THE ROLE OF ALCOHOL AND DRUG CONSUMPTION IN DETERMINING PHYSICAL FIGHTS AND WEAPON CARRYING BY TEENAGERS

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INTRODUCTION

The issue of teenage violence has been thrust into the national spotlight by a recent string of shootings in our nation's high schools. During the past few decades, violence committed by teens and against teens has become a serious problem. The Bureau of Justice Statistics [1994; 1999a] reports that violent victimization rates against youths who are between the ages of 16 and 19 have been rising since the 1970s. The rate in 1973 was 61.4 per 1,000 people. This rate grew to 64.8 in 1983, to 77.9 in 1992, and to 91.1 in 1998. The Bureau of Justice Statistics [1996] also reports that teens aged 16-19 have the highest rates of victimization as compared to all other age groups for all types of violent crimes, including rape and robbery (121.7 per 1000 people) and assault (104.8 per 1000 people).

Estimates from the National Crime Victimization Survey show that crimes against juveniles are highly likely to be committed by other juveniles. In 1996, 75 percent of violent crimes against youths ages 12-19 were committed by other youths of the same age group. In general, juveniles committed approximately 33 percent of all violent crimes in the United States.

The homicide victimization rate for teens ages 14-17 increased almost 125 percent from 1985-1995, whereas the same rate increased by only 9 percent from 1976-1985. The rate at which teens commit homicides has also been increasing. These rates fell between 1976 and 1985 from 10.6 to 9.8 offenders per 100,000 population, but then increased to 23.6 in 1995 [Bureau of Justice Statistics, 1999b].

An important question for designing policies to reduce violence is what causes teens to engage in violence and to carry weapons. Certainly a wide variety of factors contribute to the culture of violence faced by today's teenagers including family structure, environment, and peer behavior. Two of the most widely cited correlates of violent behavior are alcohol and drug use, although it is not clear from the current literature that drugs or alcohol are directly causally related to violence. This paper will examine the potential causal role of alcohol and drug consumption in determining the probabilities of being in a physical fight, carrying a gun, or carrying weapons other than guns. While the latter two acts are not necessarily violent, carrying a weapon creates the potential for violence. Simple ordinary least squares regression models are compared to two-stage least squares models in which the potential unmeasured

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correlation between substance use and violence is purged by the use of instrumental variables. Prices of drugs and alcohol serve as instruments. Results indicate that beer and marijuana consumption increases the probability of physical fights, while no firm conclusions can be drawn about cocaine use. None of the substances lead to increased probabilities of carrying a gun or other weapon. A secondary aim of this paper is to examine the direct effects that increases in the price of beer, marijuana, and cocaine may have in reducing the incidence of fighting. Results show that higher beer taxes will lower the probability of physical fights but not weapon carrying.

THE LITERATURE

The Link between Violent Behaviors and Substance Use

The association between drug or alcohol use and violent behaviors is well documented for both youths and adults. In research on adult violence, alcohol and drug consumption has frequently been shown to be a correlate of criminal violence. Miczek et al. [1994] provides a complete review of this literature. Studies by Kwon et al. [1997], Jarrell and Howsen [1990], and Kellermann et al. [1993] show that higher alcohol consumption or availability is associated with higher rates of gun-related fatalities. Kellermann et al. [1993] show that illicit drug use is positively associated with homicides. Studies on domestic violence also show a link between alcohol consumption and violence [Gelles and Cornell, 1990; Leonard, 1993].

In considering violence by youths, Rossow et al. [1999] and Bernburg and Thorlindsson [1999] show that when violence is measured as a specific act, such as beating or threatening to beat someone or having been in a fight with a weapon, frequent intoxication will lead to increased violence, as will the use of marijuana or other drugs. Salts and Lindholm [1995] find that alcohol and marijuana use are highly correlated with increased violent behaviors in both black and white adolescent males. Similar findings hold for teens of both genders when examining drug use and violence in school [Furlong et al., 1997].

Weapon carrying by youths is also correlated with drug and alcohol use. Miller et al. [1999] find a strong association between drinking, drugs and gun ownership by college students in the College Alcohol Study. Their results show that 4.3 percent of students who binge drink own a gun as compared with 2.9 percent who do not binge drink. A more striking number is that 12.4 percent of the students who report they need a drink first thing in the morning own a gun. Seven percent of gun owners used crack or cocaine during the semester as compared to 3 percent of students who did not own a gun. Sheley and Brewer [1995] find that drug activity (either using or selling) positively influences the likelihood of carrying a gun. Hemenway et al. [1996] find the same result for alcohol consumption.

The Issue of Causality

It is important to note that none of these studies establishes whether alcohol or drug use cause violent acts or vice versa. In fact, no general agreement exists in the literature on the direction of the causality. One prominent theory is that alcohol and drug use causes violence by acting through a behavior altering pharmacological mechanism. For example, alcohol may supress inhibitions against violent behavior, or may affect the brain in such a way as to produce aggressive behaviors [Pernanen, 1981; Fagan, 1990]. Cocaine and crack cocaine use may lead to paranoid or psychotic states in which violence may occur [Reiss and Roth, 1993; Fagan, 1993]. As for marijuana, while moderate doses of marijuana may inhibit violent behavior, long-term chronic use may alter the nervous system in a way that may promote violence [Reiss and Roth, 1993]. A competing theory proposes the reverse causal relationship —that people who plan on being violent may drink to give themselves courage or an excuse for the behavior [Fagan, 1990; Cordilia, 1985]. Finally, a third theory states that drug use, alcohol use and violence are all outcomes of an unobserved third factor, for example, a risk-taking personality [Fagan, 1990].

Even less is known about why youths carry weapons. One commonly cited reason is for protection [Hemenway et al., 1996], while other research has shown that weapon carrying is a result of antisocial attitudes and behaviors [Page and Hammermeister, 1997]. A third hypothesis is the "replicative externalities" model in which adolescents feel less safe when their classmates carry guns causing them in turn to acquire guns [Hemenway et al., 1996]. These theories all imply that the link between substance use and weapon carrying are a result of a third factor, be it measurable or unmeasurable. While there is little reason to believe that short-term alcohol use will directly cause teens to carry weapons, participation in the illegal drug market may promote weapon carrying [Goldstein, 1985]. In addition, long-term use of alcohol, marijuana, opiates, amphetamines, or PCP can alter the nervous system in a way that actually promotes tendencies towards violence [Reiss and Roth, 1993; Goldstein, 1985].

Evidence from the Economics Literature

Some evidence that drug and alcohol use causes physical violence has emerged from the economics literature. This literature looks at the direct effects of substance prices and other related regulations on violence. Any observed direct effect of the price of alcohol on occurrences of violence provides evidence that consumption causes violence because the only reason to expect any correlation between prices and violence is through consumption. Grossman and Markowitz [2001] examine the relationship between the price of alcohol and violence on college campuses. The measures of violence used in this paper are indicators for whether the student has gotten in trouble with authorities; has damaged property or pulled a fire alarm; has gotten into an argument or a fight; and has taken advantage of another person sexually or has been taken advantage of sexually. Results of this paper show that increasing the price of alcohol reduces the incidence of these violent behaviors. In addition to the reduced-form estimates of price on violence, this paper also uses a two-stage least squares estimation technique similar to the one used in this paper to examine the direct effect of consumption on violence. Results are consistent with a causal explanation of the relationship between alcohol consumption and violent activities.

