DOES STEROID USE GATEWAY INTO MARIJUANA USE? EVIDENCE FROM 2001-2007 MONITORING THE FUTURE DATA

By

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I want to thank Christian Rojas for helpful comments that significantly improved an earlier version of this paper. I also want to thank the anonymous referee, as well as the Editor, for their insightful comments and suggestions. The usual caveat applies.

ABSTRACT

Steroid use is accompanied by a host of unpleasant side effects. Researchers have found that as a means of alleviating these side effects, steroid users turn to opiates. This paper examines whether steroid use also gateways into the use of marijuana, using 2001-2007 Monitoring the Future data on 12th graders. Marijuana is the most commonly used illicit drug in the United States, is easy to obtain, and just like opiates is effective at relieving many of steroid's side effects. Our results, which suggest a gateway effect, are robust across a variety of empirical specifications.

INTRODUCTION

According to the gateway hypothesis, the use of one (typically softer) drug begets the use of another (typically harder) drug. The former are referred to as gateway drugs, examples of which include alcohol (e.g., Bretteville-Jensen, Melberg, and Jones, 2008), cigarettes (e.g., Beenstock and Rahav, 2002), marijuana (e.g., Bretteville-Jensen, Melberg, and Jones, 2008; Pudney, 2003; DeSimone, 1998), and amphetamines (e.g., Bretteville-Jensen, Melberg, and Jones, 2008; Pudney, 2003). In this paper, we examine steroids as a gateway drug.

Steroids are synthetic substances related to the male sex hormones and promote the growth of skeletal muscle and the development of male sexual characteristics in

both males and females. People use steroids to improve athletic performance, increase muscle size, and/or reduce body fat (NIDA, 2006a). Among 12th graders, approximately 40 percent say that it is fairly or very easy to obtain steroids (Johnston et al., 2006), especially online (Kaplan, 2007), and roughly 2.2 percent of 12th graders in 2007 report steroid use at least once during their lifetime (Johnston et al., 2008b). Steroids are enough of a concern in our nation's high schools that as a means of curbing use by athletes, the ATLAS (Adolescents Training and Learning to Avoid Steroids) and ATHENA (Athletes Targeting Healthy Exercise and Nutrition Alternatives) prevention programs were created, and have been judged positively by researchers and even endorsed by Congress (NIDA, 2006a). Recently, steroids have received a great deal of media attention surrounding their use (alleged and otherwise) by such high profile athletes as Mark McGwire, Barry Bonds, Manny Ramirez, and Alex Rodriguez.

Steroid use is accompanied by a host of unpleasant side effects, including insomnia, irritability, jitteriness, and depression (Hall, Hall, and Chapman, 2005).[1] Researchers have uncovered evidence that, as a means of alleviating these side effects, steroid use gateways into the use of opiates (e.g., Arvary and Pope, 2000; Kanayama et al., 2003). Steroid users are often introduced to these drugs through either their steroid suppliers or, in the case of bodybuilders, a fellow bodybuilder (Arvary and Pope, 2000).

This paper examines the possibility that steroid use also gateways into the use of marijuana. Marijuana is a mixture of the dried, shredded leaves, stems, seeds, and flowers of the hemp plant, and is either smoked, mixed in food, or brewed as a tea (NIDA, 2008). That steroid use might gateway into marijuana use is supported by various studies in which marijuana users report that they use marijuana to relax, relieve tension, cope with stress, and deal with anxiety (e.g., Reilly et al., 1998; Ogborne et al., 2000; Hathaway, 2003). In addition, the active ingredient in marijuana (THC) causes users to feel euphoric, and then sleepy (NIDA, 2005), and marijuana is the most commonly used illicit drug in the United States and is easy to obtain (NIDA, 2008; Johnston et al., 2008a; Johnston et al., 2008b).

The concern over a gateway effect of steroid use into marijuana use is twofold. First, marijuana has its own host of side effects, including memory and learning impairment, addiction, and increased risk of chronic cough, bronchitis, emphysema, and various head, neck and lung cancers (NIDA, 2005). Second, there is evidence that marijuana use gateways into the use of even harder drugs, such as amphetamines (e.g., Bretteville-Jensen, Melberg, and Jones, 2008) and cocaine (e.g., Pudney, 2003; DeSimone, 1998), with equally or even more dangerous side effects than steroids or marijuana (NIDA, 2006b; NIDA, 2004).

