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## ABSTRACT

In this study we use data from the National Longitudinal Survey of Youth (NLSY). We estimate the relationship between high school graduation, and alcohol and marijuana use among the sample of high school students. We also estimate these students' demand determinants for each of these substances. Our results show that there are significant adverse effects of alcohol and marijuana use on high school graduation. In addition, we find that beer taxes, minimum drinking age laws and marijuana decriminalization have a significant impact on the demand for these substances. Our findings have important policy implications. We find that a ten percent increase in beer tax, reduces alcohol consumption among high school students, which in turn raises the probability of high school graduation by about 3.7 percent. Further, a ten percent increase in liquor prices, raises the probability of high school graduation by 6.6 to 8.2 percent. Raising the minimum drinking age for liquor also reduces liquor and wine consumption, and consequently, improves the probability of high school graduation.

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## I. Introduction

During the 1980s, the Federal Government placed a high priority on helping youth who were at risk of alcohol and drug abuse. In 1984, Congress passed the Federal Uniform Drinking Age Act (Public Law 98-363), which had a significant influence on young persons' consumption of alcoholic beverages. The Anti-Drug Abuse Act of 1986 (Public Law 99-570), allowed a number of Federal agencies to address alcohol and drug abuse problems. The role of government at the Federal, State and Local level was broadened by the Anti-Drug Abuse Act of 1988 (Public Law 100-690). Also, a program entitled *Healthy People 2000*, has been co-sponsored by the Department of Labor and the Public Health Service. This program focuses on the objectives set for the year 2000, aimed at youth at high risk of substance abuse, and is designed to reduce their alcohol and drug use.[1]

While the aforementioned programs and legislative measures have been partially successful in reducing youth drug and alcohol abuse, these problems persist and remain a major social issue. According to the General Report on Youth and Alcohol, published by the U.S. Department of Health and Human Services (1992), 89.5 percent of high school seniors in the class of 1990 had consumed alcohol at least once during the two weeks before the survey date. In addition, 32.2 percent experienced a binge of five or more drinks in a row. Junior and senior high school students consume an average of 1.1 billion bottles and cans of beer each year.

The General Report also shows that between 11.4 and 25.9 percent of the 8th grade high school students are aware of the availability of drugs. This number rises to between 17.4 and to 53.9 percent for 10th grade students and 30.6 to 83.3 percent for 12th grade students. The General Report also indicates that about three million persons aged between 10 and 17

experience multiple problems resulting from alcohol and drug abuse. In short, high school students engaged in excessive alcohol and drug use are suffering from many difficulties, in particular, poor academic performance.

There is a large literature on the efficacy of decriminalization of drug use and its relationship to alcohol and illicit drug abuse. Goldstein and Kalant (1990) report that policies which simultaneously reduce demand and supply are the key to alleviating the drug.[2] Some studies have suggested that young people regard alcohol and marijuana as substitutes (Chaloupka and Laixuthai 1992; and DiNardo and Lemieux 1992). In addition, there is an apparent relationship between the age of initial drug use, and the likelihood of moving from soft to hard drug use, among senior high school students (Kandel and Yamaguchi 1993).

Demand studies for alcoholic beverages have reported the following findings. Excise taxes on beer are highly effective in reducing beer consumption among youths aged 16 to 21, since beer is generally their drink of choice (Grossman 1989; and Laixuthai and Chaloupka 1993). The estimated own price elasticities of alcohol use for youth are elastic, i.e., between -1.53 and -1.54 for beer and between -3.29 and -4.08 for liquor (Grossman, Coate and Arluck 1987). This suggests that there are substantial negative price effects on youth alcohol use. Youths who are frequent beer drinkers are more price sensitive than those who drink less (Coate and Grossman 1988). Further, among college students, those who consume alcohol less frequently have a higher probability of a successful college career (Cook and Moore 1992).

Bennett (1991) investigates the impact of prevention policies on drug abuse among youth, and finds these programs to be highly effective. In an analysis of the demand for psychoactive drugs, Garrison, *et al* (1993) report suicidal behavior associated with substance use among high

school students.

The primary objective of our research is to investigate the sensitivity of high school graduation to alcohol consumption and marijuana use, and to estimate the demand determinants for these substances. Despite repeated reports relating high school dropout rates to drug and alcohol abuse and their implication for social and health policies, relatively few studies have documented the effects of alcohol consumption and marijuana use on high school completion. Following Becker and Murphy (1988), and other authors' theoretical and empirical investigations into *rational addictive* behavior associated with drug, alcohol and cigarette use,[3] we hypothesize that high school students' accomplishments are sensitive to their addictive behavior, and this in turn is subject to the pecuniary and other related costs of alcohol and drug abuse. Specifically, our paper addresses the impact of high school students' alcohol consumption and marijuana use on high school graduation, and the policy implications from our estimates of these effects.

