, Susan.S. and Rydell, C.Peter

1994   Modeling the Demand for Cocaine. Santa Monica, CA: RAND

Farrelly M.C. Bray J.W., Zarkin, G.A., and B.W.Wendling

2001   The joint demand for cigarettes and marijuana: Evidence from the National Household

      Surveys on Drug Abuse. Journal of Health Economics 20: 51-68.

Johnson-Bruce-D, Golub-Andrew, and Fagan-Jeffrey

1995   Careers in crack, drug use, drug distribution, and nondrug criminality. Crime and

      Delinquency 41(3).

Johnston, L. D., O'Malley, P. M., & Bachman, J. G.

2001   *Monitoring the Future national survey results on drug use, 1975-2000. Volume I:*

      Secondary school students (NIH Publication No. 01-4924). Rockville, MD: NIDA.

Kahneman, D. & Tversky, A.

1979   Prospect Theory: An Analysis of Decision Under Risk. *Econometrica.* 47, 263-291.

Kleiman, Mark A.R.

1989   Marijuana: Costs of Abuse, Costs of Control. New York: Greenwood Press.

Larson, Richard C. and Amadeo Odoni

1981   Urban Operations Research. Englewood, NJ: Prentice Hall

Maguire, K. & Pastore, A.L.

2001   Sourcebook of Criminal Justice Statistics: 2000. Washington, DC: USGPO.

Natarajan, Mangai and Mike Hough (eds.)

2000   Illegal Drug Markets: From Research to Prevention Policy. Crime Prevention Studies,
        Volume 11. Monsey, NY: Criminal Justice Press

National Institute of Justice (NIJ)

2003   Toward a Drug and Crime Research Agenda for the 21st Century. Washington, DC: US
        Government Printing Office

Office of National Drug Control Policy (ONDCP)

2001   What America's Users Spend on Illegal Drugs. Washington, DC: The White House.

Office of National Drug Control Policy (ONDCP)

2002   Pulse Check: Trends in Drug Abuse November 2002. Washington DC: The White
        House. Office of National Drug Control Policy (ONDCP) NCJ 197242.

2004   Pulse Check: Trends in Drug Abuse January 2004. Washington DC: The White House.

Office of National Drug Control Policy (ONDCP) NCJ 201398.

2004   National Drug Control Strategy, 2004. Washington, DC: The White House.

Office of National Drug Control Policy (ONDCP).

Forthcoming. The Price and Purity of Illicit Drugs: 1981 Through the Second Quarter of 2003.
        Washington DC: The White House.

Pacula, R.L.; Grossman, M; Chaloupka, F.J.; P. O'Malley; L.D. Johnston and M.C. Farrelly.

2001   Marijuana and Youth (pp. 193-191). In Risky Behavior Among Youths: An Economic
        Analysis. Jonathan Gruber (Ed.), Chicago, IL: University of Chicago Press.

Parker, H.

2000   How Young Britons Obtain Their Drugs: Drugs Transactions at the Point of

Consumption (pp.59-82). In Illegal Drug Markets: From Research to Prevention Policy.

Mangai Natarajan and Mike Hough (eds.), Monsey, NY: Criminal Justice Press.

Prelec, D.

2000. Compound invariant weighting functions in prospect theory. In D. Kahneman & A.

Tverky (Eds.), *Choices, Values, and Frames.* New York: Cambridge University Press.

Saffer H. and F.J. Chaloupka.

1999   The demand for illicit drugs. Economic Inquiry 37(3): 401-411.

Simon, D., and E Burns

1997   The Corner. New York: Broadway Books

Substance Abuse and Mental Health Services Administration (SAMHSA)

2003   How Youth Obtain Marijuana. The NSDUH Report, September 19th,

www.DrugAbuseStatistics.samhsa.gov.

United Nations Office on Drugs and Crime

2004   2004 World Drug Report. Oxford University Press.