Other evidence of a causal link comes from studies on domestic violence [Markowitz and Grossman, 1998; 2000; Markowitz, 2000] and crime [Cook and Moore, 1993; Chaloupka and Saffer, 1992]. The studies on domestic violence show that higher alcoholic beverage prices lead to lower incidence of both child abuse and wife abuse. In studies on crime, Cook and Moore [1993] and Chaloupka and Saffer [1992] examine the effects of alcohol prices on a time series of aggregate state crime rates in the United States. In particular, both sets of authors look at rates of murder, rape, assault, and robbery. Results of these studies indicate that increasing the tax on beer reduces most types of violent crimes (with the exception of assault).

ANALYTICAL FRAMEWORK

Two simple equations highlight the possible relationships between violence and drug or alcohol consumption:

$$V_i = \alpha_0 + \alpha_1 A_i + \alpha_2 E_j + \alpha_3 X_i + \alpha_4 u_i + \varepsilon, \tag{1}$$

$$A_i = \beta_0 + \beta_1 V_i + \beta_2 P_j + \beta_3 Y_i + \beta_4 u_i + \omega, \tag{2}$$

where V represents a measure of violence or weapon carrying, A is a measure of alcohol or drug consumption, P is the full price of alcohol or drugs, E represents variables affecting violence levels such as law enforcement or gun control measures, and X and Y represent observed individual characteristics which may affect violence (X) and drug and alcohol use (Y).[1] The vectors X and Y may have many of the same elements in common. Unobserved individual traits, such as personality or propensity towards violence, are represented by u_i. The subscripts i and j refer to individuals and geographic area, respectively.

Many of the studies discussed in the literature review have used ordinary least squares (OLS) regression to estimate equation 1. However, estimating equation 1 by OLS can lead to biased and inconsistent coefficients if reverse causality is present ($\beta_1 \neq 0$) or if the unmeasured individual-level factor is correlated with violence and substance use ($\alpha_4 \neq 0$ and $\beta_4 \neq 0$). If either is true, drug and alcohol consumption will be correlated with the error term in equation 1, and estimating the coefficients by OLS will violate the requirement that the right-hand side variables be orthogonal to the error term. In the case of reverse causality when no third factor is present, alcohol is correlated with the error term in the violence equation because all the same exogenous variables, including the error term, that determine violence also determine alcohol consumption. This can be seen by substituting equation 1 into equation 2. In the case where the third factor is present but there is no reverse causality, u_i is present in both the violence and alcohol equations, thus, alcohol consumption is correlated with the error term in the violence equation.

To avoid the problems presented by OLS estimation, the two-stage least squares (TSLS) technique is used to estimate equation 1. The TSLS estimates of the consumption coefficients are purged of their correlation with the error term in the violence equation, leading to unbiased estimates of drugs and alcohol use on violence. A positive coefficient on predicted alcohol or drug consumption will indicate that substance use increases the probability of violence. This is consistent with a causal hypothesis that alcohol and drugs directly lead to violence. A zero coefficient rules out this direction of causality.

A reduced-form violence equation can be derived by substituting equation 2 into equation 1:

$$V_i = \delta_0 + \delta_1 P_j + \delta_2 E_j + \delta_3 Y_i + \delta_4 X_i + \delta_5 u_i + \eta. \tag{3}$$

Estimating the reduced-form equation shows the direct effect of changes in the prices of drugs and alcohol in reducing violence or weapon carrying. A negative price coefficient implies that violence is a result of consumption since there is no intuitive reason to believe that the prices of drugs and alcohol affect violence if consumption is held constant.[2] Thus, the reduced-form estimation will serve to check the validity of the results from the instrumental variable estimation as well as to directly provide the magnitude of the effect of price changes on the incidence of violence or potential violence.

DATA

Data on violent behaviors and drug and alcohol consumption come from the 1991, 1993 and 1995 National School-Based Youth Risk Behavior Surveys.[3] These surveys contain nationally representative samples of high school students in grades 9-12.[4] In each year, a different sample of students is interviewed. Dependent variables are constructed from the questions on physical fighting and the carrying of weapons. The first dependent variable is a dichotomous indicator for whether the respondent had been in a physical fight in the past year. The second is a dichotomous indicator for whether the respondent carried a gun in the past 30 days, and the third is a dichotomous indicator for whether the respondent carried a weapon other than a gun, such as a knife or club, in the past 30 days. Information on yearly weapon carrying or fighting in the past 30 days is not available from the survey questionnaire. Caution must be exercised in interpreting the meaning of the weapon carrying variable. While the survey question does ask the respondent specifically about carrying a weapon, it may be possible that teens who carry pocket knives (such as Swiss Army knives) and who have no violent intentions will respond positively to this question.

The questions on alcohol include the number of days in the past 30 days on which the respondent had at least one drink of alcohol (termed *drink*), and the number of days in the past 30 days on which the respondent had five or more drinks of alcohol in a row within a couple of hours (termed *binge*). Questions on drug use include the number of times in the past 30 days the respondent used marijuana (termed *marijuana*) and the number of times in the past 30 days the respondent used any form of cocaine including crack, powder, or freebase (termed *cocaine*).

The socioeconomic and demographic characteristics of the respondents are very limited in that only age, gender, and race are consistently reported in all surveys. All of these variables are included in each model. Four additional measures, which may

help control for the respondent's personality or propensity towards risk, are also included. The first is an indicator of how often the respondent wears a seatbelt when he or she is a passenger in a car; the second is whether the respondent seriously considered attempting suicide in the past year; the third is the number of sports teams run by either the school or an outside organization on which the respondent plays; and the fourth is the number of days in the past 30 days on which the respondent smoked. While these measures are certainly not perfect representations of different personality traits, they may help identify "good" kids versus "troubled" kids. For example, teens who have thought about suicide may be generally angry and more likely to engage in fights. Respondents who wear seatbelts frequently may be risk-averse and therefore less likely to drink, use drugs, or carry weapons.

It is clear that these four personality variables may be endogenous in that they are probably determined by the same unmeasured factors that predict violence and/or drug and alcohol use. They are included because these variables are not likely to be causal determinants of violence (with the possible exception of suicide); rather, they will help to control for some of the unmeasured personality traits of each individual. Their inclusion is designed to help lessen the correlation of the drug and alcohol consumption variables with the error term. Nevertheless, models that first exclude only the suicide indicator and second, exclude all four measures of risk were tested. Results of models that exclude only the suicide variable remain virtually unchanged. Results of models that exclude all four variables are discussed below.

Since the set of individual characteristics is very limited in these data, some state-level variables are included to proxy for some of the unmeasured individual-level characteristics. All models include the percentage of the population in the respondent's state who are Mormon, Protestant, Southern Baptist, and Catholic, as well as their state's real income per capita and the unemployment rate. Some models also include dummies for the region of the country in which the respondent resides. Data on religious affiliation in 1990 come from Bradley et al. [1992]. Data for 1991, 1993 and 1995 are interpolated based on a rate of growth from 1980 to 1990. Data on real income come from the Bureau of Economic Analysis and unemployment figures come from the Bureau of Labor Statistics.

Instruments

Variables measuring the prices of drugs and alcohol will serve as instruments to predict consumption. The prices are theoretically valid instruments because there is little reason to believe that the prices of drugs and alcohol are predictors of teen violence or weapon carrying, holding consumption constant. Prices should, however, predict consumption. Previous research has shown that the consumption of these goods is negatively related to their prices. [Leung and Phelps, 1993; Grossman, et al., 1998; Grossman and Chaloupka, 1998; Saffer and Chaloupka, 1999b].

