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Effects of State Education Requirements for Substance Use Prevention

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Abstract

We provide the first evidence on the effects of state laws requiring students to receive education about alcohol, tobacco, and other drugs (ATOD) using data on over a million youths from the 1976-2010 Monitoring the Future Study. In difference-in-differences and event-study models we find robust evidence that these laws significantly reduced recent alcohol and marijuana use among high school seniors by 2-3 percentage points, or about 11-18 percent of the overall decline over this period. There is some evidence that the laws also increased the amount of drug instruction. Our results suggest that information interventions can reduce youth substance use.

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I. Introduction

The most recent round of the nationally representative Monitoring the Future study (MTF), which surveys high school youths every year about substance use, indicated that 11.4% of grade 12 youths smoked cigarettes regularly, and over 20% of grade 8 youths have tried cigarette smoking. Almost two thirds (64%) of youths have consumed alcohol by grade 12, with 26% having done so by grade 8. Over a third (35.3%) of grade 12 youths report drinking alcohol in the past month. One in 17 high school seniors reported using marijuana on a daily basis in 2015 (Johnston et al. 2016). High rates of youth substance use are associated with enormous social costs from harmful sequelae (Bonnie and O'Connell 2004). HealthyPeople2020 calls for reductions in average population-wide alcohol consumption, as well as reductions in youth and adolescent binge drinking, tobacco use, and marijuana use (Healthy People 2020, 2016).

Notably, youth substance use rates from the 2015 MTF study reflect consistent year-over-year declines since the mid-1970s (Appendix Figures 1-4). In this paper we provide the first evidence on whether adoption of state ATOD education requirements over this period contributed directly to these reductions in youth substance use. From 1976 to 2010, the number of states requiring that students receive instruction on alcohol, tobacco, and other drug (ATOD) prevention nearly tripled from 13 to 38, and the associated proportion of students living in states covered by such policies rose similarly (Appendix Figures 1-4).

Understanding whether ATOD education requirements caused reductions in youth substance use is important for many reasons. First, it is commonly argued that one reason youth substance use rates are so high – in addition to arguments about low discount rates and deviance (Gruber 2004) – is that young adults are not appropriately informed of the risks. Our research provides a direct test of this hypothesis by using plausibly exogenous variation in the timing and content of state laws requiring ATOD prevention instruction in schools. In so doing, our work relates to a large literature in economics about the effects of plausibly exogenous information interventions on youth behavior (Jensen 2010, Dupas 2011). Second, several states still do not require ATOD education to be taught in schools. If such education causally reduces youth substance use, there could be substantial latitude for further reducing substance use and its associated sequelae.

Notably, there are gaps in our understanding on the effects of school-based anti-drug policies. This gap in knowledge is surprising given that youths spend approximately 14% of their waking hours in school (Downey and Gibbs 2010). While we know that some school-based policies such as having clear rules and consistent enforcement are associated with less substance use (Evans-Whipp et al. 2004, Evans-Whipp et al. 2015), far less attention focuses on aspects of the educational environment that specifically relate to ATOD education and instruction requirements. This absence is especially surprising given that there

has been much study of the effects of instructional policies in core subjects such as math (Goodman 2012) and science (Plunk et al. 2014), as well as in other subjects such as physical education (Cawley et al. 2007) and sex education (Atkins and Bradford 2013).

Disentangling the independent effect of ATOD education requirements is challenging for two reasons. First, there has been little systematic tracking of these state laws. Second, over this period many other programs and policies were adopted that could have plausibly affected youth substance use (e.g., minimum drinking ages, medical marijuana laws, and others). To address the first issue, in 2011 we completed detailed legislative histories for each state and coded the timing and content of state laws regarding ATOD education.¹ To address the second challenge, we compile information on a range of other ATOD policies, as well as other state demographic and economic characteristics that may be correlated with adoption of such policies.