Wilkins, Chris, James Reilly, Megan Pledger, and Sally Casswell

2004   Estimating the Total Dollar Value of Illicit Market for Cannabis in New Zealand. Mimeo.

Table 1: Patterns of Most Recent Marijuana Acquisition, Survey Questions Answered, and Days of Marijuana Use

Respondent Questioned About	Nature of Most Recent Acquisition	Respondent Bought in Last Year?	Respondent Traded in Last Year?	Group ID Number	Group's Share of Past Year Users	Avg Days Used in Past Year	Group's Share of Past Year Days of Use
Purchase	Purchase	Yes		1	39.1%	154	63.1%
Purchase	Trade	Yes		2	0.9%	142	1.4%
Purchase	Gift	Yes		3	13.5%	127	17.9%
Purchase	Grew	Yes		4	0.4%	192	0.8%
				Total 1-4	**53.9%**	**147**	**83.1%**
Trade	Trade	No	Yes	5	1.1%	95	1.1%
Trade	Gift	No	Yes	6	0.9%	95	0.9%
Trade	Grew	No	Yes	7	0.1%	117	0.1%
				Total 5-7	**2.1%**	**96**	**2.1%**
Gift	Gift	No	No	**8**	**43.3%**	**30**	**13.5%**
Grew	Grew	No	No	**9**	**0.7%**	**171**	**1.2%**

Table 2: Source and Location of Most Recent Acquisition by Nature of Acquisition

	Got for Free	Purchased	Traded	Total
% of Respondents	58%	39%	2%	
Most Recently Acquired From:				
Friend	82%	79%	56%	80%
Relative	11%	4%	30%	9%
Stranger	7%	16%	14%	11%
Most Recently Acquired …				
In a Public Bldg	5%	7%	22%	6%
In a School	2%	2%	28%	2%
Outside on School Property	1%	1%	3%	1%
Inside Home, Apt or Dorm	62%	53%	24%	57%
Outside in Public Area	10%	14%	11%	12%
Other	21%	22%	13%	21%
Most Recently Acquired…				
Near Where Now Living	41%	41%	39%	41%

Table 3: Proportions of Past Year Marijuana Users Who Gave/Shared and/or Sold Some of Their Most Recent Acquisition

Group, defined by past acquisition pattern	Gave or Shared	Sold	Either	Total N
Have bought in last year	71%	10%	73%	10,944,160
Most recent acquisition was a purchase	67%	9%	69%	7,909,005
Most recently got free but have bought in last year	82%	9%	83%	2,760,850
Have traded for in last year but not bought	44%	6%	48%	251,240
Most recently got free and haven't bought or traded for	41%	1%	41%	7,418,268
Most recently grew and haven't bought or traded for	61%	45%	65%	37,102
Total (all respondents who answered qustions)	58%	6%	60%	18,650,770

Table 4: Typical Purchase Quantities Measured in Grams

	Percent of Total Loose Purchases	Median Price per Gram Paid	Average Price per Gram Paid
< 5 grams	33.5%	$6.40	$7.84
>= 5 grams but < 10 grams	38.6%	$3.47	$4.68
>= 10 grams but < 1 oz	14.2%	$2.63	$3.84
>= 1 oz but < 1 pound	11.4%	$1.15	$1.79
> 1 pound	2.2%	$0.33	$0.49

Table 5
Weighted Descriptive Statistics of Sample of Loose Marijuana Purchasers
Used in Multivariate Analysis (N=3872)

Variable	Mean	Standard Deviation	Minimum Value	Maximum Value
Price and Total Cost Variables				
Total Cost	64.310	158.626	2.50	1500.00
Price per Gram	5.112	4.426	3.67E-04	19.925
Quantity (Q_i)				
ln (amount in grams)	2.174	1.383	0.916	10.617
Amount measured in Grams (omitted category)	0.635	0.481	0	1
Amount measured in Ounces	0.342	0.474	0	1
Amount measured in Pounds	0.023	0.150	0	1
Individual Characteristics (X_i)				
Male	0.689	0.463	0	1
African American	0.129	0.335	0	1
Hispanic	0.084	0.277	0	1
Other Race	0.033	0.177	0	1
Age	27.740	10.987	12	57
Age squared	890.213	724.789	144	3249
Total Family Income: < $20,000 (omitted category)	0.242	0.401	0	1
Total Family Income: $20,000 - $49,999	0.411	0.492	0	1
Total Family Income: $50,000 - $74,999	0.152	0.359	0	1
Total Family Income: >= $75,000	0.195	0.396	0	1
Educational Attainment	8.074	2.029	1	11
Interviewed in 1st Quarter (omitted category)	0.251	0.432	0	1
Interviewed in 2nd Quarter	0.237	0.425	0	1
Interviewed in 3rd Quarter	0.250	0.433	0	1
Interviewed in 4th Quarter	0.261	0.439	0	1
Live in MSA with 1 Million Plus Pop. (omitted category)	0.445	0.491	0	1
Live in MSA with Fewer than 1 Million population	0.366	0.482	0	1
Not in an MSA	0.189	0.392	0	1
Sold Some of Last Purchase	0.100	0.300	0	1
Shared Some of Last Purchase	1.282	0.450	1	2
New Initiate	0.070	0.255	0	1
Transaction Characteristics (E_i)				
Purchased from Friend (omitted category)	0.801	0.400	0	1
Purchased from Family	0.043	0.202	0	1
Purchased from Stranger	0.151	0.358	0	1
Purchased in Private Dwelling (omitted category)	0.550	0.498	0	1
Purchased Inside Public Bldg	0.093	0.290	0	1
Purchased Outside	0.151	0.358	0	1
Purchased in Other Location	0.206	0.405	0	1
Purchased Close to Home	0.409	0.492	0	1