DATA

We rely on pooled 2001-2007 Monitoring the Future ("MTF") data on 12th graders, which are publicly available through the Substance Abuse and Mental Health Data Archive (SAMHDA). Since 1975, the University of Michigan Institute for Social Research ("UMISR") has conducted annual MTF surveys of 12th graders to explore changes in values, behaviors, and lifestyle orientations of contemporary American youth.[2] Each data collection occurs in roughly 130 high schools, and covers approximately twenty subject areas, including "drugs", "education", "work and leisure", "sex roles and family", "population concerns", "conservation, materialism, equity, etc.", "religion", "politics", "social change", "social problems", "major social institutions", "military", "interpersonal relationships", "race relations", "concern for others", "happiness", "other personality variables", "background", "deviant behavior and victimization", and "health".

Because a large number of questions is required to span the above twenty subject areas, much of the questionnaire content is divided into six different questionnaire forms, resulting in six separate data subsets. However, approximately one-third of each of the six questionnaire forms consists of key or "core" variables common to all forms. All demographic variables, and some measures of drug use, are included in this "core" set of measures. For example, the 2007 MTF survey surveyed 15,132 individuals, each of whom received only one of the six questionnaire forms, but all of whom answered the key or "core" questions. Therefore, the 2007 MTF survey data consist of six data subsets of approximately 2,500 observations each, the sum of which equals 15,132, the size of the "core" data set. To the extent possible, we relied on each year's core data set.[3]

The majority of the substance use questions on the survey ask respondents about the frequency of their lifetime, past twelve month, and past thirty day use, allowing as possible responses: 0 occasions, 1-2X, 3-5X, 6-9X, 10-19X, 20-39X, and 40+ occasions. These responses, evaluated at their respective midpoints, were used to define a new substance user as someone who has been using for thirty days or less and a veteran substance user as someone who has been using for more than thirty days. For example, if a respondent's lifetime, past twelve month, and past thirty day use of a substance was 3-5X, then that respondent was labeled a new user. If, instead, a respondent's lifetime and past twelve month use of a substance was 10-19X, but their past thirty day use was 6-9X, then that respondent would be labeled a veteran user. As a robustness check, we also considered alternative new and veteran user definitions, which we discuss in greater detail later in the paper. As a logical consistency check, substance use observations were dropped if lifetime use was recorded as less than past twelve month use, or past twelve month use was recorded

as less than past thirty day use. Gateway effects are analyzed by examining new marijuana use as a function of veteran steroid use, controlling for a variety of factors, including veteran use of other substances[4], demographics, family life, school ability, social life, and year and geographic fixed effects.

Table I describes, and presents the means and standard deviations of, the variables included in the analysis for respondents with complete data. New marijuana users comprise approximately 5 percent of the sample, while .8 percent of the sample is made up of veteran steroid users. Table II illustrates the joint frequency of new marijuana and veteran steroid use. Of veteran steroid users (respondents who have been using steroids for more than thirty days), approximately 30 percent are new marijuana users (have been using marijuana for thirty days or less), while of those respondents who do not use steroids, only about 4 percent are new marijuana users. A chi-square test of independence rejects the hypothesis that veteran steroid users are no more likely than non-users of steroids to be new marijuana users ($\chi^2 = 69.16$, $p < .001$). This preliminary gateway evidence is examined more rigorously in the next section of the paper, using probit models of new marijuana use.

Table I. Description of Variables and Summary Statistics (N = 5,761)

Variable	Description	Mean	Std Dev
Marijuana	=1 if respondent new marijuana/hashish user; 0 if respondent a non-user	0.047	0.211
Steroid	=1 if respondent veteran steroid user; 0 if respondent a non-user	0.008	0.089
Andro	=1 if respondent has used andro in last 12 months; 0 otherwise	0.006	0.080
Creatine	=1 if respondent has used creatine in last 12 months; 0 otherwise	0.055	0.227
Cigarettes	=1 if respondent has smoked in lifetime; 0 otherwise	0.262	0.440
LSD	=1 if respondent veteran lsd user; 0 if respondent a non-user	0.014	0.117
Amphetamines	=1 if respondent veteran amphetamines user; 0 if respondent a non-user	0.048	0.214
Heroin	=1 if respondent veteran heroin user; 0 if respondent a non-user	0.003	0.056
Other Narcotics	=1 if respondent veteran user of other narcotics; 0 if respondent a non-user	0.040	0.195
Alcohol	=1 if respondent veteran drinker; 0 if respondent a non-drinker	0.586	0.493
OtherHallucinogens	=1 if respondent veteran user of other hallucinogens; 0 if respondent a non-user	0.020	0.140
Cocaine	=1 if respondent veteran cocaine user; 0 if respondent a non-user	0.019	0.137
Barbiturates	=1 if respondent veteran barbiturate user; 0 if respondent a non-user	0.039	0.193