Three variables will be used as instruments: The real (1982-1984=1) state-level excise tax on beer, the real price of cocaine, and an indicator for whether a state has decriminalized the possession of small amounts of marijuana for personal use. For the latter variable, a value of 1 means the state has decriminalized; thus, users in these states face a lower expected penalty and a lower price of possessing marijuana. Beer taxes come from the Beer Institute's *Brewer's Almanac*, cocaine prices come from the Drug Enforcement Administration's System to Retrieve Information from Drug Evidence (STRIDE) and information on decriminalization of marijuana comes from the Bureau of Justice Statistics [1995]. Cocaine prices are available until 1994, so the 1995 data are assigned cocaine prices for 1994. The methodology for creating the cocaine price series is described in detail in Grossman and Chaloupka [1998]. In addition to the three true instruments, all the above mentioned state-level and individual-level characteristics are used to predict consumption, although these variables appear in the second stage equations as well.

ESTIMATION AND RESULTS

Descriptive Statistics

Table 1 shows the means and standard deviations of all the variables for the full sample and by response for the three measures of violence. All means are weighted by the sample weights, which adjusts for the oversampling of black and Hispanic teenagers.[5] Any observations with missing data are omitted from the analyses. Forty percent of the sample report having been in at least one physical fight in the past year, six percent report carrying a gun in the last 30 days, and 15 percent report having carried a weapon other than a gun in the last 30 days. In addition, 49 percent of the sample drank, 21 percent binge drank, 18 percent used marijuana and 2 percent used cocaine in the last 30 days. These rates of teenage substance use are similar to those found in the Monitoring the Future Study [Johnston, et al. 1998].

The rates of drug and alcohol use by respondents who report positive instances of fighting or weapon carrying are much higher than those for respondents who do not fight or carry weapons. Of respondents who fight, 62 percent drink, 32 percent binge drink, 27 percent use marijuana, and 4 percent use cocaine. The corresponding rates for respondents with no fighting history are 40 percent, 14 percent, 12 percent and one percent, respectively. Of respondents who carry a gun, 76 percent drink, 48 percent binge drink, 42 percent use marijuana, and 12 percent use cocaine. Again, the drug and alcohol use is much lower for respondents who do not report carrying a gun; 47 percent drink, 20 percent binge dring, 16 percent use marijuana and 1 percent use cocaine. Similar trends hold for respondents who carry other types of weapons (64 percent versus 46 for drinking, 32 percent versus 19 for binge drinking, 28 percent versus 16 for marijuana, and 3 percent versus 2 percent for cocaine use). All of these proportions are statistically different from each other.

The Youth Risk Behavior Surveys record the number of occasions on which the respondent used an illegal substance. As with the participation rates, the number of occasions on which the respondent drank, binge drank, used marijuana or used cocaine is much higher for respondents who report fighting or carrying any weapon (see Table 1).

Along with higher rates of substance use, people who fight are more likely to carry a gun (12 percent) or other weapon (23 percent) than those who do not fight (2

TABLE 1
Weighted Means and Standard Deviations

	All Respondents Mean	SD	Fight=1 Mean	Fight=0 Mean	Gun=1 Mean	Gun=0 Mean	Other Weapon=1 Mean	Other Weapon=0 Mean
Fight	0.40	(0.50)	—	—	0.76	0.37	0.62	0.36
Gun	0.06	(0.25)	0.12	0.02	—	—	—	—
Other weapon	0.15	(0.36)	0.23	0.09	—	—	—	—
Number of days drink	2.77	(5.14)	4.22	1.82	7.41	2.46	4.38	2.49
Number of days binge	1.29	(3.14)	2.08	0.77	3.84	1.12	2.06	1.16
Number of times marijuana	2.08	(7.22)	3.35	1.24	7.61	1.71	3.67	0.16
Number of times cocaine	0.20	(2.37)	0.41	0.06	1.74	0.09	0.26	0.02
Percentage drink	0.49	(0.51)	0.62	0.40	0.76	0.47	0.64	0.46
Percentage binge	0.21	(0.42)	0.32	0.14	0.48	0.20	0.32	0.19
Percentage marijuana	0.18	(0.39)	0.27	0.12	0.42	0.16	0.28	0.16
Percentage cocaine	0.02	(0.14)	0.04	0.01	0.12	0.01	0.03	0.02
Real beer tax	0.36	(0.32)	0.35	0.37	0.39	0.36	0.38	0.36
Marijuana decriminalization	0.38	(0.50)	0.38	0.38	0.36	0.38	0.37	0.39
Cocaine price	101.57	(25.21)	101.76	101.45	102.65	101.50	102.74	101.37
Age	16.16	(1.25)	16.04	16.24	16.18	16.16	16.11	16.17
Female	0.50	(0.51)	0.39	0.56	0.12	0.52	0.24	0.54
Black	0.13	(0.34)	0.15	0.11	0.19	0.12	0.14	0.13
Hispanic	0.09	(0.29)	0.09	0.08	0.11	0.09	0.09	0.09
Other race	0.07	(0.26)	0.07	0.07	0.07	0.07	0.06	0.07
Smokes	4.91	(10.18)	7.22	3.38	8.94	4.64	7.33	4.49
Seatbelt	3.65	(1.26)	3.37	3.83	3.05	3.69	3.32	3.71
Suicide	0.25	(0.44)	0.31	0.21	0.32	0.25	0.32	0.24
Sports	1.36	(1.57)	1.47	1.29	1.64	1.34	1.37	1.36
Real income	145.39	(17.65)	145.13	145.57	142.78	145.57	145.43	145.39
Unemployment	6.50	(1.62)	6.59	6.43	6.56	6.49	6.66	6.47
Protestant	22.26	(9.62)	22.31	22.23	23.81	22.16	21.51	22.40
Catholic	19.84	(11.78)	20.07	19.69	18.36	19.94	19.54	19.89
Southern Baptist	4.98	(7.21)	4.88	5.05	5.79	4.93	5.40	4.91
Mormon	0.91	(1.00)	0.87	0.94	0.85	0.91	0.91	0.91
1993	0.42	(0.50)	0.43	0.42	0.47	0.42	0.39	0.43
1995	0.28	(0.46)	0.26	0.29	0.30	0.28	0.23	0.29
Number of observations	33,430		13,310	20,120	2,420	31,010	4,990	28,440

percent and 9 percent, respectively). In addition, of the people who carry guns, 76 percent have been in a physical fight. This is compared to only 37 percent of people who do not carry guns. Finally, of the people who carry other weapons, 62 percent have been in a physical fight versus 36 percent of people who do not carry other weapons. Unfortunately, because of the wording of the survey question, it is impossible to determine the rates of multiple weapon carrying, (i.e. the rates of gun carrying given other weapon carrying).

The Structural Model

Linear probability methods are used to estimate equation 1.[6] All standard errors are corrected according to White [1980]. Logit models were tested but the conclusions remain unchanged. Tables 2 and 3 show the effects of binge drinking, drinking, marijuana use and cocaine use separately on the probability of being in a physical fight (columns 1 and 2), carrying a gun (columns 3 and 4), and carrying a weapon other than a gun (columns 5 and 6). Table 2 presents the results for binge drinking and Table 3 shows the results for drinking, marijuana use and cocaine use. Each substance is entered into a violence equation separately since including consumption of all three substances together in one TSLS model leads to severe multicollinearity between the predicted values. This occurs because all three substances are predicted using the same set of variables. To demonstrate, Panel D of Table 3 shows a model with binge, marijuana and cocaine all entered simultaneously. In the OLS models the three are jointly significant. In the TSLS model, the standard errors increase dramatically, which is a symptom of multicollinearity.