Table 6
Estimates from GLM Estimation of Total Purchase Cost

	Full Sample				Grams Only		Ounces Only	
	Model 1		Model 2		Model 3		Model 4	
	β	Robust Std Err	β	Robust Std Err	β	Robust Std Err	β	Robust Std Err
Ln(amount)*	0.425 ***	0.029	0.411 ***	0.029	0.421 ***	0.029	0.526 ***	0.029
Amt in Ounces	-0.199 *	0.090	-0.108	0.088				
Amt in Pounds	0.912	1.005	0.650	1.215				
Ln (amount)*Amt in Ounces	0.181 ***	0.041	0.138 ***	0.039				
Ln (amount)*Amt in Pounds	0.008	0.129	0.033	0.157				
Male	0.165 ***	0.036	0.144 ***	0.035	0.068	0.040	0.232 ***	0.059
African American	-0.454 ***	0.055	-0.471 ***	0.055	-0.520 ***	0.061	-0.299 **	0.114
Hispanic	-0.185 **	0.072	-0.203 **	0.072	-0.231 **	0.081	-0.238 *	0.112
Other Race	-0.038	0.109	-0.015	0.113	0.155	0.140	-0.310 *	0.143
Age	0.049 ***	0.011	0.048 ***	0.011	0.035 *	0.014	0.065 ***	0.016
Age Squared	-0.001 ***	1.55E-04	-0.001 ***	1.49E-04	0.000	2.20E-04	-0.001 ***	2.22E-04
Family Inc: $20,000 - $49,999	-0.036	0.041	-0.038	0.040	-0.049	0.046	0.024	0.072
Family Inc: $50,000 - $74,999	0.063	0.051	0.069	0.050	0.069	0.056	0.095	0.101
Family Inc: >= $75,000	0.137 ***	0.048	0.142 **	0.047	0.088	0.053	0.291 ***	0.082
Education	0.050 ***	0.011	0.050 ***	0.010	0.064 ***	0.011	0.028	0.017
Int 2nd Quarter	-0.062	0.050	-0.053	0.049	-0.037	0.058	-0.104	0.077
Int 3rd Quarter	-0.045	0.049	-0.037	0.047	0.000	0.054	-0.133	0.081
Int 4th Quarter	-0.034	0.049	-0.019	0.046	0.003	0.052	-0.034	0.084
Live in MSA with < 1 Mil pop	0.004	0.038	-0.003	0.038	-0.032	0.046	0.022	0.060
Not in an MSA	0.049	0.041	0.048	0.041	-0.032	0.049	0.191 **	0.069
Purchase from Family	-0.111	0.083	-0.106	0.084	-0.050	0.106	-0.242	0.137
Purchase from Stranger	-0.039	0.044	-0.022	0.044	-0.070	0.051	0.067	0.070
Purchased Inside Public Bldg	-0.196 ***	0.060	-0.185 **	0.063	-0.218 ***	0.067	-0.231 *	0.110
Purchased Outside	-0.182 ***	0.048	-0.198 ***	0.046	-0.127 *	0.056	-0.321 ***	0.077
Purchased in Other Location	-0.129 **	0.046	-0.126 **	0.044	-0.201 ***	0.053	0.045	0.078
Purchase Close to Home	0.042	0.033	0.022	0.033	0.050	0.039	-0.035	0.057
Sold Some of Last Purchase			0.396 ***	0.065	0.291 ***	0.083	0.462 ***	0.085
Shared Some of Last Purchase			-0.030	0.038	-0.040	0.047	0.047	0.059
New Initiate			-0.193 **	0.063	-0.245 ***	0.063	-0.030	0.133
Constant	1.425 ***	0.144	1.490 ***	0.161	1.622 ***	0.199	1.157 ***	0.271
Number of Observations	3872		3872		2525		1249	
AIC	9.272		9.259		8.459		10.368	