Tranquilizers	=1 if respondent veteran tranquilizer user; 0 if respondent a non-user	0.038	0.190
Male	=1 if respondent male; 0 otherwise	0.449	0.497
White	=1 if respondent white; 0 otherwise	0.805	0.396
Work Income	=1 if respondent reports work income; 0 otherwise	0.659	0.474
Other Income	=1 if respondent reports other income; 0 otherwise	0.601	0.490
Broken Home	=1 if both father and mother not present in respondent's home; 0 otherwise	0.240	0.427
Above Average Ability	=1 if respondent rated school ability as above average; 0 otherwise	0.677	0.468
Average Ability	=1 if respondent rated school ability as average; 0 otherwise	0.278	0.448
Below Average Ability	=1 if respondent rated school ability as below average; 0 otherwise	0.045	0.207
Social Life	=1 if respondent goes out at least 1x/week for fun/recreation; 0 otherwise	0.880	0.325
Date Life	=1 if respondent goes on dates; 0 otherwise	0.699	0.459
Northeast	=1 if respondent's school in northeast U.S.; 0 otherwise	0.192	0.394
North Central	=1 if respondent's school in north central U.S.; 0 otherwise	0.283	0.450
South	=1 if respondent's school in southern U.S.; 0 otherwise	0.363	0.481
West	=1 if respondent's school in western U.S.; 0 otherwise	0.162	0.369
2001	=1 if survey year 2001; 0 otherwise	0.116	0.320
2002	=1 if survey year 2002; 0 otherwise	0.114	0.317
2003	=1 if survey year 2003; 0 otherwise	0.139	0.346
2004	=1 if survey year 2004; 0 otherwise	0.142	0.349
2005	=1 if survey year 2005; 0 otherwise	0.154	0.361
2006	=1 if survey year 2006; 0 otherwise	0.163	0.369
2007	=1 if survey year 2007; 0 otherwise	0.172	0.378

Table II. Joint Frequencies of Veteran Steroid and New Marijuana Use

	Non-Use of Steroids	Veteran Steroid Use	TOTAL
Non-Use of Marijuana	5,460	32	5,492
New Marijuana Use	255	14	269
TOTAL	5,715	46	5,761

ANALYSIS OF GATEWAY EFFECTS

In this section, we examine the effect of veteran steroid use on new marijuana use using probit models. We also discuss the effect of omitted variables on our results and perform a variety of robustness checks.

Probit Models of New Marijuana Use

Consider the following latent variable model:

$$M_i^* = \beta_o + \beta_s S_i + \beta_j X_{ij} + \beta_n G_{in} + \beta_q D_{iq} + \varepsilon_i \quad (1)$$

where i indexes MTF survey respondents and j, n, and q index the variables comprising the vectors X, G, and D, respectively. M_i^* is the latent propensity of new marijuana use; however, M_i^* is not observed. Instead, we observe M_i (Marijuana variable), which is a dichotomous indicator of whether a respondent is a new marijuana user or is a non-user and is equal to one if $M_i^* > 0$ and is equal to zero if $M_i^* \leq 0$. S (Steroid variable) is an indicator variable of whether a respondent is a veteran steroid user or is a non-user. The vector X contains a rich set of additional variables that control for the use of other substances (Andro, Creatine, Cigarettes, Alcohol, LSD, Other Hallucinogens, Cocaine, Amphetamines, Barbiturates, Tranquilizers, Heroin, and Other Narcotics variables)[5], the respondent's demographics (Male, White, Work Income, and Other Income variables), and the respondent's family life, academic ability, and social life (Broken Home, Above Average Ability, Below Average Ability, Social Life, and Date Life variables). G is a vector of geographic location indicator variables (North Central, South, West variables) and D is a vector of survey year indicator variables (2001, 2002, 2003, 2004, 2005, 2006 variables). These geographic and year fixed effects eliminate any unobserved geographic or year specific heterogeneity that might impact the estimate of β_s. Assuming $\varepsilon \sim N(0,1)$, the probit model which we estimate is given by:

$$\text{Prob}(M_i = 1) = \Phi(\beta_o + \beta_s S_i + \beta_j X_{ij} + \beta_n G_{in} + \beta_q D_{iq}) \quad (2)$$

where Φ is the cdf of the standard normal distribution.

