Consumption Decisions in Markets with Limited Accessibility: The Case of Cannabis

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Preliminary and Incomplete

Abstract: Illicit drug use is prevalent around the world. While the nature of the market makes it difficult to determine the total sales worldwide with certainty estimates suggest sales are around $150 billion a year in the United States alone. Among illicit drugs marijuana is the most common, where the US government spends upwards of $7.7 billion per year in enforcement of the laws for marijuana sales (Miron, 2005). or the past 30 years there has been a debate regarding whether marijuana should be legalized. Previous literature has examined the impact of decriminalization on marijuana use. Studies to date have not disentangled the impact of limited accessibility from consumption decisions based solely on preferences. However, this distinction is particularly important in the market for cannabis as legalizing the drug would impact accessibility. Hence, if most individuals do not use because they don't know where to buy it, but would otherwise use, we would see a large increase in consumption ceteris paribus, which would be important to consider for policy. On the other hand, if accessibility plays little role in consumption decisions, then making drugs more readily available would impact the supply more.In order to access the impact of legalization on use, it is necessary to explicitly consider the role played by accessibility in use, the impact of illegal actions in utility, as well as the impact on the supply side. In this paper, we develop and estimate a model of buyer behavior that explicitly considers the impact of illegal behavior on utility as well as the impact of limited accessibility (either knowing where to buy or being offered) an illicit drug on using the drug. We use the demand side estimates to conduct counterfactuals on how use would change under a policy of legalization. We conduct counterfactuals under different assumptions regarding how legalization would impact the supply as well as various tax policies on the price of cannabis.

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1 Introduction

Illicit drug use is prevalent around the world. While the nature of the market makes it difficult to determine the total sales worldwide with certainty estimates suggest sales are around $150 billion a year in the United States alone. Among illicit drugs marijuana is the most common, where the US government spends upwards of $7.7 billion per year in enforcement of the laws for marijuana sales (Miron, 2005). For the past 30 years there has been a debate regarding whether marijuana should be legalized. More recently California residents were asked to decide if growing marijuana should be legal for personal use.[2] Those in favor of legalization cite the high expenditures on enforcement and the harsh consequences a criminal record can have for young users who are otherwise law-abiding citizens. Furthermore, as in the case of California, state governments could benefit from legalization by taxing the sales. Those opposed are concerned that legalization could result in lower prices, hence generating higher use. This is of particular concern if marijuana usage serves as a "gateway" to subsequent consumption of other harder drugs.

Previous literature has examined the impact of decriminalization on marijuana use. However, decriminalization and legalization differ in significant ways. The first way concerns the impact on dealers. Decriminalization makes it less costly for potential users in that they face a fine for using the drug instead of a harsher cost of a criminal punishment. In contrast, selling the drug is still illegal and hence dealers, should they be arrested, will face the same penalties regardless of the decriminalization status of the state. In other words, decriminalization does not impact the marginal costs (broadly defined to include the risk of criminal prosecution) faced by dealers. Instead it result sin a shift out in the demand curve, resulting in higher prices. Indeed, descriptive statistics show that the average price for cannabis is higher in decriminalized states. In contrast, legalization would remove the risk associated with sale for the dealers as well results in a decrease in marginal cost of production. Therefore whether price is lower or higher depends on the elasticities of the demand and supply curves. The second important way in which decriminalization and legalization differ is in the impact of accessibility of the drug. Given that illicit drugs are not as easy to find as legal products, one can argue that non-users have very little information about how

[2] The use of cannabis is already decriminalized in California where possession is an infraction, the lowest level of offence under state law. Adults caught with an ounce of marijuana will get a $100 ticket but no criminal record.

to get the drug, which is the first step to being becoming a user. Under decriminalization it is still necessary to seek out dealers in order to purchase the drug. Hence, if a potential users wishes to purchase the drug they must first determine where to purchase the drug. If the drug were legalized purchasing the drug would be as difficult as purchasing cigarettes or alcohol. Finally, while decriminalization removes criminal penalties faced by users, using the drug is still illegal. However, some non-users report their reasons for not using an illicit drug is because it is illegal (Australian National Drug Strategy Household Survey, 2001). Legalization would obviously remove this hindrance to use, which may result in use among some current non-users.