Notes: Significance is denoted as follows: *** denotes significance at the .01% level (two-tailed test), ** denotes significance
at the 1% level (two tailed test), * denotes significance at the 5% level (two tailed test).

Table 7
Proportion of Past Month Purchasers and Purchases by Number of Past Month Purchases

# of Days Purchased in Last Month	Proportion of Past-Month Purchasers	Proportion of Past Month Purchases
1	25%	4%
2	21%	7%
3-5	27%	18%
6-15	17%	30%
16-29	5%	20%
30	4%	21%

Figure 1
Method for Acquiring Marijuana
2001 Weighted NHSDA

Grew It
1.0%

Bought It
39.2%

Got It for Free
57.8%

Traded
2.0%
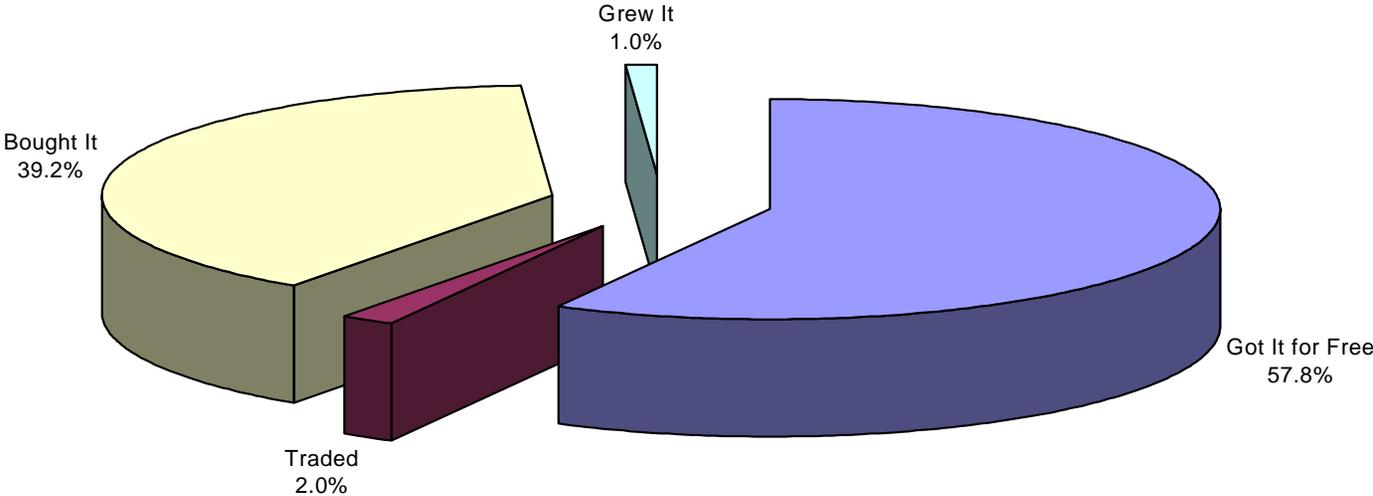
Figure 2: The Cumulative Distribution Function of Purchase Quantities for Sellers vs. Others
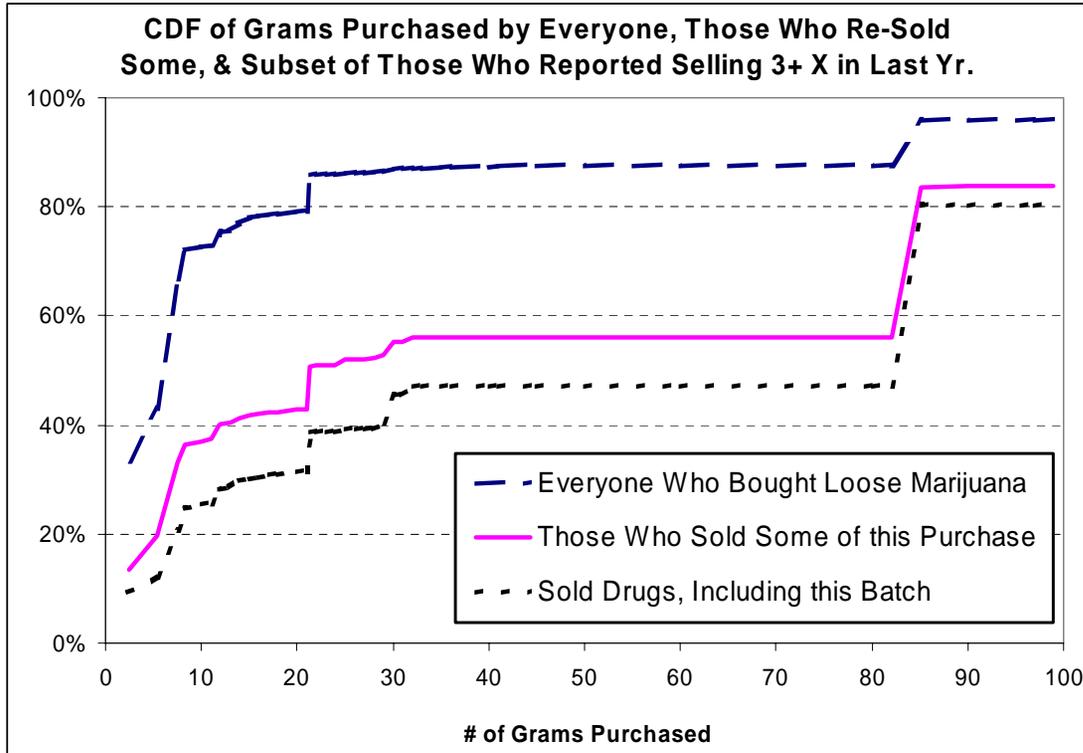
Table A1: Quantities of Marijuana Purchased by Those Purchasing in the Past Year