The results of our probit analysis suggest a gateway effect. Looking at the first column of Table III it can be seen that veteran steroid use increases the probability of new marijuana use by approximately 1.6 percentage points ($p = .079$, two-tailed z-test).[6]

Table III. Probit Marginal Effects of Veteran Steroid Use on New Marijuana Use (N = 5,761)

Variable	Coefficient (3a)	Coefficient (3b)	Coefficient (3c)	Coefficient (3d)	Coefficient (3e)
Constant	*-0.106***	*-0.125***	*-0.116***	*-0.114***	*-0.163***
	(0.013)	(0.013)	(0.011)	(0.009)	(0.005)
Steroid	0.016*	0.018*	0.019*	0.022*	0.114***
	(0.009)	(0.010)	(0.011)	(0.012)	(0.019)
Andro	-0.011	-0.009	-0.009	-0.011	-
	(0.012)	(0.013)	(0.015)	(0.016)	
Creatine	0.007	0.007	0.007	0.013**	-
	(0.005)	(0.005)	(0.006)	(0.006)	
Cigarettes	0.022***	0.024***	0.027***	0.029***	-
	(0.003)	(0.003)	(0.003)	(0.004)	
LSD	0.036***	0.042***	0.045***	0.051***	-
	(0.013)	(0.015)	(0.016)	(0.017)	
Amphetamines	0.016***	0.019***	0.020***	0.021***	-
	(0.005)	(0.005)	(0.006)	(0.006)	
Heroin	-0.026**	-0.022	-0.025	-0.032*	-
	(0.013)	(0.014)	(0.016)	(0.018)	
Other Narcotics	0.009*	0.010	0.011*	0.013*	-
	(0.006)	(0.006)	(0.007)	(0.007)	
Alcohol	0.012***	0.015***	0.017***	0.017***	-
	(0.003)	(0.004)	(0.004)	(0.004)	
Other Hallucinogens	0.041***	0.047***	0.053***	0.059***	-
	(0.010)	(0.011)	(0.012)	(0.013)	
Cocaine	0.064***	0.070***	0.076***	0.081***	-
	(0.011)	(0.013)	(0.013)	(0.014)	
Barbiturates	0.012**	0.014**	0.016**	0.016**	-
	(0.005)	(0.006)	(0.007)	(0.007)	
Tranquilizers	0.017***	0.017***	0.019***	0.021***	-
	(0.005)	(0.006)	(0.006)	(0.006)	
Male	0.009***	0.011***	0.012***	-	-
	(0.003)	(0.003)	(0.003)		
White	-0.007*	-0.005	-0.007	-	-
	(0.004)	(0.004)	(0.004)		
Work Income	0.004	0.005	0.007*	-	-
	(0.003)	(0.003)	(0.004)		

Dependent variable is Marijuana. LSD, Amphetamines, Heroin, Other Narcotics, Alcohol, Other Hallucinogens, Cocaine, Barbiturates, Tranquilizers reflect veteran use. Andro and Creatine reflect past twelve month use and Cigarettes reflects lifetime use (see endnote 4). Marginal effects evaluated at variable means. White corrected standard errors given in parentheses. ***Significant at 1%, **Significant at 5%, *Significant at 10% (two-tailed).

Omitted Variables

Omitted variables could pose a potential endogeneity problem here, as we might have omitted important characteristics that are correlated with veteran steroid use (S_i). One such characteristic mentioned in the gateway literature that likely exerts a significant influence is susceptibility (Beenstock and Rahav, 2002). The likely effect of omitting a measure of susceptibility from the analysis would be to overstate (bias upward) the effect of veteran steroid use on new marijuana use.

One possible solution to omitted variables bias that has been used in previous gateway work (e.g., Yamaguchi and Kandel, 1984; Fergusson and Horwood, 2000), and which we use here, is to incorporate into the analysis a rich set of controls.[7] As described earlier, we control for the use of other substances, respondent demographics, the respondent's family, academic, and social life, and geographic and year fixed effects.[8] If the omitted susceptibility variable upwardly biases the coefficient on S_i, and if our controls are effective at mitigating this bias, then the coefficient on S_i should decrease as we incrementally and cumulatively add controls to our probit model. Evidence of this is provided in Table III. Looking at column 3e, with no controls the estimated coefficient on S_i is .114. As we move towards column 3a, adding, respectively, controls for the use of other substances (3d), demographics (3c), family/academic/social factors (3b), and geographic/year fixed effects (3a), the coefficient on S_i falls significantly.