Studies to date have not disentangled the impact of limited accessibility from consumption decisions based solely on preferences. However, this distinction is particularly important in the market for cannabis as legalizing the drug would impact accessibility. Hence, if most individuals do not use because they don't know where to buy it, but would otherwise use, we would see a large increase in consumption ceteris paribus, which would be important to consider for policy. On the other hand, if accessibility plays little role in consumption decisions, then making drugs more readily available would impact the supply more.

In order to access the impact of legalization on use, it is necessary to explicitly consider the role played by accessibility in use, the impact of illegal actions in utility, as well as the impact on the supply side. In this paper, we develop and estimate a model of buyer behavior that explicitly considers the impact of illegal behavior on utility as well as the impact of limited accessibility (either knowing where to buy or being offered) an illicit drug on using the drug. We use the demand side estimates to conduct counterfactuals on how use would change under a policy of legalization. We conduct counterfactuals under different assumptions regarding how legalization would impact the supply as well as various tax policies on the price of cannabis.

Literature Review to be completed.

We apply the model to dataset from Australia that is particularly suited to examine the role of accessibility in cannabis use. Preliminary results indicate that decisions regarding accessibility and use are linked in both observed and unobserved ways. The paper is structured as follows. Section 2 discusses the background of cannabis and the legal policies in Australia. In Section 3 we discuss the data in more detail. Sections 4 and 5 present the model and the estimation technique. Section 6 contains our preliminary estimates and

counterfactual results.

2 Background

Cannabis comes in a variety of forms and potency levels. The herbal form consists of the dried flowering tops, leaves and stalks of the plant. The resinous form consists of the resin secreted from the plant and resin oil In this paper we focus on the most commonly used forms of cannabis: the leaf of the plant, the flowering tops (or head) of the plant, and sinsemilla, a high potency form selectively bred from certain species commonly called skunk. The leaf, head, and skunk are collectively known as marijuana.[3]

The major psychoactive chemical compound in marijuana is delta-9-tetrahydrocannabinol (or THC). According to the United Nations Office on Drugs and Crime,"the amount of THC present in a cannabis sample is generally used as a measure of cannabis potency." The amount of THC absorbed by marijuana use differs according to the part of the plant that is used, the way the plant is cultivated, and the method used to imbibe cannabis. On average marijuana contains about five percent THC, where the flowering tops contain the highest concentration followed by the leaves (Adams and Martin, 1996). Cannabis that grown hydroponically (hydro) under artificial light with nutrient baths is thought by some to have higher concentrations of THC than naturally grown cannabis (Poulsen and Sutherland, 2000). Given that the forms of marijuana vary in THC content and users may select the forms based on THC content we include a variable to capture the level of THC in the model. When the drug is smoked, the level of THC in the blood reaches a peak in a relatively short time and then decreases to about five to ten percent of the initial level within the first hour. With ingestion, absorption is much slower and it takes one to three hours for the THC to enter the bloodstream, delaying the onset of psychoactive effects; the 'high' may be less intense but the period of intoxication is much longer (up to several hours) because of the digestive process. "

In Australia the use of cannabis for any purpose is illegal, however, all states/territories have introduced legislation to allow police to deal differently with minor offenses. Table 1 presents an overview of the policies across states. Four jurisdictions (South Australia (SA), Northern Territory (NT), Australia Capital Territory (ACT), and Western Australia (WA))

[3] We do not consider hashish use (the resin or resin oil of the plant), as these forms are much harder to obtain and have a much higher level of THC, which can be as high as 60%.

have decriminalized the possession of small quantities of cannabis via the introduction of infringement schemes. Under an infringement scheme individuals which are found to have violated the law with a minor cannabis offence are fined but are not jailed. What constitutes a minor offense and the fine varies by state. These include possession of small amount of cannabis plant material (bulbs, leaves) and resin (SA and NT), growing of one plant (SA) or two plants. The quantity considered a minor offence varies by cannabis type (plant versus resin), ranging from 100 grams of plant material in SA to 25 grams in ACT. Infringement schemes were introduced at different times across the states: SA was the first to implement them in 1987, followed by NT in 1992 and ACT in 1996. In 2004 WA moved to this system. In other states and territories (Tasmania (TAS), Victoria (VIC), New South Wales (NSW), and Queensland (QLD)) possession of any amount of cannabis is a criminal offence, and individuals may be jailed for possession of any quantity. However, these jurisdictions have introduced "diversion schemes" where the police may issue a caution of diversion into treatment or education for a minor offence instead of jail time. The number of cautions issued before a criminal conviction varies by jurisdictions. The diversion schemes were introduced at different times: in 1998 in TAS and VIC; in 2000 in NSW, and 2001 in QLD. The state of WA gradually introduced the schemes between 2000 to 2003.[4] We construct two measures of the degree of decriminalization. These include whether the state uses an infringement scheme and the maximum number of grams for which possession is a minor offense. Table 1 summarizes the policies across states.