	Fraction of Loose Purchases Reported in Unit	Percent Reporting Response Within Unit	Conversion of Amount Category to Grams
Grams	64.40%		
At least 1 but less than 5		52%	2.5 g
At least 5 but less than 10		36%	7.5 g
10 grams or more		12%	Amount Written In
Ounces	33.30%		
At least 1/8, but less than 1/4		29%	5.32 g
At least 1/4, but less than 1/3		16%	8.27 g
At least 1/3, but less than 1/2		5%	11.81 g
At least 1/2 but less than 1 ounce		20%	21.26 g
At least 1 but less than 5 ounces		25%	85.05 g
At least 5 but less than 10 ounces		4%	212.62 g
At least 10 but less than 16 ounces		1%	368.55 g
Pounds	2.20%		
At least 1 but less than 2 pounds		46%	680.4 g
At least 2 but less than 3 pounds		12%	1133.99 g
At least 3 but less than 4 pounds		8%	1587.59 g
At least 4 but less than 5 pounds		5%	2041.19 g
5 or more pounds		29%	453.6 g x Amount Reported in Pounds

End Notes

[1] Specifically, the marijuana market questions were asked of people who responded to the "MJREC" question by saying that they had used in the past month, used in the past year but not in the past month, or for whom past-year use was inferred and logically assigned.

[2] In unweighted terms, 292 of the 3,027 people who answered MMBTREC1 reported it had been more than 12 months since they last bought marijuana.

[3] We compared respondents who bought more than a year ago to those who bought within the last year. They were demographically similar. They were also similar with respect to many characteristics of the purchases. However, they were more likely to purchase joints as opposed to loose marijuana (9% vs. 4% for past year purchasers) and to purchase at work (9% vs. 5% for past-year purchasers). They also reported using marijuana on only one-third as many days in the last year (average of 54 vs. 166 days).

[4] To illustrate the potential problems, the number of people the NHSDA estimated had *ever* used cocaine was essentially unchanged in each survey taken between 1990 and 1998 (at about 21 million). That is hard to reconcile with self-reported annual initiation averaging about 500,000 people per year over that time.