We test the effects of state ATOD education requirements using data on over one million middle and high school students from the 1976-2010 waves of the Monitoring the Future (MTF) study, the largest and oldest study of youth substance use in the United States. In addition to asking students about substance use behaviors, the MTF study has also asked about experiences of drug education in schools. We estimate straightforward difference-in-differences (DD) models

¹ These data are publicly accessible at: <http://nid.gse.uci.edu/>.

with controls for individual and state demographic characteristics, other ATOD policies, state and year fixed effects, and linear state trends. We also estimate event-study type models to directly inspect systematic pre-trends in outcomes correlated with state adoption of ATOD education requirements.

To preview, we find that state ATOD education requirements for drug use significantly reduced alcohol and marijuana use among youths in grade 12 by about 2-3 percentage points. A causal role for the education requirements is strongly supported by event study models. Our estimates suggest that ATOD education laws can explain 11-18 percent of the overall decline in alcohol and marijuana use among grade 12 students over this period. These effects are robust and are concentrated among girls, whites, and youths outside metropolitan areas. We find no effects of education requirements for youths in grades 8 and 10. Finally, we find some evidence that the state education requirements changed student reports of drug education experiences.

The remainder of the paper proceeds as follows. Section II describes the relevant institutional background and offers a brief literature review. Section III describes the data and empirical approach, Section IV presents the results, and Section V offers a discussion and concludes.

II. INSTITUTIONAL BACKGROUND AND LITERATURE REVIEW

Our focus is state adoption of laws requiring students to receive education about alcohol, tobacco, and/or other drugs (ATOD) in schools. Figure 1 provides text from Pennsylvania's law that is representative of many of the state requirements we study. While specific regulations vary across states, most states require that students receive instruction about the harms and dangers of alcohol, tobacco, and other drug use, as well as skills and strategies to prevent use (e.g., how to combat peer pressure). States also commonly require that students be taught about the legal ramifications of use of the various substances. States generally direct the state board of education to set minimum standards for ATOD prevention but leave the design of instruction up to the local school districts.

Figure 2 shows the timing of when states adopted ATOD education requirements. States that adopted earlier are shaded more darkly, while states that adopted more recently are shaded more lightly. Diagonal lines denote states that as of 2010 had not adopted an ATOD education requirement. Figure 2 indicates that there is not an obvious geographic pattern to the presence or absence of a state ATOD education requirement. While there is a belt of non-adopting states from Washington to Minnesota, there are non-adopters in the east (New Hampshire) and the south (Kentucky). The vast majority of the country lives in a state that adopted a state ATOD education law at some point from 1970 to 2010. More importantly for the identification strategy we use in our main analyses, Figure 2 also suggests that there is not a simple geography-based story about

when states adopted ATOD education requirements. Each region of the country has some very early adopters and very recent adopters, but it is not the case that the more conservative southern states all adopted first and all the liberal coastal states were slow to adopt.²

Regarding prior literature, we are not aware of any work that has evaluated the effects of the ATOD education requirements we study here except for one paper that documents the patterns and correlates of diffusion across states and over time in the adoption and content of ATOD education requirements (Wakefield et al. 2016). Despite the lack of research on ATOD education requirements, other subject-specific requirements have been studied extensively in economics and education. Arguably the most closely related to our paper is a series of studies exploiting variation in state physical education (PE) requirements. Cawley et al. (2013) find that the number of minutes of PE mandated by states is significantly associated with increases in the number of reported minutes of PE per week in the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K). They further show that instrumenting for PE minutes with the state requirements suggests that PE reduces obesity among

² This informal visual inspection is consistent with more rigorous empirical analysis of ATOD education policy diffusion. Wakefield et al. (2016) show that a host of detailed state demographic and political variables – which have been shown in prior work to correlate strongly with the timing of state adoption of criminal justice policies such as three strikes laws (Karch and Cravens 2104) and other public health policies such as clean indoor air laws (i.e., smoking bans) (Shipan and Volden 2006) – cannot readily explain the timing of adoption of a state ATOD education policy, consistent with our core identifying assumption that the variation in when states began to require such education is plausibly unrelated to the unobserved determinants of youth substance use in a state.