State	Decrimilized?	Year Diversion Scheme Introduced	Maximum grams still a minor offence
New South Wales	No	2000	15
Victoria	No	1998	50
Queensland	No	2001	50
Western Australia	2004	2000	30
South Australia	1987	Decrimilized	100
Tasmania	No	1998	50
ACT	1996	Decrimilized	25
Northern Territory	1992	Decrimilized	50

Table 1: Cannabis Legislation by State

[4] Minor cannabis offences only refer to the possession of cannabis, not the possession of a plant. Trafficking and possessions of larger amounts of cannabis are serious offences that incur large monetary fines and long prison sentences.

3 Data

3.1 Individual-Level Data

We use data from two sources. The first is an individual-level cross-section survey called the Australian National Drug Strategy Household Survey (NDSHS). The NDSHS was designed to determine the extent of drug use among the non-institutionalized civilian Australian population aged 14 and older.[5] About 20,000 individuals are surveyed every 2 or 3 years from all Australian states/territories. We use data from three waves: 2001, 2004, and 2007. These contain demographic information, information on cannabis use, as well as accessibility measures.

Cannabis is the most commonly used illicit drug (Australian Institute of Health and Welfare, 2005a). As Table 2 shows over 40% of individuals report that they have ever used cannabis. The average age of onset is 19 across all years. An individual i is observed to use cannabis if they answer yes to the question "Have you used cannabis in the last 12 months." In 2001 just over 16% reported using cannabis in the past year, but this declined to around 12% by 2007. The use of hydro grown cannabis has increased over time in Australia, which is consistent with patterns seen in the rest of the world. Although the rates of cannabis use are considerable, most people who use cannabis do so infrequently. Those that report they use cannabis daily or habitually is around 3%. We should note that hard core drug users are less likely to return the survey or to be available for a telephone survey. Hence, our study will reflect more recreational users.

Cannabis use varies with age and is the most prevalent among those in their twenties and thirties. Use declines to under 0.4% for those in their sixties. We restrict the data to individuals aged between 14 and 60. The average age of a respondent in our sample is just under 40. Approximately 60% are married and 2% of the sample are of Aboriginal descent. Finally, we construct an indicator variable equal to one if individuals report their health status is good, very good, or excellent. About 56% of individuals report being in good or better health.

[5] Respondents were requested to indicate their level of drug use and the responses were sealed so the interviewer did not know their answers.

	Year		
	2001	2004	2007
Demographics			
Male	42.89%	42.38%	42.26%
Age	38	38	39
Married	60.69%	57.64%	61.80%
Aboriginal Descent	1.63%	1.64%	1.91%
Cannabis Use			
Used Cannabis Ever in Life	43.68%	43.60%	45.15%
Used Cannabis in Last 12 Months	16.48%	14.78%	12.26%
Report Use of Cannabis is a Habit	3.05%	2.85%	2.28%
Report Daily Use	2.73%	2.44%	2.78%
Use Leaf	7.55%	6.36%	4.84%
Use Head	13.08%	11.19%	8.48%
Use Hydro	22.57%	18.20%	40.35%
Average Age First Used	19	19	19
Number of Observations	18261	19861	13479

Table 2: Descriptive Statistics

The NDSHS data also ask questions relating to accessibility of cannabis, which is particularly suited to the focus of this research. We construct a measure of accessibility from the answers to three questions: whether the individual reports that they had the opportunity to use or had been offered the drug in the past 12 months; whether they report it would be easy for them to obtain; and two responses of non-users to a question about why they didn't use the drug: it was "too difficult to get" or they had "no opportunity" to use it:

$$a_{im} = \begin{cases} 1 & \text{been offered or had opportunity to use in past 12 months} \\ 1 & \text{easy to obtain} \\ 0 & \text{too difficult to get; no opportunity to use} \end{cases}$$

We discuss descriptive statistics regarding accessibility in use in the next subsection.