For brevity, the coefficients on all variables are shown in Table 2 while only the coefficients on the illicit substances are shown in Table 3. The results of the other variables in the regressions do not vary depending on the inclusion or exclusion of a particular substance. Columns 1, 3 and 5 of these tables show the OLS results and columns 2, 4, and 6 show the TSLS results. Three tests of the validity of the TSLS regressions are reported. The first is an F-test on the set of true instruments. Bound et al. [1995] show that as the F-statistic on the instruments gets smaller, the bias in the TSLS estimates approaches that of OLS. Thus, it is important for the instruments to have explanatory power in predicting consumption. Second, the results for an overidentification test is presented.[7] An insignificant value of this test indicates that the instruments are not mistakenly left out of the second stage, and they are not correlated with the error term. Finally, the Hausman [1978] test shows whether the OLS estimators are consistent. The first stage results for binge drinking, drinking, marijuana use and cocaine use are shown in Table A2. The first stage models presented are based on the regressions for physical fighting since the first stage results are very similar to those of the other two dependent variables, and vary only because of missing values on the dependent variables.

Drinking and Drug Use. The OLS results of Table 2 show that binge drinking is positively and statistically significantly related to physical fighting, carrying a gun and carrying an other type of weapon. These OLS results are consistent with the literature discussed above. The TSLS estimates tell a slightly different story. For physical fighting, the TSLS estimate confirms the OLS estimate. Here, the coefficient on binge drinking is positive and significant. A one percent decrease in the number of days on which a respondent binge drinks will decrease the probability of being in a physical fight by 0.348 percent.

The statistics at the bottom of the even numbered columns check the validity of the TSLS estimates. In column 2, the F-test on the instruments shows that the prices of drugs and beer are statistically significant predictors of binge drinking. Second,

TABLE 2
OLS and TSLS Estimates
Binge Drinking

	Physical Fight		Gun		Other Weapon	
	OLS (1)	TSLS (2)	OLS (3)	TSLS (4)	OLS (5)	TSLS (6)
Binge	0.019	0.108	0.017	−0.016	0.004	−0.083
	(22.71)[b]	(2.34)[a]	(20.92)[b]	(−0.62)	(5.01)[b]	(−2.21)[a]
Age	−0.041	−0.058	−0.003	0.003	−0.013	0.003
	(−20.62)[b]	(−6.50)[b]	(−2.51)[a]	(0.64)	(−8.38)[b]	(0.41)
Female	−0.138	−0.084	−0.097	−0.116	−0.139	−0.191
	(−26.46)[b]	(−2.92)[b]	(−34.24)[b]	(−7.45)[b]	(−35.03)[b]	(−8.33)[b]
Black	0.107	0.144	0.055	0.042	0.005	−0.030
	(15.24)[b]	(6.94)[b]	(13.74)[b]	(3.71)[b]	(0.90)	(−1.85)
Hispanic	0.035	0.030	0.024	0.027	−0.014	−0.008
	(5.37)[b]	(3.74)[b]	(6.87)[b]	(6.35)[b]	(−2.88)[b]	(−1.23)
Other race	0.020	0.050	0.039	0.029	−0.032	−0.058
	(2.01)[a]	(2.63)[b]	(6.76)[b]	(2.92)[b]	(−4.20)[b]	(−4.03)[b]
Smokes	0.007	−0.004	0.002	0.006	0.002	0.013
	(22.48)[b]	(−0.65)	(8.61)[b]	(1.87)	(8.71)[b]	(2.82)[b]
Seatbelt	−0.036	−0.009	−0.014	−0.024	−0.017	−0.042
	(−16.97)[b]	(−0.60)	(−11.39)[b]	(−3.07)[b]	(−10.23)[b]	(−3.78)[b]
Suicide	0.118	0.078	0.020	0.034	0.067	0.104
	(19.57)[b]	(3.53)[b]	(5.90)[b]	(2.88)[b]	(14.14)[b]	(6.08)[b]
Sports	0.022	0.012	0.007	0.011	−0.004	0.006
	(12.59)[b]	(2.03)[a]	(6.46)[b]	(3.37)[b]	(−3.24)[b]	(1.22)
Income	0.0002	0.001	0.0004	−0.0002	0.001	0.0002
	(0.79)	(1.99)[a]	(0.38)	(−0.89)	(5.70)[b]	(0.76)
Unemployment	0.009	0.003	0.001	0.003	0.009	0.015
	(4.00)[b]	(0.63)	(0.81)	(1.49)	(5.68)[b]	(4.77)[b]
Protestant	−0.0003	−0.0003	−0.0001	−0.00003	0.0005	0.001
	(−1.16)	(−1.30)	(−0.45)	(−0.24)	(2.30)[a]	(2.30)[a]
Catholic	0.0001	−0.0005	−0.001	−0.001	0.0004	0.001
	(0.16)	(−0.93)	(−4.86)[b]	(−2.96)[b]	(1.46)	(2.25)[a]
Southern Baptist	−0.001	−0.002	−0.0003	0.0001	0.001	0.002
	(−2.27)[a]	(−2.73)[b]	(−1.08)	(0.23)	(4.03)[b]	(3.92)[b]
Mormon	0.0001	−0.008	−0.002	0.001	0.005	0.012
	(0.03)	(−1.30)	(−0.95)	(0.26)	(1.74)	(2.56)[a]
1993	−0.009	−0.004	0.037	0.035	−0.061	−0.067
	(−1.47)	(−0.52)	(11.68)[b]	(9.23)[b]	(−12.69)[b]	(−10.64)[b]
1995	−0.026	−0.034	0.021	0.024	−0.073	−0.068
	(−3.56)[b]	(−3.67)[b]	(5.61)[b]	(5.44)[b]	(−13.40)[b]	(−9.54)[b]
Observations	35,276	35,276	35,408	35,408	35,201	35,201
R-squared	0.12	0.08	0.12	0.08	0.07	0.04
F on instruments		5.524[b]		4.970[b]		5.499[b]
Overidentification test		0.128		4.407		0.145
Hausman test		4.792[a]		1.814		7.952[b]

Robust t-statistics in parentheses and intercept not shown.
a. significant at 5 percent level.
b. significant at 1 percent level.

the overidentification restrictions are valid, and third, consistency of the OLS coefficient is rejected. These tests provide evidence that the TSLS is the appropriate technique for estimation and that the TSLS results for physical fighting are unbiased.

The TSLS results for the probability of carrying a gun do not confirm the OLS results. The coefficient on binge drinking in the TSLS model (column 4) is negative and not statistically significant. Interestingly, the F-test of the instruments in the first stage is statistically significant, and the overidentification restriction is valid. However, the difference in the two estimates is not large enough to result in a significant value of the Hausman test, so consistency of the OLS estimator cannot be rejected.

As with the probability of carrying guns, the OLS estimation of binge drinking on the probability of carrying other weapons shows a positive relationship, however this result becomes negative once the unobserved correlation between binge drinking and carrying a weapon has been purged. The coefficient on the TSLS estimate in column 6 of Table 2 indicates that a one percent decrease in the number of binge drinking occasions will actually raise the probability of carrying a weapon by 0.714 percent. The TSLS results for other weapons are trustworthy because the first stage instruments are significant, the overidentification restrictions are valid, and consistency of OLS is rejected.