The organization of the paper is as follows. Section II describes our empirical framework and the data. The empirical results are presented in Section III and are followed by the policy implications and conclusion in Section IV.

## II. The Empirical Framework and Data

A typical high school student is assumed to be a rational individual, who maximizes his or her (hereafter, "his" for brevity) utility:

$$U_i = U_i( P_i^*(D_i;Y_i), D_i, Z_i )$$

where $P_i^*$ is the probability that the student will graduate from high school, $D_i$ is the student's alcohol consumption or marijuana use, $Y_i$ is a vector of the student's personal characteristics including his family and ethnic background; and $Z_i$ is a composite good that contains no alcohol or illicit substances.

The student chooses the levels of $Z_i$ and $D_i$ which maximize his utility, subject to his budget constraint. We assume that utility increases when high school graduation becomes more likely. When $D_i$ is positive, there are two effects on utility. First, utility increases due to the direct impact of $D_i$. Secondly, there is an indirect effect whereby, if $D_i$ exceeds some threshold level, the probability of high school graduation is lower, and therefore, utility is reduced. In essence, we assume that a rational student trades off a higher probability of high school graduation, for alcohol and marijuana use.

We assume the likelihood of a student's graduation from high school has a linear reduced form thus:[4]

$$P_i^* = \Gamma_1 D_i + \Gamma_2 Y_i + \epsilon_i$$

where $\epsilon_i$ is a normally distributed random error term. The probability of graduation, $P_i^*$, is an

unobservable variable, therefore, we define $P_i$ such that

$P_i = 1$ if $P_i^* > 0$ (the student graduates from high school)

$P_i = 0$ otherwise (the student does not graduate from high school).

Thus we can write that

$$\text{Prob}( P_i = 1 ) = \text{Prob}( \epsilon > - \Gamma_1 D_i - \Gamma_2 Y_i )$$
$$= 1 - \Phi( - \Gamma_1 D_i - \Gamma_2 Y_i ).$$

In this case, the errors are distributed normally, so $\Phi$ represents the cumulative normal distribution function, and we use a probit model to estimate the unobservable probability of a student graduating from high school.

The data in this study are from the National Longitudinal Survey of Youth (NLSY). The NLSY began collecting data on 12,686 persons between the ages of 14 and 21 in 1979 and has continued each year. We use a sample of high school students who were seniors in the 1981-82 academic year; 1035 students in the NLSY sample were attending the twelfth grade in 1982. These were the first and largest cohort of respondents in the NLSY sample, who provided answers on questions about their concurrent use of alcohol in the twelfth grade.[5] The set of 1035 individuals was reduced to a sample of 672 persons, since not all the variables were available for all respondents. The NLSY deliberately over-samples minorities, enabling more precise estimates of the impact of race variables (see Table 1 for the statistics). The NLSY is

representative of the general population in all other respects.

During the course of our investigation, we experimented with a number of different variables to measure alcohol consumption and marijuana use among high school students. In their study of college students' alcohol consumption, Cook and Moore (1992) define a *frequent drinker* as a respondent who drank alcohol two or more days in the past week. They also use a *frequent drunk* variable, defined as a respondent who reported at least four occasions of consuming six or more drinks during the past month. We use two definitions of alcohol use in our study: first, Cook and Moore's *frequent drinker* and second, the number of liquor and wine drinks the student reported consuming in the past week.[6] The latter variable is of interest to us, since beer drinking is extremely common among high school students, and its consumption, unless excessive, is not usually regarded as particularly detrimental. Consequently, we are concerned that the effects of a variable encompassing all types of alcohol (mainly beer for our sample) is less likely to reflect abnormal or problem drinking. In contrast, the consumption of stronger forms of alcohol such as liquor and wine, is less common than beer consumption among high school students. Consumption of liquor and wine is likely to be more detrimental than beer due to its greater potency and, consequently, more likely to reduce the probability of high school graduation.

Questions about illicit drug use were not asked in the NLSY before 1984. The respondents were asked to list the months in which they used marijuana from 1979 onward. We examine our sample of high school seniors' responses to this set of questions during the 1981-82 academic year (September 1981 to June 1982). If the student responded "yes" to using marijuana in each of the ten months during the academic year, they were classified as a

"frequent marijuana user."[7] In this way, we focus on chronic use of marijuana and its impact on high school students' graduation.[8]

Work by Heien and Pompelli (1989) and Manski, *et al* (1992) has shown the importance of demographic and family structure effects. We, therefore, include a number of demographic and family-related variables in our model of high school graduation. These include gender, race, family structure (an intact family measure and number of siblings in the family), parents' education, degree of religious activity and a poverty indicator (see Table 1 for the variable definitions).