Finally, to assess the role the legal status of cannabis plays in the decision to use, we construct the variable l_{im} that is intended to capture the disutility associated with doing something illegal. It is defined from responses to questions of the form"If marijuana/cannabis were legal to use, would you..." where

$$l_{im} = \begin{cases} 0 & \text{Not use it - even if legal and available} \\ 1 & \text{Try it} \\ & \text{Use it as often or more often than I do now} \\ -1 & \text{Use it less often than I do now} \end{cases}.$$

About 7% of the sample reports they would use cannabis if it were legal.

3.2 Prices

Our pricing data comes from the Australian Bureau of Criminal Intelligence, Illicit Drug Data Reports which are collected during undercover buys. Given that cannabis is an illicit drug there are a few data issues to resolve regarding the prices. First, we do not observe prices in all years due to different state procedures in filing reports and the frequency of drug arrests of that certain cannabis form. To deal with missings across time we use linear interpolation when we observe the prices in other years. Second, the price per gram is the most frequently reported price, but in some quarters the only price available is the price per ounce. We cannot simply divide the price per ounce by 28 to convert it to grams as quantity discounts are common (Clements 2006). However, assuming price changes occur at the same time with gram and ounce bags, when we observe both the gram and ounce prices we substitute the corresponding price per gram for the time period in which it is missing when the price per ounce is the same in the period where both are reported. Third, some prices are reported in ranges in which case we use the mid-point of the reported price range. Finally, when skunk prices are not available we use the price per gram for hydro. We deflate the prices using the Federal Reserve Bank of Australia Consumer Price Index for Alcohol and Tobacco where the prices are in real 1998 AU$. These data are reported on a quarterly or semi-annual basis. We construct an annual price per gram measure by averaging over the periods.[6] As Figure 1 illustrates the real leaf prices has not varied much over states across time. This is consistent with other studies of the price of cannabis in Australia.

[6] A joint contains between 0.5 to 1.5 grams of plant material.