Robustness Checks

We performed several robustness checks (not shown) to confirm our findings in Table III.[9] First, lending strength to our finding of a gateway effect of steroid use on marijuana use, no evidence of the reverse (a gateway effect of marijuana use on steroid use) was found ($p = .609$, two-tailed z-test).

Second, Equation 2 was estimated using logit, the results of which are consistent with the probit results in Table III. The logit analysis reveals that veteran steroid use increases the probability of new marijuana use by approximately 1.1 percentage points ($p = .095$, two-tailed z-test).

Finally, we considered two sets of alternative new and veteran substance user definitions. One set defines a new substance user as someone who has been using for twelve months or less, and a veteran substance user as someone who has been using for more than twelve months. For example, if a respondent's lifetime and past twelve month use of a substance was 3-5X, but their past thirty day use was 1-2X,

then that respondent would be labeled a new user. If, instead, a respondent's lifetime use of a substance was 3-5X, but their past twelve month and past thirty day use was 1-2X, then that respondent would be labeled a veteran user. Under this set of definitions, veteran steroid use increases the probability of new marijuana use by about 7.3 percentage points ($p = .031$, two-tailed z-test) based on a probit analysis and by roughly 5.5 percentage points ($p = .043$, two-tailed z-test) based on a logit analysis.

The second set of new and veteran substance user definitions defines a new substance user as someone who has been using for thirty days or less, and a veteran substance user as someone who has been using for more than twelve months. For example, if a respondent's lifetime, past twelve month, and past thirty day use of a substance was 3-5X, then that respondent would be labeled a new user. If, instead, a respondent's lifetime use of a substance was 3-5X, but their past twelve month and past thirty day use was 1-2X, then that respondent would be labeled a veteran user. Under this set of definitions, veteran steroid use increases the probability of new marijuana use by approximately 1.6 percentage points ($p = .026$, two-tailed z-test) based on a probit analysis and roughly 1.1 percentage points ($p = .045$, two-tailed z-test) based on a logit analysis.

CONCLUSION

This study examined the gateway effect of steroid use on marijuana use, lending credence to a gateway effect of between 1.1 and 7.3 percentage points. The magnitude of our gateway effect is most consistent with the .7 – 9.1 percentage point gateway effects estimated in Bretteville-Jensen, Melberg, and Jones (2008), and much smaller than the 29 percentage point gateway effect estimated by DeSimone (1998).

The marginal effects of dummy variables in this paper were calculated using the standard derivative approach. However, in order to shed additional light on the practical significance of our results, we also computed the marginal effects of dummy variables using an alternative approach, as suggested by Greene (2003). This alternative approach expresses the marginal effect of a particular dummy variable as the discrete change in the dependent variable as the dummy variable changes from 0 to 1. This allows us to also express the marginal effect as a percent change.[10], [11] Using this approach, we found that veteran steroid use increases the probability of new marijuana use by between 1.7 and 11.2 percentage points, which is similar to our earlier results.[12] Expressing this, instead, as a percent change reveals a more sobering picture - we found that the probability of new marijuana use among veteran steroid users is 156 percent to 671 percent larger than the probabil-

ity of new marijuana use among non-users of steroids.

Our study provides the first evidence of its kind that steroid use is dangerous not just because of the side effects associated with such use, but also because of the gateway effect steroid use exerts on marijuana use, the latter which has its own host of deleterious side effects and can, in turn, gateway into the use of even harder drugs such as amphetamines and cocaine (e.g., Bretteville-Jensen, Melberg, and Jones, 2008; Pudney, 2003; DeSimone, 1998). One limitation, though, is that because the sample is restricted to 12th graders, the results may or may not generalize to the overall population; however, to the best of our knowledge, publicly available data on adult steroid use are not available.

Regarding efforts aimed at curbing steroid use, it has been reported that 60 to 70 percent of steroid users are actively involved in organized sports (Hall, Hall, and Chapman, 2005), so it is not surprising that such efforts have primarily targeted athletes. For example, at the high school level, the National Institute on Drug Abuse (NIDA) funds two programs, ATLAS and ATHENA, which studies have judged as effective at reducing steroid use among high school athletes (NIDA, 2006a). At the collegiate level, an organization begun by two former college athletes known as Life After Sports helps equip student-athletes with the skills and guidance necessary to ensure that they are able to successfully transition into a non-athletic career. While not directly aimed at curbing steroid use, the thought is that athletes who have a serious alternative to playing professional sports should be less likely to engage in steroid use. Finally, at the professional level, most professional sports leagues, as does the National Collegiate Athletic Association and some high schools, have a steroid testing policy in place. However, there is a strong incentive for steroid manufacturers to create drugs that can avoid detection by drug testers, so to better deter would-be steroid users, it has been suggested by economists that urine and blood samples of professional athletes be stored and tested every ten years using the most up-to-date technology available (Levitt, 2008).