"Intact family" is a dummy variable equal to one for those respondents who lived with both parents at age 14. This accounts for variation in family support and stability of home life, which may impact graduation probabilities. We also use a dummy variable to estimate the effect of parents' educational attainment on the student's completion of high school. Based on previous studies by Register and Williams (1992) and Laixuthai and Chaloupka (1993), we hypothesize a negative causal relationship between practicing religion and substance abuse rates. We, therefore include a "religion" variable to account for this effect.

A family which falls below the poverty line has fewer resources to devote to their child's education, which lowers the probability of high school graduation.[9] We also account for the idea that family resources are stretched thinner when there is a large number of siblings. Larger family size may reduce educational attainment, as shown by Cook and Moore's (1992) analysis of college students. We use a dummy variable to indicate students with more than four siblings.

We include two variables to represent a student's academic potential: the combined English and Mathematics scores from the ASVAB tests; and the respondent's class ranking as

a percent of their class size.[10] We hypothesize that better scores and higher class ranking are associated with a higher probability of graduation.

In addition to a probit model of high school graduation, we also estimate demand models of alcohol consumption and marijuana use among high school students. This allows us to evaluate the impact of the deterrent effects of policy variables on student's high school completion. The demand equations include the following policy variables: the student's home state's beer tax, the price of liquor beverages in the state, marijuana decriminalization and minimum drinking age indicators.

## III Empirical Results

The summary statistics and definitions of the variables used in this study are listed in Table 1. Table 2 reports the maximum likelihood estimates of the probit models of high school graduation, including the "frequent drinker" variable in Model I; the "liquor and wine consumption" variable in Model II; and the "frequent marijuana user" in Model III. The results of these three estimations show that high school graduation is sensitive to, and is negatively associated with, alcohol consumption and marijuana use: frequent drinker in Model I, liquor and wine consumption in Model II, and frequent marijuana user in Model III.

Our calculations of the marginal probabilities associated with changes in alcohol and marijuana use are presented in Table 4.[11] An examination of the marginal effects of the three variables under the column entitled "High school graduation" reveals that frequent marijuana use lowers the probability of high school graduation by 5.6 percent.[12] A student who drinks beer two or more days a week, i.e., the definition of a frequent drinker, reduces their graduation probability by 4.3 percentage points. Finally, ten drinks of liquor and wine per week reduce the probability of high school graduation by 3 percentage points. The estimated elasticities of high school graduation with respect to frequent drinker, liquor and wine consumption, or frequent marijuana user, are -0.650, -0.201, and -0.662, respectively.

In contrast to beer drinking among high school students, the consumption of liquor and wine is less common. The latter alcoholic beverages produce intoxication more quickly and can create more serious substance abuse problems than beer. Comparing the marginal effect of liquor and wine consumption with the frequent drinker variable is not straightforward due to their different units of measurement. The estimated elasticity for the latter is larger than that

of the former, although both are inelastic.

The results for Models I, II, and III (see Table 2), show a significant and positive coefficient estimate for blacks. These results are consistent with other studies by Cook and Moore (1992) and Manski, et al. (1992). The impact of an intact family structure is positive and significant at the 5 percent level in all three equations. Students living with both parents have a higher probability of graduating from high school. Students living with more than four siblings have a lower probability of graduation. The ASVAB test score variable is statistically significant at the 1 percent level; higher scores are associated with an increased probability of high school graduation. There is only modest evidence that students attending religious services more than once a week, are more likely to graduate from high school (see the results for Model II).[13]

To evaluate the potential impact of beer tax and liquor price on high school graduation, we estimate demand functions for frequent drinker, liquor and wine consumption and marijuana user, as shown in Table 3. Their marginal effects and some elasticities (only with respect to the continuous independent variables) are reported in Table 4.[14]

The estimated coefficient for the beer tax variable is only statistically significant in the frequent drinker model, as shown in Table 3. The beer tax elasticity with respect to the probability of being a frequent drinker is -0.282 (shown in Table 4), which is similar to Cook and Moore's (1992) estimate.[15] Applying our beer tax elasticity to a beer tax of 32 cents per six pack, a ten percent increase in the beer tax directly increases the price of beer by only about 3 cents, but the eventual increment in the beer price will be approximately 6 to 8 cents due to the large indirect costs (see Grossman, *et al* 1993). A ten percent increase in beer tax will

therefore, raise the probability of high school graduation by about 3.7 percent.[16]