elementary school students. In related work, Cawley et al. (2007a, b) use a similar strategy and find that state PE requirements induce predictable changes in PE minutes for high school students as well but that they do not reduce weight for high school age youths. Atkins and Bradford (2013) examine state sex education requirements and find that sexuality education requirements do not significantly reduce teen sexual activity, though there is evidence that sex education laws requiring contraception content are associated with higher contraceptive use rates among teens and that states that require abstinence content decrease birth control use among sexually active teens.³

Our work also complements a large health economics literature on the policy determinants of youth substance use.⁴ For example, among high school seniors, more permissive minimum legal drinking ages (MLDA) have been shown to increase alcohol consumption (Dee 1999a), increase smoking (Dee 1999b), and reduce marijuana use (Dinardo and Lemieux 2001). More recently a series of studies has also shown that the age-21 minimum drinking limit also significantly reduces alcohol consumption of young adults below the MLDA (Carpenter and Dobkin 2009, 2011). Researchers have also extensively studied the relationship between beer taxes and youth drinking (Dee 1999a, Cook and Moore 2001,

³ Research has also examined the effects of state education laws for academic subjects, including math and science (Goodman 2012, Plunk et al. 2014).

⁴ Our work is also related to a large literature on the effects of other school-based health services, such as school health centers. Lovenheim et al. (2015) finds that the introduction of school-based health centers significantly reduces birth rates.

Carpenter et al. 2007) and marijuana use (Pacula 1998).⁵ Vertical identification cards have been shown to reduce youth alcohol consumption and smoking (Bellou and Bhatt 2012), while there is mixed evidence on the effectiveness of false-identification laws with scanner provision at reducing youth drinking (Yoruk 2014, Zheng 2016). Graduated driver licensing laws with an intermediate phase have been shown to reduce youth involvement in alcohol-related traffic fatalities (Dee et al. 2005), and Zero Tolerance age-targeted drunk driving laws have been shown to reduce binge drinking among young adults (Carpenter 2004). An extensive literature has studied the effects of large increases in the effects of state excise taxes on cigarettes on youth smoking, with strong evidence on the effectiveness of such taxes in the 1990s and 2000s (Carpenter and Cook 2008) and weaker evidence in more recent periods (Hansen et al. 2016, forthcoming). Dee (1999b) also studies the effects of cigarette taxes on youth drinking, finding a negative relationship. Finally, a series of studies has examined the effects of recent state changes in access to medical marijuana on youth marijuana and alcohol use, with mixed results (Anderson et al. 2013, 2015; Wen et al. 2015). Thus, our work contributes to a large and robust literature on the effectiveness of various government interventions on youth substance use by providing the first

⁵ Cook and Tauchen (1982) is one of the first quasi-experimental analyses of liquor taxes and heavy drinking (as proxied by deaths from cirrhosis of the liver) in the literature, though their focus is not on youths.

evidence on a new policy lever: state education requirements for ATOD prevention.

III. DATA AND EMPIRICAL APPROACH

We use confidential geocoded versions of the 1976-2010 Monitoring the Future (MTF) study matched to hand-collected data on state education requirements for ATOD instruction. The MTF is the nation's largest ongoing survey of youth substance use. Students in grade 12 have been interviewed annually since 1976; MTF added samples of grade 10 and grade 8 youths in 1991. The MTF is a series of repeated cross sections; the data do not follow the same students over time.

For substance use outcomes, we focus on indicators of recent use. PAST MONTH DRINKER is an indicator variable equal to one if the student reported consuming any alcohol in the past 30 days and zero otherwise. BINGE DRINKER is an indicator variable equal to one if the student reported consuming 5 or more drinks on a single occasion in the past two weeks and zero otherwise (also called ‘heavy episodic drinking’ in the literature). PAST MONTH SMOKER is an indicator variable equal to one if the student reported smoking any cigarettes in the past 30 days and zero otherwise. PAST MONTH MARIJUANA USER is an indicator variable if the student reports smoking any marijuana in the past 30 days and zero otherwise. We also consider combinations

of the alcohol and marijuana consumption variables, such as having consumed both alcohol and marijuana in the past month.