The negative coefficients on binge drinking in the weapon carrying equation and the gun carrying equation (the latter of which is not statistically significant) are at odds with the evidence provided by the simple means presented in Table 1 and with the OLS estimation in Table 2. At this point, some additional checks on the validity of this result are offered. One explanation for this result may be based on the states in which the teenagers live. The TSLS estimation relies on variations in the state-level prices of drugs and alcohol to predict consumption. For the TSLS coefficient to be negative, states that have higher prices of drugs and alcohol also must have higher probabilities of weapon carrying. If states that are traditional hunting states also have higher beer taxes (as is the case in some southern states) then a positive relationship would appear between taxes and weapon carrying, leading to a negative relationship between binge drinking and weapon carrying. As discussed below, estimates in Table 5 attempt to control for unobserved area effects by adding dummies for the nine census divisions of the country. In this model, a negative coefficient on the TSLS estimate for other weapons remains, although the standard error of this coefficients increases. The coefficient for gun carrying becomes positive and significant.

To further test the theory that some weapons are being carried for recreational purposes, a new dependent variable was created that takes on a value of one only if the respondent carried any type of weapon to school. This question is only available in the 1993 and 1995 cross sections. Results are not shown, but the TSLS coefficient on binge drinking remains negative and significant at just over the 10 percent level in a two-tailed test when using this dependent variable. In light of this evidence, the most plausible explanation for the contradictory results is that the OLS estimates are biased and there is indeed no positive relationship between substance use and weapon carrying. Rather, the positive simple correlation between the two behaviors is a re-

flection of some other trait that is unaccounted for. It may also be the case that weapons and alcohol and drugs are substitute goods, that is, that teens spend their income on either illicit substances or weapons. As is discussed further below, the reduced-form estimates presented in Table 5 present some evidence to support this theory.

Table 3 shows the coefficients on drinking, marijuana use and cocaine use on the probability of physical fights, carrying a gun and carrying other weapons. The effects of drinking (Panel A) and using marijuana (Panel B) on these three variables are very similar to that of binge drinking. The OLS and TSLS estimations both show that drinking and marijuana use are positively related to the probability of physical fighting. The TSLS estimates show that a one percent decrease in the mean number of days of drinking will decrease the probability of fighting by 0.43 percent, while a one percent decrease in the mean number of occasions on which marijuana is used will decrease the probability of fighting by 0.23 percent. As shown in Panel C, cocaine use has no impact on fighting.

Column 3 of Table 3 shows that drinking and using drugs are all positively related to carrying a gun, but this result is not upheld by the TSLS estimation in column 4. Column 5 of Table 3 shows that alcohol is positively related to other weapon carrying, marijuana has no relationship, and cocaine use is associated with a lower probability of carrying a weapon other than a gun. Again, these results change once TSLS is used to estimate the equations. The TSLS results in column 6 display a negative relationship between substance use and other weapon carrying.

The models in Table 4 exclude the four potentially endogenous individual characteristics: seatbelt use, smoking, consideration of suicide, and sports. Here, the OLS coefficients on drugs and alcohol become larger in magnitude, although statistical significance is unaffected. For physical fighting, the TSLS estimates become smaller in absolute value, but statistical significance is unaffected. Lastly, the TSLS estimates of the drinking and marijuana variables on carrying weapons other than guns remain negative but become insignificant in all equations; thus, the results for other weapons will be discussed with this caveat in mind.

Table 5 re-estimates the models in Tables 2 and 3, but includes eight dummy variables for the region of the country in which the respondent lives. The areas are New England, Mid-Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, and Mountain. The Pacific is the omitted category. Regions are included to further control for unobserved state-level variation that may be correlated with a teenager's substance use and violent behaviors. Recall that the measures such as religion, unemployment, and per capita income also help control for unobservable traits. State dummies were tested, but are not used for two reasons. First, only 38 states are represented in the three years of the survey and not all states are available in all years. To include dummies for every state, a state would have to appear in more than one year so as to not be collinear with the other state-level variables. Including only the respondents who live in states that are surveyed in multiple years reduces the number of respondents by about 12 percent and includes only 23 states. Secondly, by including the state dummies, the TSLS estimates become biased because the first stage results are unreliable. This is a result of

TABLE 3
OLS and TSLS Estimates
Drinking, Marijuana Use, and Cocaine Use

	Physical Fight		Gun		Other Weapons	
	OLS (1)	TSLS (2)	OLS (3)	TSLS (4)	OLS (5)	TSLS (6)
PANEL A						
Drink	0.014	0.062	0.011	-0.020	0.004	−0.049
	(26.67)[b]	(2.35)[a]	(24.74)[b]	(−1.16)	(8.59)[b]	(−2.14)[a]
R-squared	0.12	0.09	0.12	0.07	0.07	0.04
F on instruments		5.834[b]		4.585[b]		5.208[b]
Overidentification test		0.467		3.120		0.495
Hausman test		4.088[a]		4.427[a]		8.026[b]
Observations	34,302	34,302	34,419	34,419	34,230	34,230
PANEL B						
Marijuana	0.005	0.045	0.007	−0.003	0.0004	−0.034
	(12.87)[b]	(2.22)[a]	(19.56)[b]	(−0.33)	(1.12)	(−2.16)[a]
R-squared	0.11	0.08	0.11	0.08	0.06	0.05
F on instruments		5.15[b]		4.84[b]		5.11[b]
Overidentification test		0.391		5.380		0.788
Hausman test		4.968[a]		1.006		6.345[a]
Observations	35,498	35,498	35,639	35,639	35,434	35,434
PANEL C						
Cocaine	0.007	0.019	0.013	0.054	−0.002	−0.015
	(8.39)[b]	(0.32)	(13.98)[b]	(1.59)	(−2.45)[a]	(−0.33)
R-squared	0.11	0.10	0.10	0.08	0.06	0.06
F on instruments		3.46[a]		3.16[a]		3.08[a]
Overidentification test		6.765[a]		2.194		7.143[a]
Hausman test		0.040		1.638		0.084
Observations	35,730	35,730	35,880	35,880	35,665	35,665
PANEL D						
Binge	0.018	0.020	0.012	−0.461	0.005	−0.213
	(18.96)[b]	(0.06)	(14.36)[b]	(−0.25)	(5.38)[b]	(−0.29)
Marijuana	0.003	0.044	0.005	0.187	0.0003	0.056
	(6.42)[b]	(0.30)	(12.51)[b]	(0.23)	(0.74)	(0.17)
Cocaine	0.001	-0.034	0.008	0.026	−0.004	−0.010
	(0.75)	(-0.36)	(7.78)[b]	(0.10)	(−4.00)[b]	(−0.09)
R-squared	0.12	0.08	0.13	0.003	0.07	0.02
F test on 3 substances	190.96[b]	1.86	240.75[b]	0.06	13.02[b]	0.61
Hausman test		4.244[a]		4.347*		8.020[b]
Observations	34,919	34,919	35,043	35,043	34,846	34,846

Robust t-statistics in parentheses and intercept not shown.
a. significant at 5 percent level.
b. significant at 1 percent level.