Our estimates for the liquor price variable are not statistically significant in either the frequent drinker or the liquor and wine consumption equations (see Table 3), although they are significant in the marijuana user equation. Since our estimate of the effect of the liquor price is not significant and has the wrong sign in the liquor and wine equation, we make an implicit calculation using the liquor price elasticity of alcohol consumption of youth, i.e. -3.29 to -4.08, estimated by Grossman, Coate and Arluck (1987). A ten percent increase in liquor price, i.e. approximately 82 cents per gallon, reduces liquor consumption by 32.9 to 40.8 percent. Using our elasticity estimate, i.e. -0.201, of liquor and wine consumption on high school graduation, a ten percent increase in the liquor price raises the probability of high school graduation between 6.61 and 8.20 percent. These calculations suggest that higher liquor prices have a substantial positive impact on high school completion; equally effective as an increase in the beer tax.[17]

In contrast to the substitute relationship between alcohol and marijuana found by Chaloupka and Laixuthai (1992) and DiNardo and Lemieux (1992), our estimate of liquor price in the marijuana user equation in Table 3 is negative and statistically significant at the 10 percent, implying that they are complements. The marginal effect in Table 4 shows that a one percent increase in liquor prices, discourages marijuana use among high school students by 3.3 percentage points. On the other hand, the variable on marijuana decriminalization has a significant and negative impact i.e. -0.3788, in the frequent drinker equation in Table 3. Marijuana decriminalization reduces the probability of a student being a frequent drinker by 7.2 percent (see Table 4).[18] This result implies a substitute relationship between marijuana and alcohol. In summary, our study finds only ambiguous evidence regarding the substitute-

complement relationship between liquor and marijuana.

Finally, the estimates for the minimum drinking age variables (18 years old for both beer and liquor) show that the 18 year old minimum drinking age for liquor is statistically significant at the 1 percent level (see Table 3). Currently, the minimum drinking age in all jurisdictions is twenty-one years, however, in 1982 the age requirement varied across states. We find that the presence of an 18 years minimum drinking age for liquor increases liquor and wine consumption among high school students. Hence, the policy of imposing higher minimum drinking ages may have had an effective impact on reducing the consumption of liquor and wine, and indirectly improving the educational attainment of high school students.

In summary, our data on 672 high school seniors suggests that increases in the use of alcohol and marijuana have substantial negative effects on high school graduation probabilities. Furthermore, our results suggest the viability of using alcohol taxes, marijuana decriminalization and minimum drinking laws to improve high school graduation rates.

## IV Conclusion

In this study we have used data from the National Longitudinal Survey of Youth (NLSY) on 672 individuals, who were in the twelfth grade in 1982, in order to analyze the impact of alcohol and marijuana use on high school graduation.

Our analysis shows that there are substantial negative effects of alcohol and marijuana use (using our measures: frequent drinker, liquor and wine consumption, and frequent marijuana user) on high school graduation probabilities. The marginal effects of these activities reduce the probability of high school graduation by 4.3 percent, 0.3 percent and 5.6 percent, respectively. These results indicate that high school students who use alcohol and marijuana are exposing themselves to significant risk of academic failure.

Our findings have a number of important policy implications. A ten percent increase in liquor price raises the probability of high school graduation by 6.6 to 8.2 percent. The estimated elasticity of frequent beer drinker with respect to beer tax is approximately -0.28, thus a ten percent increase in beer tax, i.e. about 6 to 8 cents, reduces beer consumption among high school students, and in turn raises the probability of high school graduation by about 3.7 percent. Raising the minimum drinking age for liquor has an effective influence on reducing the consumption of liquor and wine, and, consequently, improves the probability of high school graduation.

Our results show no significant relationship between marijuana decriminalization and marijuana use among high school students, however, marijuana decriminalization is found to reduce the probability of becoming a frequent drinker. This result indicates a substitute relationship between marijuana use and frequent drinking. If raising the cost of using marijuana

reduces marijuana consumption, a number of policy implications follow. Since raising taxes on illegal drugs, e.g. marijuana, is not a viable policy option, imposing harsher penalties for using and selling marijuana might reduce the demand and supply of marijuana. These types of policies have been used extensively during the past ten years, but there is no consensus as to their effectiveness. On the other hand, if alcohol and marijuana are substitutes, policy makers need to consider the full ramifications of imposing higher non-pecuniary costs of marijuana consumption, upon youth alcohol use.