[5] It is natural to wonder whether data about illicit activities collected through a government-administered survey, even one that guarantees anonymity, can have much validity. A simple calculation illustrates that the Household Survey can give a rough indication of important quantities. We have criminal justice system data on the number of drug arrests. Suppose, however, those data were not available and one tried to estimate that number from the household survey and data on those incarcerated. The 2000 survey suggests that 721,114 people in the household population had been arrested for a drug law violation in the last 12 months. In addition, there were 133,000 drug law violators in jail (Caulkins and Chandler, in submission). Presumably almost all of them were arrested in the last 12 months and so were not available to answer the household survey. Likewise, after adjusting for average time served, one would estimate that about 154,000 federal and state prison inmates were arrested for drug law violations in the last year. That leads to a combined estimate of 721,000 + 133,000 + 154,000 = 1,008,000 arrests. The difference between that and the actual figure of 1,042,334 (Maguire and Pastore, 2001) is well within the confidence interval

stemming from sampling error. Furthermore, estimated demographic characteristics are similar. For example, 18.9% of self-acknowledged arrestees in the household survey were female, vs. 17.6% of arrestees identified by the Sourcebook.

[6] One percent of past year marijuana users report that they grew marijuana and did not acquire it through other methods (e.g. purchase or trade). These individuals are not asked specific questions regarding where and from whom they acquired the marijuana.

[7] Respondents did this sharing between acquiring the marijuana and being interviewed. Some of those who had not shared or given any away may have just obtained their marijuana. If they had not used it all, they might still give away or share some of it later.

[8] There do not appear to be many "professional" marijuana sellers who acknowledge their activity in the household survey. Among past-year marijuana users (the universe for the marijuana market questions), only about 500,000 acknowledge both buying marijuana within the last 30 days and having sold an illicit drug six or more times in the last year. These individuals report a moderately high level of deviance. 58% admit having been arrested and booked (10% for a drug-related offense in the last 12 months). Within the past year, 24% were on probation, and 23% report having attacked someone with the intent to seriously harm them. These individuals also report higher rates of dependence and use of other substances than do people who report selling fewer than six times in the past year.

[9] Dollar values are obtained by assigning the midpoint of each response category to that purchase. For example, for the response category "less than $5.00", an amount of $2.50 is assigned. For the response category, "more than $1000.99", we assign a value of $1500.

[10] Jumps in the cumulative distribution functions at odd quantities come from assigning all people in a category to the midpoint of that category. E.g., 21.26 grams is 0.75 ounces; it corresponds to the answer "at least half, but less than one ounce".

[11] Additional runs excluding the location and source variables reveal that the coefficient on ln(amount) is slightly larger (less than 0.06 change in magnitude) when the full sample is included. The difference is due to including the information on the source and location of the transaction, not the dropped observations.

[12] A boxcox transformation test was used to determine the appropriate specification of the dependent variable. We then used a Cook-Weisberg test for heteroskedasticity in the log transformed version of the model and could reject constant variance at the 1% significance level. The nature of the

heteroskedasticity was determined through a link test, which determined that the error structure could be approximated by a gamma distribution. For more information on these diagnostic tests, see Deb, Manning and Norton (2003).

[13] Quantity discounts for the buyer are the mirror image of price markups for the seller.

[14] The dilution of marijuana is not a chemical process given that the plant's potency is determined by how it was grown and the parts of the plant material that are sold (e.g. buds have higher THC content then do leaves). Dilution can only occur through the introduction of "filler" material, which is physically identifiable, particularly to experienced buyers. Given that dilution can be easily detected through physical inspection, there is no reason to expect there to be systematic differences in potency across different levels of the distribution chain. Hence, any bias caused by omitting potency should be constant across distribution levels.

[15] There is a parallel question MMT30FRQ asking about the number of trades for marijuana in the last 30 days, but with only 38 responses, it is hard to do detailed analysis of that variable.

[16] (11.9 million users) x 18.7 joint per month * 12 months = 2.7 billion joints in the year.

[17] $25 is considerably less than the average of the amount spent on the most recent purchase, but that is not surprising. Larger and more expensive purchases could be followed by longer than average inter-purchase times. Hence, by random incidence (Larson and Odoni, 1981), they would to be more likely to be the most recent purchase made at the time of the survey than would be smaller purchases followed by shorter inter-purchase intervals.