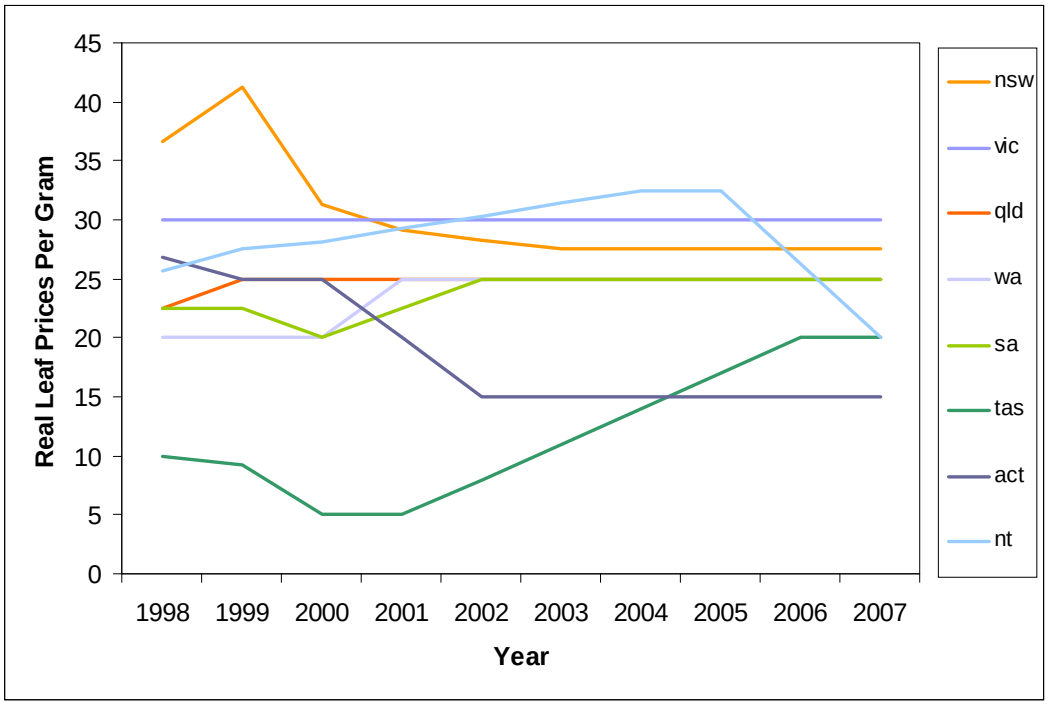

Figure 1: Leaf Prices By State

Table 3 reports descriptive statistics by state. They indicate that cannabis use varies across states, ranging from 12% in Victoria to over 20% in the Northern Territory. Between 49 and 66% of the population report having access to cannabis. Not surprisingly both use and access are higher in states where cannabis use is decriminalized. Interestingly, if we compute the percentage of users among those with access (as opposed to the percentage of users among the entire population) the percent with access that report using cannabis has a higher mean and lower variance across states.

State	Percent Used Cannabis in Last 12 Months	Percent Report Access To Cannabis	Percent With Access that Use Cannabis	Average Price of Cannabis	Number of Observations
New South Wales	13.09%	51.25%	25.50%	41.76	13959
Victoria	12.68%	49.35%	25.68%	33.51	10825
Queensland	14.45%	52.25%	27.64%	33.12	9319
Western Australia	19.36%	60.92%	31.77%	42.31	5808
South Australia	15.45%	57.85%	26.69%	40.96	4183
Tasmania	14.98%	58.43%	25.64%	26.09	2283
ACT	14.24%	52.03%	27.34%	28.39	2629
Northern Territory	21.72%	65.82%	32.96%	38.20	2595
Decrimilized State	16.59%	58.12%	28.52%	38.90	12838
Not Decrimilized	14.11%	52.29%	26.95%	36.26	38763

Table 3: Descriptive Statistics by State

We constructed an individual-specific price using a weighted average across per-gram prices for various cannabis forms, where the weights are the percentage of that form that individual i reports using as reported in the survey. Consistent with other studies, we find that marijuana is expensive in New South Wales, which contains the city of Adelaide, which is known to be the center of the marijuana industry. The price of cannabis is higher on average in decriminalized states. This is consistent with the fact that decriminalization doesn't affect the suppliers as it is only applicable to users who use small amounts. So there is no shift in the supply curve brought about by lower risk/costs. However, the risk/cost has declined for small-users so the demand curve shifts up, resulting in higher prices on average.

4 Model

An individual chooses whether or not to consume cannabis in market m which is defined as a state-year combination. The indirect utility individual i obtains from using cannabis in market m is given by

$$U_{im1} = p_i\alpha_1 + p_i d_i^{age\prime}\alpha_2 + d_i'\beta_1 + x_m'\beta_2 + L_m'\delta_1 + L_m^{decr} d_i^{age\prime}\delta_2 + L_m^{decr}\nu_i\sigma_v + \varepsilon_{im1} \quad \nu_i \sim N(0,1), \tag{1}$$

where p_i is the price. The d_i is a vector of exogenous individual attributes including gender, age in brackets (young adult, college age, pensioner, etc.), a dummy for aboriginal descent,

health status, and the (dis)utility from engaging in illegal behavior.[7] The d_i^{age} is subset of the vector of individual attributes that includes only the age brackets. The x_m and L_m are market-specific, where x_m includes year fixed effects and the proportion of high quality cannabis sold in the market, while L_m include variables related to legality including whether cannabis use is decriminalized and the amount of cannabis that can be grown for a minor offense. The L_m^{decr} is a dummy variable for whether cannabis is decriminalized in market m.[8] There may be individual characteristics that are not observed by the econometrician that impact the utility one obtains from cannabis use. The σ_v measures how "unobserved" individual tastes for cannabis use (ν_i) vary with the decriminalization status. We assume that ν_i are independently normally distributed with a variance to be estimated. Individuals have utility from not using cannabis, which we model as

$$U_{im0} = x_{m0} + \epsilon_{im0}.$$

We normalize x_{m0} to zero, because we cannot identify relative utility levels. The $\varepsilon_{im} = \varepsilon_{im0} - \varepsilon_{im1}$ is a mean zero stochastic term distributed i.i.d. normal across markets and individuals.