Failure to complete high school due to alcohol and drug abuse is likely to result in lower lifetime earnings and adverse outcomes; for example, persons without a high school diploma or its equivalent, are more likely to be unemployed and consequently may lack health insurance. High school-based preventive programs, which discourage alcohol and marijuana use are highly recommended as a means of reducing these indirect societal costs and directly improve high school graduation rates.

## Endnotes

1. Prevention efforts have been directed toward both the youth and the general population, and the number and frequency of television warning drunk driving and anti-drug messages have increased considerably in recent years (Saffer 1991).

2. Some states and localities decriminalize marijuana use, while others have substantial penalties for even its casual use.

3. See Becker, Grossman and Murphy (1991); Chaloupka, Grossman, Becker and Murphy (1993); and Grossman (1993).

4. We assume that the quantity of the composite (other goods), $Z_i$, does not impact the probability of high school graduation.

5. Other information regarding illicit substance use is obtained from retrospective responses to survey questions.

6. Among the respondents in our data set, 25 percent admitted consuming at least one beer in the past week, compared with the 17 percent reporting at least one drink of either alcohol or wine.

7. We note that an individual who used marijuana every day during a month will be classified in the same group as a person who used marijuana only once a month.

8. We recognize the unreliable nature of data reported retrospectively, however, this is the only data available on marijuana use for this cohort of high school seniors. Aside from errors in the variables due to genuine inability to recall past events, there is the potential for respondents to lie about their illicit drinking and marijuana use. The designers of the NLSY are well aware of these difficulties and take extensive measures to ensure anonymity. Nevertheless, there may be systematic under-reporting of these activities, as discussed in Cook and Moore (1992).

9. We also estimated our probit model by replacing the poverty indicator with family income. The overall empirical results were not significantly affected. The empirical results using the family income variable are available on request.

10. A number of observations on student's class ranking are missing. Therefore, we include a dummy variable labeled "missing class rank" in the model, which equals one for observations where the individual class ranking is not available.

11. See the appendix for the method of calculation of the marginal effects.

12. According to Kandel and Yamaguchi (1993), although marijuana users may graduate from high school, those who are unable to control their marijuana use within two years, are more likely to progress to using cocaine.

13. We find that the religion variable is statistically significant in the demand analysis for both frequent drinker and frequent marijuana user, as reported in Table 3. That is, high school students who frequently attend religious services are less likely to be frequent drinkers or

frequent marijuana users. This implies an indirect effect, whereby students engaged in religious activities are less likely to be substance abusers and hence more likely to graduate high school.

14. In the probit model of high school graduation, the "frequent drinker" and "frequent marijuana" variables are not continuous, however, their elasticities are presented in Table 4, despite the difficulty of interpretation.

15. Our estimate of beer tax elasticity among high school students is -0.282 (= ∂ln Beer/∂ln tax), which is much smaller than for the youth population as a whole. For example, the beer price elasticities (= ∂ln Beer/∂ln Price) for youth aged between 16 to 21 is -1.53 to -1.54, reported by Grossman, Coate and Arluck (1987). There are at least two reasons for this discrepancy in magnitude. First, there is a difference in the age of the respective cohorts: our study only uses data on senior high school students. Secondly, the price of beer is not fully reflected by the beer tax. Due to the elastic demand for beer among high school students, the beer-price elasticity with respect to beer tax (= ∂ln Price/∂ln tax) is about 0.18. In other words, a one percent rise in the beer tax raises the beer price by only 0.18 percent, so that: ∂ln Beer/∂ln tax = (∂ln Beer/∂ln Price) (∂ln Price/∂ln tax). Thus, ∂ln Price/∂ln tax =(∂ln Beer/∂ln tax)/(∂ln Beer/∂ln Price) = -0.282/-1.53 = 0.18.

16. A ten percent increase in the beer tax will lower the probability of a student being a "frequent drinker" by 2.82 percent. However, if we include the indirect effect in the calculation, the beer price rises approximately by 6 cents per pack of beer, which is equivalent to a 20 percent increase in the beer tax without any indirect effects. Hence, a ten percent increase in the beer tax will cause the probability of a student being a frequent drinker to

decrease by 20x(0.282) = 5.64 percent. If we then multiply -5.64 by -0.650 (which is the impact elasticity of "frequent drinker" on high school graduation, listed in Table 4) this results in a 3.66 percent increase in the probability of high school graduation.

17. Grossman, Chaloupka, Saffer and Laixuthai (1993) evaluate the welfare costs and benefits of a reduction in youth alcohol abuse following an increase in taxes. Their calculation shows that the welfare benefits are approximately one and a half times greater than the welfare costs.

18. Our estimates of the relationship between marijuana decriminalization and marijuana use are not definitive. This is also the case for DiNardo and Lemieux (1992).