TABLE 4
OLS and TSLS Estimates
Binge Drinking, Drinking, Marijuana Use, and Cocaine Use
Smoking, Seatbelt Use, Suicide, and Sports Excluded

	Physical Fight		Gun		Other Weapon	
	OLS	TSLS	OLS	TSLS	OLS	TSLS
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A						
Binge	0.031	0.107	0.021	-0.035	0.009	-0.051
	(42.33)[b]	(2.28)[a]	(28.27)[b]	(-1.16)	(12.20)[b]	(-1.41)
R-squared	0.08	0.03	0.11	0.04	0.05	0.04
F on instruments		4.40[b]		4.15[b]		3.86[b]
Overidentification test		0.204		3.835		4.990
Hausman test		3.201		4.661[a]		3.327
Observations	37,761	37,761	37,875	37,875	37,640	37,640
PANEL B						
Drink	0.021	0.058	0.013	-0.027	0.007	-0.019
	(47.21)[b]	(2.164)[a]	(32.85)[b]	(-1.43)	(15.81)[b]	(-0.92)
R-squared	0.09	0.04	0.12	0.04	0.06	0.04
F on instruments		4.37[b]		4.02[b]		3.70[b]
Overidentification test		0.570		2.577		6.864[a]
Hausman test		2.190		7.541[b]		1.713
Observations	36,618	36,618	36,723	36,723	36,512	36,512
PANEL C						
Marijuana	0.010	0.046	0.008	-0.11	0.002	-0.018
	(31.64)[b]	(2.35)[a]	(26.45)[b]	(-0.95)	(8.03)[b]	(-1.29)
R-squared	0.06	0.03	0.11	0.05	0.05	0.04
F on instruments		4.81[b]		4.30[b]		4.71[b]
Overidentification test		0.082		5.563		5.463
Hausman test		4.121[a]		3.549		2.375
Observations	38,021	38,021	38,143	38,143	37,910	37,910
PANEL D						
Cocaine	0.014	-0.053	0.016	0.078	0.001	0.015
	(19.36)[b]	(-0.66)	(18.58)[b]	(1.57)	(1.21)	(0.25)
R-squared	0.05	0.04	0.09	0.04	0.05	0.04
F on instruments		1.80		1.71		1.62
Overidentification test		4.812		2.518		8.635[a]
Hausman test		0.812		2.295		0.055
Observations	38,320	38,320	38,453	38,453	38,206	38,206

Robust t-statistics in parentheses and intercept not shown.
a. significant at 5 percent level.
b. significant at 1 percent level.

TABLE 5
OLS and TSLS Estimates
Binge Drinking, Drinking, Marijuana Use, and Cocaine Use
Regional Dummies Included

	Physical Fight		Gun		Other Weapons	
	OLS	TSLS	OLS	TSLS	OLS	TSLS
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A						
Binge	0.019	−0.042	0.017	0.105	0.004	−0.025
	(22.63)[b]	(−0.55)	(20.93)[b]	(1.96)[a]	(5.16)[b]	(−0.44)
R-squared	0.12	0.10	0.12	0.05	0.07	0.06
F on instruments		1.81		2.00		1.80
F on region dummies	4.89[b]	4.30[b]	7.48[b]	4.32[b]	7.67[b]	5.93[b]
Overidentification test		6.659[a]		1.273		2.526
Hausman test		0.733		5.171[a]		0.286
Observations	35,276	35,276	35,408	35,408	35,201	35,201
PANEL B						
Drink	0.014	-0.020	0.011	0.066	0.004	−0.009
	(26.67)[b]	(-0.43)	(24.78)[b]	(1.98)[a]	(8.74)[b]	(−0.27)
R-squared	0.12	0.10	0.13	0.05	0.07	0.07
F on instruments		1.71		1.89		1.63
F on region dummies	5.20[b]	4.74[b]	8.19[b]	4.30[b]	7.75[b]	6.00[b]
Overidentification test		6.988[a]		1.428		3.250
Hausman test		0.607		5.504[a]		0.164
Observations	34,302	34,302	34,419	34,419	34,230	34,230
PANEL C						
Marijuana	0.005	−0.008	0.007	−0.009	0.0004	−0.007
	(12.82)[b]	(−0.66)	(19.62)[b]	(−1.28)	(1.19)	(−0.77)
R-squared	0.11	0.10	0.12	0.08	0.07	0.07
F on instruments		11.25[b]		12.36[b]		12.36[b]
F on region dummies	5.33[b]	5.32[b]	8.50[b]	7.27[b]	7.59[b]	6.97[b]
Overidentification test		6.807[a]		9.179[a]		2.250
Hausman test		1.126		6.381[a]		0.677
Observations	35,498	35,498	35,639	35,639	35,434	35,434
PANEL D						
Cocaine	0.007	−0.263	0.013	0.022	−0.002	−0.127
	(8.35)[b]	(−1.70)	(13.97)[b]	(0.39)	(−2.37)[a]	(−1.36)
R-squared	0.11	0.04	0.10	0.09	0.07	0.04
F on instruments		1.19		1.18		1.14
F on region dummies	5.12[b]	2.41[a]	7.29[b]	6.57[b]	7.59[b]	4.44[b]
Overidentification test		0.173		10.753[b]		0.127
Hausman test		7.491[b]		0.022		2.796
Observations	35,730	35,730	35,880	35,880	35,665	35,665

Robust t-statistics in parentheses and intercept not shown.
a. significant at 5 percent level.
b. significant at 1 percent level.

the state-level prices being highly collinear with the state dummies which leads to the problems associated with severe multicollinearity.[8]

Including dummies for the broader regions of the country rather than the state dummies allows the entire sample to be included, as well as lessening the problem of multicollinearity in the first stage.[9] Table 5 shows the coefficients on the illicit substances. Across all models, the OLS results remain unchanged from the corresponding estimates in Tables 2 and 3. The TSLS estimates are almost always statistically insignificant, with signs that often reverse. Note that the F-statistics on the instruments in the first stages have become insignificant (with the exception of Panel C, marijuana), and the overidentification restrictions are often not valid. Thus, the TSLS estimates are not reliable.[10]

Individual characteristics. The results of the other independent variables generally do not depend on the method of estimation (OLS versus TSLS) and are fairly consistent across the dependent variables as well. For example, older teens are less likely to fight or carry guns and other weapons, as are females and teens who report wearing a seatbelt when they are a passenger in a car. Being black, Hispanic or of another non-white race is associated with higher probabilities of being in physical fights and carrying guns. There is no association with other weapons for blacks, while Hispanics and other races are less likely to carry other weapons. Teens who smoke are more likely to engage in all three acts, although with the exception of the regressions that include cocaine use, this result only holds in the OLS estimates. The most likely explanation for the insignificant coefficient in the TSLS models is that smoking is being used to predict consumption in the first stage, and since smoking, drinking, and marijuana use are highly correlated, the effects of smoking are being picked up by the predicted values of consumption in the second stage.[11] Teens who have thought about committing suicide are more likely to engage in violent behaviors, as are teens who play on sports teams. This last result does not hold for other weapons. Finally, the larger the percentage of the state that is reported to be Southern Baptist the lower the probability of physical fighting but the higher the probability of carrying weapons other than guns. More Catholics in a state leads to a lower probability of carrying a gun.

The Reduced Form

Estimating the reduced-form model as shown in equation 3 provides indirect evidence for or against the causality link from substance use to violence, as well as the magnitude of the direct effect of changes in the prices of the substances on the probability of violence. If drinking alcohol, for example, actually causes teens to engage in physical fights, and beer taxes are negatively related to drinking, then one would expect the beer tax to be negatively related to physical fighting in the reduced form. If there is no causal relationship from substance use to a measure of violence then the prices should have no direct effect on violence. In the case of weapons, the reduced form will also show whether weapons and alcohol or drugs are net substitutes, complements, or have no relation to each other.