This paper concerns the role of accessibility in cannabis use.[9] The probability person i has access to cannabis in market m, denoted ϕ_{im}, is assumed to be a function of individual i's observed characteristics and market characteristics:

$$\phi_{im} = \Pr(h_i'\gamma_1 + w_m'\gamma_2 + L_m^{decr\prime}\gamma_3 + \eta_{im} > 0). \tag{2}$$

The vector of individual attributes, h_i, includes whether the individual lives in a city, gender, a dummy for aboriginal descent, age in brackets, and education variables. The market-specific variables that influence access (w_m) include arrests-per-capita for cannabis use (as a proxy

[7] We do not include potentially endogenous covariates that may impact the utility from using cannabis such as lifetime use, education status, labor force participation, marital status, and number of children. We would need to instrument for them and the impact of these variables on cannabis use is not the primary focus of this paper.

[8] As an alternative to including market-specific legalization variables we could have included state fixed effects, but state limits and decrimilization status vary across states and time.

[9] We are not modeling the frequency of use rather the decision to use in the past 12 months. For this reason we focus on whether an individual has access to cannabis, which is different than whether they can buy it each time they want it due to supply side (potential) shortage reasons or the dealer not being available, etc.

of prevalence) and year-fixed effects.[10]

It is likely that access to cannabis and the use decision are correlated (i.e., through selection). Some individuals may have high levels of utility associated with using cannabis, and therefore will search for where to purchase it. For this reason, the error terms in equations (**??**) and (**??**) are likely to be correlated. The probability that individual i chooses to use cannabis depends upon the probability they know where to purchase cannabis (ϕ_{im}) and the probability they would use it given availability. Let $R_i \equiv \{v : U_{im1}(v_i, p_i, d_i, x_m, L_m, \epsilon_{im1}) \geq U_{im0}(v_i, p_i, d_i, x_m, L_m, \epsilon_{im0}), \phi^*_{im}(h_i, w_{m,} L^{decr\prime}_m, \eta_{im}) > 0\}$ define the set of variables that results in consumption of cannabis given the parameters of the model, where $\phi^*_{im} = h_i'\gamma_1 + w_m'\gamma_2 + L^{decr\prime}_m\gamma_3 + \eta_{im}$. The probability i chooses to use cannabis is given by

$$P_{im} = \int_{R_i} dF_{\varepsilon,\eta,\nu}(\varepsilon, \eta, \nu) = \int_{R_i} dF_{\varepsilon,\eta}(\varepsilon, \eta) dF_{\nu}(\nu)$$

where $F(\cdot)$ denote joints distribution functions and the latter equality follows from independence assumptions. An implicit assumption in economic models that have been considered in this literature is that all individuals have access to cannabis. In our framework, this is equivalent to assuming $\phi_{im} = 1$ and the errors in equations (**??**) and (**??**) are not correlated.

5 Econometric Specification

We specify an econometric model for cannabis access and utility to estimate the parameters from a sample of subjects for whom we observe cannabis use and access. Suppose we have a sample of $i = 1, .., n$ consumers. Let $a_{im} = 0, 1$ denote whether a consumer has access to cannabis ($a_{im} = 1$) or not ($a_{im} = 0$). Whether a subject has access to cannabis will depend on some random shock η_{im} and some covariate vector. Here we assume that an individual's indicator of having access to cannabis can be modeled in terms of a probit

$$a_{im} = I[\mu^a_{im} + \eta_{im} > 0] \text{ where } \eta_{im} \sim N(0, 1),$$

where $\mu^a_{im} \equiv h_i'\gamma_1 + w_m'\gamma_2 + L^{decr\prime}_m\gamma_3$ so that $\phi_{im} = \Pr(a_{im} = 1) = \Phi(\mu^a_{im})$. Further, we let $u_{im} = 0, 1$ denote whether individual i has a positive utility from using cannabis. For ease

[10] Arrests-per-capita refer to arrests of suppliers, not users. For this reason, arrests-per-capita are unlikely to impact the utility associated with using cannabis but are likely to impact the prevalence of cannabis for sale.

of exposition, we refer to u_{im} as net-utility. We have

$$u_{im} = I[U_{im1} > U_{im0}] = I[\mu^u_{im} > \varepsilon_{im0} - \varepsilon_{im1}],$$

where $\mu^u_{im} \equiv p_i\alpha_1 + p_i d_i^{age\prime}\alpha_2 + d_i'\beta_1 + x_m'\beta_2 + L_m'\delta_1 + L_m^{decr} d_i^{age\prime}\delta_2 + L_m^{decr}\nu_i\sigma_v$. We let $(\eta_{im}, \varepsilon_{im}) \sim N_2(0, \Xi)$ where Ξ is $2x2$ covariance matrix with 1 on the diagonal and ρ on the off-diagonal.