## Appendix: Calculating the marginal effect of substance abuse on the probability of high school graduation

There are two methods used to calculate the marginal effects, depending upon whether the variable is a continuous variable, e.g. liquor and wine consumption; or a qualitative dummy variable (i.e., a discrete variable), e.g. frequent drinker and frequent marijuana user.

Case I - Continuous variable (liquor and wine consumption):

We calculate the model's mean predicted probability of graduation for the whole sample:

$$A_0 = \frac{1}{N}\sum_{i=1}^{N} \Phi(X_i\beta),$$

where $X_i$ is the vector of observations for the i-th student, $\beta$ is a vector of coefficients, $\Phi$ is the normal cumulative density function and N is the sample size. Next we calculate

$$A_1 = \frac{1}{N}\sum_{i=1}^{N} \Phi(XI_i\beta),$$

where $X1_i$ is the same as $X_i$ except that one is added to the value of $X_{ij}$, where $X_{ij}$ (the j-th element in $X_i$) is the variable of interest; for example, the amount of wine and liquor consumed. The marginal effect of increasing all students consumption by one unit, on the probability of graduation is $A_1$ minus $A_0$.

Case II - Qualitative dummy variable (frequent drinker and frequent marijuana user):

Again, let $X_{ij}$ represent observations on the variable of interest; for example, frequent marijuana user. First, consider the sub-sample (size $N_0$) of students with $X_{ij} = 0$ and calculate the model's mean predicted probability of high school graduation for these $N_0$ persons;

$$G_0 = \frac{1}{N_0}\sum_{i=1}^{N_0} \Phi(X_i\beta),$$

Next, using the same $N_0$ person sub-sample, calculate the mean predicted probability of high school graduation if the dummy variable of interest for these students were switched to equal 1:

$$G_1 = \frac{1}{N_0}\sum_{i=1}^{N_0} \Phi(X1_i\beta) ,$$

where $X1_i$ is the same as $X_i$ except the dummy variable of interest is changed to equal 0. $G_1$ minus $G_0$ calculates the marginal impact on the probability of graduation if, for example, a non-frequent marijuana user were to become a frequent marijuana user.

Next, consider the sub-sample of students with $X_{ij} = 1$ and calculate the model's mean predicted probability of graduation for this sub-sample of $N_1 = N - N_0$ persons:

$$H_0 = \frac{1}{N_1}\sum_{i=1}^{N_1} \Phi(X_i\beta),$$

where $X_i$ is now the vector of observations for students whose dummy variable of interest equals 1. Next, using the same $N_1$ person sub-sample, calculate the mean predicted probability of high school graduation with the value of $X_{ij}$ switched to equal 0:

$$H_1 = \frac{1}{N_1}\sum_{i=1}^{N_1} \Phi(X1_i\beta) \ ,$$

where $X1_i$ is the same as $X_i$ except that the dummy variable of interest is changed to equal 0. $H_0$ minus $H_1$ is the marginal impact on the probability of high school graduation if, for example, a frequent marijuana user were to become a non-frequent marijuana.

The overall marginal impact of being a frequent drinker or marijuana user is calculated as the average of $G_1$ minus $G_0$ and $H_0$ minus $H_1$.

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Table 1 Variable Definitions and Statistics

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High school graduation
Dummy variable equal to 1 if the student graduated at the end of the 1982 academic year, and 0 otherwise.
(Mean = 0.939, S.D. = 0.240)

Frequent drinker
Dummy variable equal to 1 if the student reported at least 2 days during the past week when alcohol was consumed (same as in Cook and Moore, 1992), and 0 otherwise.
(Mean = 0.142, S.D. = 0.349)

Liquor and wine consumption
Number of liquor and wine drinks the student reported consuming during the past week. (Mean = 0.625, S.D. = 2.094)

Frequent marijuana user
Dummy variable equal to 1 if the student reported using marijuana during every calendar month of the school year between September 1981 and June 1982, and 0 otherwise.
(Mean = 0.111, S.D. = 0.314)

Male
Dummy variable equal to 1 for males and 0 for females.
(Mean = 0.510, S.D. = 0.500)

Black
Dummy variable equal to 1 for blacks and 0 otherwise.
(Mean = 0.236, S.D. = 0.425)

Hispanic
Dummy variable equal to 1 for hispanics and 0 otherwise.
(Mean = 0.134, S.D. = 0.341)

Intact Family
Dummy variable equal to 1 if the student lived with own parents at the age of 14: either biological, adoptive or step-parents, and 0 otherwise. (Mean = 0.816, S.D. = 0.387)

More than 4 siblings
Dummy variable equal to 1 if the student has more than 4 siblings and 0 otherwise. (Mean = 0.193, S.D. = 0.395)