Table 6
Reduced-Form Estimates

	Physical Fight (1)	Gun (2)	Other Weapons (3)
Beer tax	−0.019	0.007	0.014
	(−2.27)[a]	(1.53)	(2.29)[a]
Marijuana decriminalization	0.005	0.005	−0.000001
	(0.87)	(1.62)	(−0.0002)
Cocaine price	−0.0001	−0.00004	0.0002
	(−0.59)	(−0.44)	(1.15)
Age	−0.038	0.0004	−0.012
	(−18.90)[b]	(0.36)	(−8.22)[b]
Female	−0.151	−0.109	−0.140
	(−29.16)[b]	(−37.79)[b]	(−35.97)[b]
Black	0.101	0.050	0.003
	(14.36)[b]	(12.27)[b]	(0.61)
Hispanic	0.035	0.029	−0.010
	(4.96)[b]	(−7.46)[b]	(−1.81)
Other race	0.013	0.034	−0.031
	(1.30)	(5.61)[b]	(−4.10)[b]
Smokes	0.009	0.004	0.003
	(32.40)[b]	(18.43)[b]	(11.53)[b]
Seatbelt	−0.042	−0.020	−0.018
	(−20.12)[b]	(−15.52)[b]	(−10.84)[b]
Suicide	0.126	0.026	0.069
	(20.98)[b]	(7.77)[b]	(14.73)[b]
Sports	0.023	0.009	−0.004
	(13.54)[b]	(8.20)[b]	(−3.01)[b]
Income	0.00001	−0.0001	0.001
	(0.06)	(−0.88)	(5.37)[b]
Unemployment	0.009	0.002	0.010
	(4.14)[b]	(1.78)	(5.81)[b]
Protestant	−0.0004	0.0001	0.001
	(−1.39)	(0.32)	(2.37)[a]
Catholic	−0.0001	−0.001	0.001
	(−0.23)	(−3.30)[b]	(2.28)[a]
Southern Baptist	−0.001	−0.0001	0.001
	(−1.09)	(−0.34)	(3.42)[b]
Mormon	−0.0002	0.0003	0.008
	(−0.05)	(0.16)	(2.61)[a]
1993	−0.010	0.035	−0.060
	(−1.50)	(10.41)[b]	(−12.06)[b]
1995	−0.027	0.022	−0.069
	(−3.20)[b]	(4.87)[b]	(−10.87)[b]
Observations	35,820	35,972	35,756
R-squared	0.10	0.09	0.06

Robust t-statistics in parentheses and intercept not shown.
a. significant at 5 percent level.
b. significant at 1 percent level.

Table 6 shows the results of the reduced-form estimates for physical fighting (column 1), carrying a gun (column 2) and carrying another type of weapon (column 3). The negative and statistically significant coefficient on the beer tax in the physical fight equation (column 1) confirms the TSLS estimates from Table 2. This result indicates that a one percent increase in the beer tax will lower the probability of physical fighting by 0.02 percent. The marijuana decriminalization indicator and the price of cocaine have no direct effects on physical fighting. This result is consistent with the TSLS results for cocaine, but not for marijuana. The likely explanation for the contradictory marijuana result is that the decriminalization indicator is a weak measure of the price of marijuana and therefore has no direct effect on fighting. Nevertheless, marijuana consumption may still be adequately predicted by the models in Table 3 if the price of beer predicts marijuana use due to complementarity between the two substances.[12] As shown in Table A1, the first stage results for marijuana use confirm that this is the case since the coefficient on the decriminalization indicator is positive and statistically significant, and the coefficient on the beer tax is negative and statistically significant.

As discussed earlier, the TSLS results in Tables 2 and 3 for the probability of carrying a gun show no statistically significant relationship between drinking or drug use and carrying a gun. Not surprisingly, the reduced-form estimate is in agreement with these results, for column 2 of Table 6 shows that none of the prices are statistically significant predictors of carrying a gun.

Finally, column 3 of Table 6 shows the reduced-form equation for other weapon carrying. Recall that the TSLS estimate predicts that the more days on which a respondent drinks implies a lower probability of weapon carrying. This result is confirmed by the reduced form where the tax on beer is positively related to weapon carrying. These results also provide evidence that beer consumption and weapons such as knives are net substitute goods since increasing the price of beer will increase the probability of carrying a weapon, holding real income constant. Note that the income effect estimated here is imprecise since income is measured by the state per capita income, which may not be a good measure of the actual income of teens, and is also not adjusted for the cost of living faced by teens.

CONCLUSION

The purpose of this study is to examine whether alcohol and drug use increases the likelihood that teenagers will engage in violent behaviors as measured by physical fighting, carrying a gun, or carrying other types of weapons. Simple means and OLS regression estimation both show that drinking (as measured by number of days the respondent had a drink and by the number of days the respondent had 5 or more drinks in a one sitting), marijuana use, and cocaine use are all positively related to the probability of physical fighting, and carrying a gun. Drinking is also positively associated with carrying other types of weapons, although drug use is not. While drugs, alcohol, and violent behaviors may be linked, these simple results do not provide evidence of causality from drugs and alcohol to violence. In fact, the OLS estimates may be biased because of the possibility that both substance use and violent behaviors are determined by unmeasured individual traits.

Two-stage least squares is used to estimate the drug and alcohol consumption coefficients. The technique predicts consumption using the prices of beer, marijuana and cocaine as instruments, thus allowing the consumption measures to be purged of their correlation with unobserved individual characteristics. Results from the two-stage estimation show that binge drinking, drinking, and marijuana use will increase the likelihood of engaging physical violence. The results of cocaine use on physical violence are not trustworthy. None of the substances lead to increased probabilities of carrying a gun or other weapon. Additionally, the magnitudes of the effect of a decrease in drinking or marijuana use on fighting may be small. A one percent decrease in the mean number of days on which a respondent binge drinks will decrease the probability of being in a physical fight by 0.35 percent. The percentage reductions in fighting from a one percent decrease in the number of days of drinking or using marijuana are 0.43 percent and 0.23 percent, respectively.

Reduced-form estimates show the direct effect of raising substance prices on the probability of physical violence. Policies aimed at reducing alcohol consumption, such as raising the price of beer through increased taxes, would be effective in reducing the incidence of physical fights, although again, the magnitude may be very small. A one percent increase in the beer tax will lower the probability of physical fighting by 0.02 percent. According to the findings in this study, re-criminalizing marijuana or raising the price of cocaine through increased enforcement of drug laws would have no direct effects on teenage physical fighting or carrying guns or other weapons.

APPENDIX

TABLE A1
OLS and TSLS Estimates
Binge Drinking, Drinking, and Marijuana Use
1991, 1993, 1995, 1997 and 1999 Data Included

	Physical Fight		Gun		Other Weapon	
	OLS (1)	TSLS (2)	OLS (3)	TSLS (4)	OLS (5)	TSLS (6)
PANEL A						
Binge	0.019	0.161	0.016	-0.025	0.004	-0.049
	(29.73)[b]	(2.82)[b]	(27.19)[b]	(-0.94)	(7.58)[b]	(-1.36)
R-squared	0.12	0.07	0.12	0.07	0.06	0.05
F on instruments		6.91[b]		6.26[b]		6.53[b]
Overidentification test		0.039		0.782		7.899[a]
Hausman test		10.582[b]		2.776		2.600
Observations	63,471	63,471	63,681	63,681	63,269	63,269

TABLE A1 (Cont.)
OLS and TSLS Estimates
Binge Drinking, Drinking, and Marijuana Use
1991, 1993, 1995, 1997 and 1999 Data Included

	Physical Fight		Gun		Other Weapon	
	OLS (1)	TSLS (2)	OLS (3)	TSLS (4)	OLS (5)	TSLS (6)
PANEL B						
Drink	0.014	0.142	0.011	−0.028	0.004	−0.032
	(35.20)[b]	(2.06)[a]	(32.34)[b]	(−0.92)	(12.16)[b]	(−0.95)
R−squared	0.13	0.04	0.13	0.06	0.07	0.05
F on instruments		2.67		2.21		2.75
Overidentification test		0.005		1.077		8.438[a]
Hausman test		9.419[b]		2.550		1.447
Observations	61,715	61,715	61,900	61,900	61,517	61,517
PANEL C						
Marijuana	0.005	0.030	0.006	−0.001	0.001	0.002
	(21.25)[b]	(2.78)[b]	(24.89)[b]	(−0.13)	(5.46)[b]	(0.23)
R−squared	0.12	0.10	0.11	0.09	0.06	0.06
F on instruments		20.01[b]		18.23[b]		17.51[b]
Overidentification test		3.516		2.194		12.586[b]
Hausman test		5.900[a]		1.293		0.005
Observations	63,731	63,731	63,954	63,954	63,543	63,543

Robust t-statistics in parentheses and intercept not shown.
a. significant at 5 percent level.
b. significant at 1 percent level.