To identify the effect of the state ATOD education requirements we estimate straightforward two-way fixed effects regression models of the form:

$$(1) \quad \text{OUTCOME}_{ist} = \beta_1 X_{ist} + \beta_2 \text{STATE REQUIRES EDUCATION ABOUT DRUGS}_{st} + \beta_3 \text{STATE REQUIRES EDUCATION ABOUT ALCOHOL}_{st} + \beta_4 \text{STATE REQUIRES EDUCATION ABOUT TOBACCO}_{st} + \beta_5 Z_{st} + \text{STATE}_s + \text{YEAR}_t + \text{STATE*TREND}_{st} + \varepsilon_{ist}.$$

In this specification, OUTCOME represents the substance use (and, later, drug education outcomes) for student i in state s in survey year t . X_{ist} is a vector of student characteristics, including: age in months and its square, a male dummy, race/ethnicity dummies (black race, other race, and Hispanic ethnicity), a dummy for being not married, dummy variables for living in a large standard metropolitan statistical area (SMSA) and any SMSA other than a large SMSA, father's education (high school or less, some college, bachelor's degree or more, and an indicator for father education missing), mother's education (same variables as for the father), and dummy variables for missing data on sex and marital status. STATE REQUIRES EDUCATION ABOUT DRUGS_{st} is an indicator variable representing whether the law in that year in the student's state requires him/her to receive education about drug use, and the alcohol and tobacco use education variables are defined analogously.

Z_{st} is a vector of other state/time varying ATOD policies that have been shown in prior work to be related to youth substance use and related outcomes, including: a minimum legal drinking age of 18; medical marijuana legalization; Zero Tolerance age-targeted drunk driving laws; a graduated driver licensing law with an intermediate phase; false-id laws with scanner provision; vertical identification cards; the state and federal excise tax on beer in 2015 dollars; and the state excise tax on cigarettes in 2015 dollars. Z also includes an indicator for the presence of a No Child Left Behind-related state accountability policy and time-varying state demographic, economic, and political characteristics, including: the adult population, the black population, total public expenditures in the state, expenditures by category (education, welfare, hospitals, health, police, corrections, and other), crime rates in the state (violent crime, murder, rape, robbery, aggravated assault), the state unemployment rate, and dummy variables for the presence of a democratic governor, a democrat-controlled legislature, and a republican-controlled legislature.

$STATE_s$ is a vector of state fixed effects and control for time invariant characteristics about states. $YEAR_t$ is a vector of year fixed effects and controls for secular changes in outcomes common to all students in a given year. $STATE*TREND_{st}$ is a vector of linear state-specific time trends where we interact each state fixed effect with a variable TREND that equals 1 in 1976, 2 in 1977, and so forth. Standard errors are clustered by state throughout (Bertrand et al.

2004). The coefficients of interest are $\beta_2-\beta_4$ and represent the effects of the state education requirements for various substances on the key outcomes under study (youth substance use and receipt of drug education). The key identifying assumption in this augmented two-way fixed effects model is that the timing of adoption of education requirements across states is uncorrelated with the unobserved determinants of youth substance use and receipt of drug education, or put differently that the outcomes under study would have evolved similarly in states that did and did not adopt substance use education requirements in a particular year in the absence of adoption of the education requirements.

IV. RESULTS

a. Descriptive Patterns

We begin by documenting national trends in key variables of interest. Appendix Figures 1-4 present trends in substance use outcomes over our sample period for students in grade 12 (since 1976) for students in grades 8 and 10 (since 1991) for each of: past month drinking participation (Appendix Figure 1), past two week binge drinking (Appendix Figure 2), past month smoking (Appendix Figure 3), and past month marijuana use (Appendix Figure 4). In each figure we also show the associated proportion of grade 12 students living in a state covered by a state law requiring education on the relevant substance (i.e., alcohol for Appendix

Figures 1 and 2, tobacco for Appendix Figure 3, and drugs for Appendix Figure 4).⁶