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Table 1 (continued)

Parents' high school education
Dummy variable equal to 1 if both parents completed 12 years of education (high school education), and 0 otherwise.
(Mean = 0.542, S.D. = 0.499)

Poverty line
Dummy variable equal to 1 if the student's family is below the poverty line in 1982, and 0 otherwise. (Mean = 0.225, S.D. = 0.418)

Class ranking
Percent ranking of student in their class in 1981: the numerical value equals 1 if the student is ranked in the top 1 percent.
(Mean = 30.695, S.D. = 32.533)

Missing class rank
Dummy variable equal to 1 if the class rank of the student is missing, and 0 otherwise. (Mean = 0.352, S.D. = 0.478)

ASVAB Score
Armed Services Vocational Aptitude Tests administered in 1980. Score is the sum of the average of the three scores on the Mathematics tests and the average of two scores on the English tests.
(Mean = 94.755, S.D. = 16.932)

Religion
Dummy variable equal to 1 if the student reported attending religious services at least once a week, and 0 otherwise.
(Mean = 0.366, S.D. = 0.482)

Alcoholic parent
Dummy variable equal to 1 if the student reported that either parent had a drinking problem, and 0 otherwise.
(Mean = 0.202, S.D. = 0.401)

Beer tax
Tax on beer in the student's state of residence.
(Mean = 0.436, S.D. = 0.421)

Table 1 (continued)

Liquor price
Liquor price in the student's state: average price of 11 different brands of liquor, reported in the Annual Statistical Review 1982, published by the Distilled Spirits Council of the United States.
(Mean = 8.169, S.D. = 0.601)

Marijuana decriminalization
Dummy variable equal to 1 if using marijuana was decriminalized in the student's state of residence in 1982, and 0 otherwise.
(Mean = 0.279, S.D. = 0.449)

Age 18 for beer
Dummy variable equal to 1 if the minimum age for drinking beer was 18 in the student's state of residence in 1982, and 0 otherwise.
(Mean = 0.273, S.D. = 0.446)

Age 18 for liquor
Dummy variable equal to 1 if the minimum age for drinking liquor was 18 in the student's state of residence in 1982, and 0 otherwise.
(Mean = 0.148, S.D. = 0.355)

Note: Mean and S.D. are the sample mean and standard deviation, respectively. The sample size is 672 observations.

Table 2 Estimated Probit Coefficients of High School Graduation

| Independent Variable | Models I | II | III |
|---|---|---|---|
| Constant | -0.2688 | -0.3384 | -0.2458 |
| | (0.26) | (0.32) | (0.23) |
| Frequent Drinker | -0.4144[c] | | |
| | (1.64) | | |
| Liquor and wine consumption | | -0.0608[b] | |
| | | (1.96) | |
| Frequent marijuana user | | | -0.5013[b] |
| | | | (1.98) |
| Male | 0.1132 | 0.0977 | 0.1280 |
| | (0.56) | (0.49) | (0.63) |
| Black | 1.0623[a] | 1.0626[a] | 1.1051[a] |
| | (3.57) | (3.60) | (3.75) |
| Hispanic | 0.0415 | 0.0240 | 0.0318 |
| | (0.16) | (0.10) | (0.13) |
| Intact family | 0.5387[b] | 0.5144[b] | 0.5241[b] |
| | (2.31) | (2.21) | (2.22) |
| More than 4 siblings | -0.3684[c] | -0.3460 | -0.3899[c] |
| | (1.67) | (1.56) | (1.77) |
| Both parents graduated high school | 0.2519 | 0.2093 | 0.2507 |
| | (1.09) | (0.92) | (1.09) |
| Poverty | -0.0799 | -0.0920 | -0.6507 |
| | (0.36) | (0.41) | (0.29) |
| ASVAB Score | 0.0262[a] | 0.0269[a] | 0.0265[a] |
| | (3.67) | (3.73) | (3.69) |

Table 2 (continued)

| | | | |
|---|---|---|---|
| Class rank | -0.0065 | -0.0067 | -0.0068 |
| | (0.73) | (0.74) | (0.74) |
| Dummy missing class rank | -1.5628[a] | -1.5562[b] | -1.5633[b] |
| | (2.35) | (2.31) | (2.29) |
| Religion | 0.3494 | 0.3920[c] | 0.2704 |
| | (1.51) | (1.68) | (1.14) |
| Log likelihood | -106.5 | -105.9 | -105.9 |
| Restricted log likelihood | -154.4 | -154.4 | -154.4 |
| Likelihood ratio test | 95.8 | 97.0 | 97.0 |
| McFadden's R-squared | 0.31 | 0.32 | 0.31 |

Note. Absolute t-statistics are in parentheses. [a], [b] and [c] denote statistically significant at the 1%, 5% and 10% level, respectively.