TABLE A2
First Stage Results

	Binge	Drink	Marijuana	Cocaine
Beer tax	−0.169	−0.333	−0.314	0.053
	(−3.42)[b]	(−3.96)[b]	(−2.72)[b]	(1.19)
Decriminalization	0.031	0.015	0.161	0.049
	(0.88)	(0.25)	(1.98)[a]	(1.57)
Cocaine price	−0.002	−0.001	−0.003	−0.002
	(−1.47)	(−0.81)	(−1.36)	(−2.55)[b]
Age	0.185	0.296	0.171	0.010
	(15.26)[b]	(14.36)[b]	(6.04)[b]	(0.95)
Female	−0.607	−0.936	−1.393	−0.206
	(−19.53)[b]	(−17.72)[b]	(−19.16)[b]	(−7.37)[b]
Black	−0.408	−0.295	1.166	0.110
	(−9.74)[b]	(−4.14)[b]	(11.88)[b]	(2.92)[b]
Hispanic	0.024	0.195	0.199	0.245
	(0.56)	(2.70)[b]	(2.01)[a]	(6.43)[b]
Other race	−0.349	−0.514	0.320	0.284
	(−5.67)[b]	(−4.91)[b]	(2.22)[a]	(5.14)[b]

TABLE A2 (Con't)
First Stage Results

	Binge	Drink	Marijuana	Cocaine
Smokes	0.119	0.215	0.287	0.040
	(68.90)[b]	(73.79)[b]	(71.66)[b]	(26.02)[b]
Seatbelt	−0.308	−0.578	−0.588	−0.089
	(−24.65)[b]	(−27.10)[b]	(−20.11)[b]	(−7.95)[b]
Suicide	0.450	0.944	0.599	0.302
	(12.71)[b]	(15.69)[b]	(7.24)[b]	(9.50)[b]
Sports	0.114	0.227	−0.015	0.044
	(11.08)[b]	(12.97)[b]	(−0.61)	(4.77)[b]
Income	−0.007	−0.008	0.010	−0.001
	(−5.94)[b]	(−3.92)[b]	(3.44)[b]	(−0.58)
Unemployment	0.061	0.106	0.221	0.056
	(4.47)[b]	(4.61)[b]	(6.96)[b]	(4.60)[b]
Protestant	0.0002	−0.007	−0.029	−0.001
	(0.11)	(−2.21)[a]	(−6.81)[b]	(−0.92)
Catholic	0.004	0.002	−0.018	−0.002
	(1.54)	(0.55)	(−3.39)[b]	(−1.20)
Southern Baptist	0.015	0.031	−0.019	−0.001
	(5.03)[b]	(6.12)[b]	(−2.64)[b]	(−0.40)
Mormon	0.065	0.067	0.179	0.066
	(2.73)[b]	(1.67)	(3.23)[b]	(3.10)[b]
1993	−0.068	−0.081	0.576	0.033
	(−1.77)	(−1.23)	(6.39)[b]	(0.96)
1995	0.035	0.214	1.761	0.077
	(0.69)	(2.49)[a]	(14.93)[b]	(1.71)
Observations	35,276	34,302	35,498	35,730
R−squared	0.20	0.22	0.19	0.04

T-statistics in parentheses and intercept not shown.
a. significant at 5 percent level.
b. significant at 1 percent level.

NOTES

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1. Measures of law enforcement are not included in this analysis because the main focus of this paper is to examine the effects of drug and alcohol consumption on violence. The omission of law enforcement measures will not bias the coefficients on consumption as long as the two are uncorrelated.
2. One exception may be if the violence is committed by illegal drug sellers trying to maintain monopoly prices or exclusive territories. In this sample, the proportion of teenagers who sell illegal drugs is unknown. However, in the 1997 National Longitudinal Survey of Youth, the proportion is fairly low; about 6.6 percent sell or help to sell illegal drugs. In addition, only 1.4 percent of the sample sold drugs regularly, that is, more than once a month for 12 months, and the majority report earning less than $100.00.

3. Data are available for 1997 and 1999 as well. Since cocaine prices are only available until 1994, the 1997 and 1999 data are not used. However, Table A1 shows results for models that use all 5 available years of data by excluding the cocaine price from all models. The magnitude and statistical significance of the OLS coefficients are very similar to those in Tables 2 and 3. The TSLS coefficients and standard errors are also very similar to those in Tables 2 and 3 in the physical fighting and gun carrying equations. The TSLS coefficients for other weapon carrying become statistically insignificant in all models.
4. The data are nationally representative when sample weights are used. See CDC [1991] for details on the data and sampling method. In this paper, means are presented using weights while regression coefficients are unweighted. Maddala [1983] shows that the estimation of weighted regressions is not required in the case of exogenous stratification (oversampling based on exogenous regressors such as race). DuMouchel and Duncan [1983] also show that weighted regressions are not appropriate if averages of strata-specific regression coefficients are desired.
5. Given the large numbers of blacks and Hispanics represented in the data, it is possible to present sample means and OLS regression results by race. However, dividing the sample by race results in untrustworthy TSLS estimates due to lack of variation among states. For example, in the sample used in this paper, 51 percent of Hispanics live in Texas, 19 percent live in California, and 8 percent live in Florida. Given that over three quarters of the Hispanic sample live in 3 states, there is simply not enough variation in the alcohol and drug policies to account for any differences in consumption among Hispanics. This output is available upon request.
6. Justification for using linear probability for estimating simultaneous equations with dichotomous dependent variables is provided by Heckman and MaCurdy [1985] and Angrist [2001].
7. The test is described in Greene [1993, 617].
8. In fact, a combination of state and time dummies almost perfectly predict the beer taxes. The R-squared from a regression of the beer tax on the state dummies and year dummies is 0.985. The R-squared is 0.886 for a regression of the decriminalization on the state and year dummies and is 0.953 for cocaine price on state and year dummies.
9 The R-squares of substance prices on region and year dummies are much lower: 0.51, 0.40, and 0.48 for the beer tax, marijuana decriminalization, and cocaine price, respectively.
10. Models were also tested that included dummies for the four regions of the country. These models produce estimates similar to those in Tables 2 and 3. Results are available upon request.
11. The simple correlation coefficients between smoking and binge drinking, smoking and drinking and smoking and marijuana use are all approximately 0.40.
12. Saffer and Chaloupka [1999a] and Farrelly et al. [1999] show evidence that beer and marijuana are complement goods.

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