Several patterns are notable in Appendix Figures 1-4. First, rates of use of all substances fell steadily over this time period (with the exception of increases in smoking and marijuana use in the early 1990s), a fact that has been previously documented by the national MTF study (Bachman et al. 2013). Second, substance use rates are highest for grade 12 students and lowest for grade 8 students, and the trends since 1991 do not differ markedly by grade. Third, these substance use reductions coincided with steady increases in the proportion of students living in states with education requirements for ATOD prevention. Fourth, there is some variation across substances in the proportion of young adults living in states with education requirements for the substance: tobacco is the least common substance required to have substance-specific instruction, followed by alcohol and drugs.

In Appendix Figure 5 we show the associated trends for the proportion of students in each grade who report they had a drug education course in the past year, and we also show in Appendix Figure 5 the same line from Appendix Figure 4 that captures the proportion of grade 12 students living in states requiring drug prevention instruction. One of the most striking features of Appendix Figure 5 is

⁶ There is very little variation in the exact grades required to be taught about ATOD prevention, and most of the grade-specific variation that does exist is not relevant for our sample (grades 8-12). Most states do not specify exact grades or require it broadly for K-12.

the remarkable stability of the proportion of young adults reporting they had drug education. Over the entire sample period about 70-80 percent of young adults report drug education, and there is very little variation across grades.⁷

b. Effects on Substance Use

Table 1 presents the main estimates from estimation of equation (1) for grade 12 youths from 1976-2010. Each column in Table 2 is from a separate regression, and we report the coefficients on the three ATOD education requirements variables (drugs, alcohol, and tobacco). We also report in the bottom row of Table 1 the coefficient on the indicator variable indicating exposure to the most permissive minimum legal drinking age of 18; this variable has been studied extensively in prior work, including studies that use these same data (Dee 1999a, DiNardo and Lemieux 2001, Carpenter et al. 2007). We report results for the past month drinking outcome in column 1, the past two week binge drinking outcome in column 2, the past month smoking outcome in column 3, and the past month marijuana use outcome in column 4.

The results in Table 1 return strong evidence that students living in a state that requires them to receive instruction about drug use were significantly less likely to report recent alcohol and marijuana consumption. In column 1, for example, we estimate that the ATOD education requirement for drugs reduced

⁷ Appendix Table 1 presents descriptive statistics for key variables used in the analysis.

grade 12 alcohol use in the past month by 3.5 percentage points and reduced grade 12 binge drinking by 2.5 percentage points. Column 4 indicates that the same education requirement reduced past month marijuana use by 2.1 percentage points.⁸ We find no effects of the ATOD education requirement for drugs on past month smoking in column 3.

Several other patterns in Table 1 are notable. First, there is no consistently significant association between ATOD education requirements for alcohol or tobacco and any of the substance use outcomes. Point estimates are generally small in magnitude and are as likely to be positive as negative. Second, the most consistent evidence points to a unique role for ATOD education requirements for drugs at reducing both marijuana and alcohol use; that is, there is not a substance-specific relationship between ATOD education requirements for alcohol and lowered rates of youth alcohol use.⁹ Third, despite concerns about collinearity due to the common adoption of ATOD education requirements for drugs and alcohol, the standard errors on the various ATOD education laws indicate there is sufficient independent variation among the key policies to meaningfully identify precise protective effects of the ATOD education requirement for drugs. Fourth,

⁸ In results not reported, we also found that state education requirements for drug use prevention also significantly reduced recent combination use of alcohol and marijuana. Appendix Table 2 shows there are no effects on the intensive margin of these outcomes (i.e., the number of times the youth drank alcohol, binged, smoked, or used marijuana over the relevant reference window).