Table 3 Estimated Coefficients of High School Student's Demand for Alcohol and Marijuana

| Independent Variable | Models PROBIT Frequent drinker | OLS Liquor & wine | PROBIT Marijuana user |
|---|---|---|---|
| Constant | -1.8817 | -1.1824 | -0.0248 |
| | (1.64) | (0.82) | (0.02) |
| Beer tax | -0.5079[b] | -0.1778 | -0.2446 |
| | (2.32) | (0.84) | (1.15) |
| Liquor price | 0.0311 | 0.0893 | -0.2285[c] |
| | (0.28) | (0.63) | (1.83) |
| Marijuana decrim. | -0.3788[b] | 0.0205 | -0.0430 |
| | (2.25) | (0.11) | (0.24) |
| Age 18 for beer | 0.0938 | | 0.2047 |
| | (0.59) | | (0.89) |
| Age 18 for liquor | | 0.7678[a] | -0.1676 |
| | | (3.22) | (0.59) |
| Alcoholic parent | 0.1550 | 0.3547[c] | 0.2084 |
| | (0.98) | (1.76) | (1.26) |
| Male | 0.1355 | -0.0957 | 0.3425[b] |
| | (1.01) | (0.59) | (2.31) |
| Black | -0.8401[a] | -0.4460[c] | 0.0024 |
| | (3.40) | (1.91) | (0.01) |
| Hispanic | -0.2952 | -0.2495 | -0.3666 |
| | (1.38) | (0.99) | (1.46) |
| Intact family | -0.2038 | -0.2282 | -0.0612 |
| | (1.13) | (1.04) | (0.34) |

Table 3 (continued)

| | | | |
|---|---|---|---|
| More than 4 siblings | 0.2034 | 0.4238[b] | 0.1263 |
| | (1.17) | (1.99) | (0.71) |
| Poverty | -0.3777[b] | -0.3847[c] | -0.2180 |
| | (2.02) | (1.88) | (1.15) |
| ASVAB Score | 0.0072 | 0.0092 | 0.0020 |
| | (1.36) | (1.43) | (0.37) |
| Class rank | 0.0097[a] | 0.0094[a] | 0.0089[a] |
| | (2.96) | (2.35) | (2.46) |
| Dummy missing class rank | 0.4287[c] | 0.4971[c] | 0.6687[a] |
| | (1.89) | (1.82) | (2.62) |
| Religion | -0.3129[b] | 0.0312 | -0.8070[a] |
| | (2.12) | (0.18) | (4.25) |
| Log likelihood | -238.02 | | -202.65 |
| Restricted log likelihood | -273.50 | | -232.79 |
| Likelihood ratio test | 70.96 | | 60.28 |
| McFadden's R squared or $R^2$ | 0.13 | 0.06 | 0.13 |

Note. Absolute t-statistics are in parentheses. [a], [b] and [c] denote statistically significant at the 1%, 5% and 10% level, respectively.

Table 4 Marginal Calculations - The Impact of Alcohol Consumption and Marijuana Use on High School Graduation and High School Student's Demand for Alcohol and Marijuana

| | Models Dependent Variable | | | |
|---|---|---|---|---|
| Independent Variable | High School Graduation | Frequent drinker | Liquor & wine | Marijuana user |
| Frequent drinker | -4.3[c] (-0.650) | | | |
| Liquor and wine consumption | -0.3[b] (-0.201) | | | |
| Frequent marijuana user | -5.6[b] (-0.662) | | | |
| Beer tax | | -9.2[b] (-0.282) | -0.18 (-0.124) | -3.5 (-0.138) |
| Liquor price | | 0.6 (0.324) | 0.09 (1.167) | -3.3[c] (-2.412) |
| Marijuana decriminalization | | -7.2[b] | 0.02 | -0.7 |
| Age 18 for beer | | 1.9 | | 3.5 |
| Age 18 for liquor | | | 0.77[a] | -2.9 |

Note. Marginal effects are expressed in percentage points except those in the liquor and wine equation, in which case the changes in liquor and wine drinks are in quantity units. The values in parentheses are estimated elasticities, which are only calculated for the continuous independent variables in the demand analysis. In the case of the high school graduation, the "frequent drinker" and "frequent marijuana" variables are not continuous, however, their elasticities are presented for informational purposes, despite the difficulty of interpretation.

[a], [b] and [c] denote statistically significant at the 1%, 5% and 10% level, respectively.