We define the indicator $c_{im} = 0, 1$ to denote whether consumer i is observed using cannabis, which is given by

$$\Pr(c_{im} = 1) = \Pr(a_{im} = 1)\Pr(u_{im} = 1|a_{im} = 1)$$

$$\Pr(c_{im} = 0) = \Pr(a_{im} = 0) + \Pr(a_{im} = 1)(\Pr(u_{im} = 0|a_{im} = 1).$$

For consumers with access to cannabis the decision whether to use cannabis reflects the net-utility from use so that for those subjects $c_{im} = u_{im}$. For subjects with no access the consumption decision reveals no information about the net-utility. Thus we can observe three possible combinations of access and net-utility:

$$(a_{im} = 1, u_{im} = 1)\ ,\ (a_{im} = 1, u_{im} = 0)\ ,\ (a_{im} = 0)$$

We let $\mathbf{a}_m = \{a_{1m}, ..., a_{n_m m}\}$ denote the vector of access variables for all n_m subjects in market m, $\mathbf{u}_m = \{u_{1m}, ..., u_{n1_m m}\}$ the vector of net-utility variables for the n_{1_m} subjects in market m with access to cannabis and $\mathbf{W}_m = \{\mathbf{W}_{1m}, ..., \mathbf{W}_{n_m m}\}$ the matrix of all covariates. The (conditional on v) likelihood of cannabis access and use in terms of access and net-utility is given by

$$\prod_{U_{m0}} \left[\Pr(a_{im} = 0|W_{im}, \boldsymbol{\theta})^{1-a_{im}} + \Pr(a_{im} = 1, u_{im} = 0 W_{im}, \boldsymbol{\theta})^{(a_{im})(1-u_{im})}\right]$$

$$\prod_{U_{m1}} \Pr(a_{im} = 1, u_{im} = 0|W_{im}, \boldsymbol{\theta})^{(a_{im})(u_{im})}$$

where U_{m0} denotes the set of subjects with no cannabis use and U_{m1} the set of those with cannabis use so that the first product contains the likelihood contributions of the subjects with no cannabis use and the second product term to those of subjects with cannabis use. The vector $\boldsymbol{\theta}$ refers to the model parameters.

For the estimation it is more useful to group the subjects in each market by cannabis access and define the sets I_{m1} for all subjects with access and I_{m0} for all subjects with no access and express the likelihood as

$$\prod_{I_{m0}} \Pr(a_{im} = 0|W_{im}, \boldsymbol{\theta}) \prod_{I_{m1}} \Pr(a_{im} = 1, y_{im} = j|W_{im}, \boldsymbol{\theta})$$

where $j = 0, 1$ For subjects with no access to cannabis, the likelihood contribution is a probit for access and for subjects with access we have a bivariate probit for access and cannabis use. The exclusion restrictions are the prevalence of cannabis use by state and whether the consumer lives in a major city, both of which may impact accessibility but are assumed not to impact utility, and the presence of medical conditions, which may impact utility but not accessibility.

6 Results

The first column of Table 4 presents results from MLE Probit model where selection into use if not considered. The final columns contain estimates from a Bivariate Probit Model corrected for selection on access for 2001, 2004, and 2007 stacked cross section. Both models show that males and individuals in their teens and twenties are more likely to use cannabis relative to females and other age categories. Individuals who are of aboriginal descent are more likely to use and those who report being in better health are less likely to use cannabis.

The results from the probit and the selection model differ in that the probit model indicates individuals are more sensitive to prices (-0.007) than a model that corrects for selection (-0.0059). The selection model results show that the legal status of cannabis use matters more for access than use. Furthermore, the results show that the unobservables from cannabis use and access are positively related (the estimate of Rho is 0.177).