⁹ This could reflect the possibility that when states require teachers to teach about the dangers of drug use, they also teach about the dangers of alcohol use (and vice versa). There are a handful of states that adopted alcohol-specific ATOD education requirements before drug-specific ATOD education requirements, but we do not have enough precision to meaningfully estimate models that identify these ‘ordering’ effects, despite that they could be important in practice.

our models replicate the basic finding that exposure to a permissive MLDA of 18 was associated with large and statistically significant increases in both recent drinking (Dee 1999a, Carpenter et al. 2007) and recent smoking (Dee 1999b).¹⁰

The MLDA-18 estimates for recent drinking also help scale the estimated effects of ATOD education requirements for drug use. It seems intuitive that the direct effects of legal availability to high school seniors would be associated with much larger effects on recent drinking than the effects of ATOD education requirements, and indeed this is what we find.¹¹ Measured differently, we estimate in Appendix Figure 1 that past month drinking rates fell by about 20 percentage points over the sample period; our estimate in the top row of Table 1 indicates that ATOD education requirements for drugs can explain about 3.5 percentage points of this decline, or about 18 percent. Note also that the baseline rate of past month youth drinking in the first year of our sample was about 70 percent; we estimate that ATOD education requirements reduced this by about five percent (3.5/70). For past month marijuana use, the estimate in the top row of column 4 of Table 1 can explain about 11 percent of the overall decline from 1976-2010 and reduced use by about five percent relative to the peak of marijuana

¹⁰ These models do not, however, replicate the DiNardo and Lemieux (2001) finding that exposure to an MLDA of 18 was associated with significant reductions of past month marijuana use among youths. This could be due to differences in the sample period studied.

¹¹ Note that only about half of high school seniors may legally drink in an age-18 MLDA environment, so the MLDA estimates should be scaled up by a factor of two to obtain the direct effect of the MLDA on youth drinking. Measured this way, the MLDA effect on binge drinking is 7.4 percentage points, or three times the size of the effect of ATOD education requirements for drug use prevention.

use in the late 1970s. Thus, the estimated effects of ATOD education requirements are nontrivial but not implausible in magnitude.

Figure 3 presents event study graphs of the effects of the ATOD drug education requirements on past two week binge drinking for the sample of grade 12 youths living in states that ever adopted an education requirement for drugs. This model replaces the single drug education requirement variable with a series of dummy variables representing ‘event time’ years relative to the year in which a state adopted an ATOD education requirement for drugs. This specification allows us to directly examine whether there were systematic pre-trends in outcomes that would violate our key identifying assumption of the DD model in equation (1), and it also allows us to examine how the effects evolve over time. The patterns in Figure 3 for past month drinking show no evidence of systematic pre-trends prior to adoption. While few of the estimates for specific years following adoption of the state ATOD education requirements for drugs are individually statistically significant, the clear pattern in Figure 3 is that substance use rates declined following policy adoption.

In Table 2 we further investigate the robustness of the main results in Table 1 that ATOD education requirements for drugs significantly reduced recent alcohol and marijuana use among high school seniors. The format of Table 2 is as follows: each entry is from a separate fully saturated regression model, and we report only the coefficient on the key variable indicating that the student lives in a

state and year where ATOD education is required for drugs. Each row investigates a different specification change to the baseline model or a different sample restriction intended to gauge robustness of the main findings. Column 1 reports results for the past month drinking outcome, column 2 reports results for past two week binge drinking, and column 3 reports results for past month marijuana use. We reprint the estimates for those three outcomes from the baseline specification in the top row of Table 2.

The first set of robustness analyses investigates standard specification changes to the basic two-way fixed effects DD model in equation (1). First, we add quadratic state-specific time trends (in addition to linear state trends); our main findings remain essentially unchanged. The next row shows results from models where we cluster at the state-year level instead of the state level, and again our main findings are not affected. The fourth row in Table 2 shows results from models where we exclude the alcohol and tobacco-specific ATOD education requirements to address possible concerns about collinearity. Here too we find significant effects of ATOD education requirements for drugs at reducing youth substance use.

The bottom set of robustness analyses in Table 2 investigates the effects of focusing in on various subsamples of interest. For example, we show that restricting attention to states that ever adopt an ATOD education requirement for drugs returns stronger evidence that the laws significantly reduced substance use.