ENDNOTES

1. Additional unpleasant side effects associated with steroid use include: infertility, breast development, and shrinking of the testicles (among men); enlargement of the clitoris and excessive growth of body hair (among women); and, male-pattern baldness, short stature, tendon rupture, increases in bad cholesterol, decreases in good cholesterol, high blood pressure, heart attack, enlargement of the heart's left ventricle, liver cancer, peliosis hepatis, liver tumors, severe acne and cysts, oily scalp, jaundice, fluid retention, and even

psychiatric problems (among both men and women) (NIDA, 2006a).

2. See http://www.icpsr.umich.edu/SAMHDA/ for more information.

3. For 2001-2004, we had to rely on the much smaller Questionnaire 6 data set. This is because data on two important correlates of steroid use, androstendione and creatine use (described in more detail in endnote 5), did not appear in the core data set until 2005, and did not appear at all until 2001.

4. The variables Andro and Creatine reflect past twelve month use, and Cigarettes reflects lifetime use, since this is the extent to which use is captured for these variables by the MTF surveys.

5. Creatine is a protein supplement and is legal (Johnston et al., 2008b). Andro is short for the substance androstenedione, a precursor to steroids which could be purchased over the counter until early 2005 (Johnston et al., 2008b). Per the Monitoring the Future 2007 12th grade survey codebook: "Other Hallucinogens" refers to hallucinogens other than LSD, such as mescaline, peyote, "shrooms", and PCP. "Cocaine" also includes crack. "Amphetamines" are drugs prescribed by doctors to help people lose weight or to give people more energy, examples of which include but are not limited to Ritalin, Adde all, and Dexedrine. Crystal Meth is also an "amphetamine". "Barbiturates" are drugs prescribed by doctors to help people relax or get to sleep, examples of which include but are not limited to Tuinal, Ambien, and Seconal. "Tranquilizers" are drugs prescribed by doctors to calm people down, quiet their nerves, or relax their muscles, examples of which include but are not limited to Valium, Xanax, Soma, and Ativan. "Other Narcotics" refers to narcotics other than heroin, such as methadone, opium, morphine, codeine, Demerol, Vicodin, Percocet, and OxyContin.

6. We also looked for gateway effects of steroid use on the use of other drugs thought to produce calming effects such as heroin, other narcotics, alcohol, barbiturates, and tranquilizers. Consistent with Arvary and Pope (2000) and Kanayama et al. (2003), we found evidence that steroid use gateways into the use of other narcotics.

7. Another possible solution is instrumental variables. However, the public, and thus anonymous and non-identifying, nature of the data set that we are using severely limits our ability to find a good instrument for S_i. For example, an exercise-related variable might serve as a good IV, but unfortunately our data set does not contain any exercise variables. A steroid price variable would be

another good IV candidate, but such data do not exist; even if the data did exist, we would at best only be able to match the price data to observations by broad U.S. geographic region (northeast, north central, south, west) because of, again, the public, and thus anonymous and non-identifying, nature of the data set.

8. Research which examines drug use correlates seems to imply that a person's susceptibility to using illicit drugs is related to factors associated with the person's family and social life, their academic performance, their demographic profile, and the use of other illicit substances (Franzini and McDonald, 1973; Hall, Hall, and Chapman 2005).

9. Detailed results are available by request from the author.

10. In computing marginal effects under this approach, the other independent variables assume their mean values.

11. For example, under the definition of a new substance user as someone who has been using for thirty days or less and a veteran substance user as someone who has been using for more than thirty days, and using probit, the probability of new marijuana use when veteran steroid use equals 0 is .012 and the probability of new marijuana use when veteran steroid use equals 1 is .040. The marginal effect is thus .028, or 2.8 percentage points. Expressing this as a percent change reveals that the probability of new marijuana use among veteran steroid users is 234 percent larger than the probability of new marijuana use among non-users of steroids.

12. This range was developed by re-computing all of the marginal effects of veteran steroid use on new marijuana use presented in the paper using the alternative approach.

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