	Probit		Bivariate Probit with Selection			
	Cannabis Use		Cannabis Use		Access	
Individual Attributes						
Male	0.308***	(0.0145)	0.282***	(0.0244)	0.272***	(0.0145)
Aged in Teens	1.046***	(0.0314)	0.944***	(0.0656)	0.836***	(0.0234)
Aged in Twenties	1.211***	(0.0262)	1.034***	(0.0785)	1.077***	(0.0185)
Aged in Thirties	0.836***	(0.0256)	0.718***	(0.0564)	0.679***	(0.0164)
Aged in Fourties	0.536***	(0.0267)	0.482***	(0.0427)	0.398***	(0.0166)
Of Aboriginal Descent	0.220***	(0.0490)	0.185***	(0.0567)	0.255***	(0.0459)
In Good, Very Good, or Excellent Health	-0.296***	(0.0146)	-0.276***	(0.0167)		
Highest Education is High School	0.032	(0.0233)			0.0856***	(0.0192)
Highest Education is Trade Degree	0.079***	(0.0197)			0.158***	(0.0155)
Highest Education is University Degree	-0.053**	(0.0227)			0.00455	(0.0169)
Market and Policy Variables						
Price	-0.007***	(0.0014)	-0.0059***	(0.0012)		
High Potency	-0.202	(0.1510)	0.052	(0.1540)		
Decriminalized	0.176***	(0.0187)	0.118***	(0.0244)	0.162***	(0.0137)
Grams Possession is not Minor Offense	-0.002***	(0.0004)	-0.001**	(0.0004)		
Would Use Can if Legal	0.343***	(0.0289)	0.262***	(0.0271)		
Arrests Per Capita of Suppliers (Prevalence)	0.287***	(0.0503)			0.138***	(0.0313)
Live in City	0.017	(0.0157)			-0.148***	(0.0119)
Rho			0.177	(0.145)		

Notes: Includes Year Effects and Individuals Aged 14 through 60

Table 4: MLE Results

We use the results from the selection model to investigate the effect of legalization of the cannabis market and improve the understanding about individual's decision making in that context. Our analysis aims to address the following policy concerns: (i) what role does access play in terms of being offered the cannabis in a subject's probability of taking the drug; and (ii) what role do other factors such as demographic characteristics, illegality of the drug, prices etc. play in the decision to use the drug.

We conduct the counterfactuals under different assumptions regarding how legalization would impact the demand side and the supply side, as well as consider the impact on use of various cannabis tax policies. More specifically, if cannabis were legalized then accessibility would not be as large of a hurdle.[11] In the model this implies that ($\phi_{im} = 1$). Furthermore, the disutility associated with illegal activity would be zero (in the model this means setting the legal disutility variable equal to zero). Finally, dealers would fact different legal rami-

[11] It would continue to be a hurdle for underage users in the same sense that obtaining alcohol or cigarettes is not as easy for underage users.

fications for selling. To address this issue, we compute the counterfactuals under various assumptions about how price would change: (i) price would not change; (ii) price would increase by 20%; (iii) price would decline to the price of cigarettes; and (iv) price would decline to the marginal costs of production for other herbs (based on the price of plants, growing fertilizer, labor, etc.).

Table 5 displays the counterfactual results based on the model estimates from Table 4. The results indicate that both the accessibilty and legality barriers play a substantial role in the decision to use cannabis. Use would increase to 21.5% from 14.7% if accessibility were not an issue. Furthermore, 17.8% of the current users who report no access would use cannabis. If cannabis were legalized and accessibility were not an issue use would more than double to 33.7%. Obviously there would be an impact on prices due to the law change, if cannabis prices declined to cigarette prices then use would increase to over 40%.

Environment		Price	Predicted Probability of Use For Consumers in Current Environment with		
Accessibility	Legality		All	No Access	Access
Current Accessiblity	Current Legality		14.7%	0.0%	27.3%
No Barrier	Current Legality		21.5%	17.8%	27.3%
No Barrier	Legal	(i) No Change	33.7%	29.2%	37.7%
		(ii) 20% Increase	32.1%	27.7%	36.2%
		(iii) Cigarette Price	41.5%	36.3%	45.2%
		(iv) Production Cost	41.5%	36.3%	45.2%

Table 5: Counterfactual Results

To be completed.

7 Conclusions

Forthcoming...

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