This confirms that the main findings are driven by meaningful changes in the behavior of the treated states as opposed to states that never experienced the treatment. We also show that excluding the five most populous states (California, Texas, New York, Florida, and Illinois) also has no meaningful effect on our estimates in a qualitative sense, although all estimates are notably larger in magnitude when we exclude the largest states. Finally, in the bottom rows of Table 2 we show the effects of excluding entire regions of the country one at a time. While we lose statistical significance on some of the outcomes, all point estimates suggest nontrivial protective effects of ATOD education requirements for drugs, most of which retain statistical significance at least at the ten percent level. Thus, our main findings are robust along several reasonable dimensions.

In Table 3 we investigate heterogeneity in the effects of ATOD education requirements. The format of Table 3 follows that of Table 2 in that each entry in the table is from a separate fully saturated regression, and we only report the coefficient on the key ATOD education requirement for drugs. We also reprint the baseline full sample estimate for grade 12 youths in the top row of Table 3, and we again show results for three outcomes for which we find meaningful effects in Table 1: past month drinking, past two week binge drinking, and past month marijuana use. The results in the second and third rows of Table 3 investigate whether the main effects are driven in the early or later part of the sample period. We choose 1990/1991 as the key cutoff because 1991 was the

first year the grade 8 and 10 students were added to the MTF sample. Note that there were more state adoptions of ATOD education requirements for drugs in the earlier period compared to the later period, and indeed this is borne out in Appendix Figure 4 which shows that the percent of students living in a state covered by an ATOD education requirement for drugs increased much more from 1976 to 1990 than from 1991 to 2010. The results for the early/late split are mixed, though we do not have precision to say clearly that effects are only observed in one sample or the other. For the outcomes in columns 2 and 3, however, we estimate that the early period (1976-1990) saw much larger effects of ATOD education requirements for drugs than the later period. The reverse is true for past month drinking, though again we cannot rule out that the effects are equal across samples.

When we investigate results by gender and race in the subsequent rows, a clearer pattern emerges. Specifically, we estimate much larger effects of ATOD education requirements for females compared to males and for whites compared to nonwhites. While the sample of whites is much larger than the sample of nonwhites, the point estimates for the nonwhite sample is consistently very small and statistically insignificant. Results by whether the student's school is in a metropolitan statistical area or not (i.e., more rural) are generally inconclusive due to the small sample sizes of youths not living in an MSA (which is true by construction, since MSA designation is based in part on population density). The

point estimates for the non-MSA students are consistently much larger than those for the students in MSAs, however. Thus, the overall pattern that emerges for the grade 12 sample is that ATOD education requirements for drugs appear to have been particularly effective at reducing substance use among girls and whites and among students in less densely populated areas.

Finally, in the bottom two rows of Table 3 we show results for similarly specified models for grade 8 and 10 youths using the years they were included in the MTF study (1991-2010). These models include all the controls in equation (1), including the linear state trends. Results indicate no significant protective effects of ATOD education requirements for drugs for these younger youths, and indeed none of the point estimates is negative in sign. There is one statistically significant coefficient for grade 10 youths in column 3 for past month marijuana use, but it is implausible in magnitude relative to the baseline rate (i.e., it suggests a 50 percent increase relative to the 1991 marijuana use rate for grade 10 students). We conclude that ATOD education requirements for drugs had no meaningful effects on substance use in grades 8 and 10.

V. DISCUSSION & CONCLUSION

This paper provides the first evidence that state ATOD education requirements adopted from 1976-2010 – when the proportion of students living a state with such requirements more than doubled – were associated with significantly lower

rates of alcohol and marijuana use by high school seniors. These results are from difference-in-differences type models that include controls for a wide range of other ATOD policies, individual and state demographics, state and year fixed effects, and linear state trends, and they are validated by event study models. Effects are larger for girls, white students, and students outside major metropolitan areas. We find no evidence that the state education requirements reduced substance use among grade 8 and 10 youths. Our preferred estimates indicate that ATOD education requirements can explain 11-18 percent of the overall decline in grade 12 substance use rates since 1976.

How did the education policies achieve these reductions? Our preferred hypothesis is that the laws increased the amount of ATOD education instruction received by high school students in the United States. A challenge in testing this mechanism is that there are not good historical data on the nature and extent of drug education in schools before, during, and after the state education requirements were adopted. We can, however, provide some indirect evidence on the mechanism of increased ATOD education instruction using data from a module administered by the MTF. Specifically, the MTF asked a 1/6 random subsample of students direct questions about whether they had ever received drug education in school.¹² Students are then asked how many of each types of specific drug education experiences they have had, including: a special course

¹² Notably, the MTF did not ask specifically about alcohol or tobacco education, though it is likely that most drug education courses also contain content about alcohol and tobacco.

about drugs; films, lectures, or discussions in a regular course; films or lectures outside of a regular course; and special group discussions about drugs. We convert these responses into indicator variables for each of the drug education experiences and estimate variants of equation (1).

Table 4 presents these results on the relationship between state ATOD education requirements for drug use prevention and youth reports of drug education experiences in school. Each entry is the coefficient on the ATOD education required for drugs variable from estimation of equation (1) but where we change the outcome to be indicator variables for ever having had any type of drug education (column 1); having had drug education in a regular course (column 2); having had drug education outside of a regular course (column 3); having had drug education in a special course about drugs (column 4); and having had drug education in special discussions about drugs (column 5).¹³

The results in Table 4 return limited evidence that ATOD education requirements for drugs increased the amount and type of drug education. The estimate in column 1, for example, indicates that such requirements are associated with a 3.1 percentage point increase in the probability a grade 12 student reports she ever had drug education. Relative to the baseline rate of drug education reported by the sample in 1976 (80 percent), this represents about a 3.9 percent increase, though it is not statistically significant. Estimates for the other drug

¹³ The outcomes in columns 2-5 are subsets of the outcome in column 1.

education outcomes are mixed, though in column 3 we find a marginally significant increase in the probability a student reports she had drug education outside a regular course. Overall, the findings in Table 4 provide limited support to the idea that ATOD education requirements reduced substance use by introducing students to drug education who had not been exposed to it before.

Additional literature indicates that, before the mid-1970s, funding for ATOD education in schools remained quite low. In addition, many of the school-based ATOD education programs in the 1960s and early 1970s focused on disadvantaged groups rather than the general student population, and therefore did not reach most students (Allensworth et al. 1997). This circumstance, however, changed in the late 1970s and early 1980s due to several factors. First, the 1973 Report on the President's Committee on Health Education required health education instruction in public schools and provided support for increased funding (Guinta and Allegrante 1992). Second, in the early 1980s Congress provided approximately \$500 million per year for the US Department of Education to fund school-based ATOD education (Wyrick et al. 2001). Third, several high profile publications encouraging the role of health education as a part of core public school curriculum set the stage for the development of ATOD state education policies (Allensworth et al. 1997). These factors may have contributed to a substantial increase over time in the content and quality of ATOD school-based instruction.

Of course, there are several mechanisms through which ATOD education requirements could have affected instruction, and we can only test one of them (the likelihood of reporting ever having received different types of instruction). There are many others that we cannot directly test. These include: mode of instruction (e.g., lectures versus role-play versus films); quality of instruction (e.g., teacher credentialing/background in substance use education); and other measures of quantity of instruction (e.g., more class periods or longer units devoted to drug education). It could also be that schools are implementing programs and policies that are correlated with the timing of ATOD education requirements for drugs that are not captured by the state/year controls we have for state spending on health and education.¹⁴

While we are the first to document a protective effect of state ATOD education requirements, our study is subject to some limitations. First, we do not have true panel data on students which precludes our ability to make definitive causal claims regarding the effects of state education requirements on individual students. Second, we do not observe some important characteristics of the teachers or schools. Regarding teachers, we do not observe how well prepared or efficacious they are in delivering ATOD instruction. Regarding schools, we do

¹⁴ In results not reported but available upon request, we also made use of the fact that a subset of grade 8 and 10 youths were directly asked whether they had the DARE (drug abuse resistance education) program in school. This question was only asked from 1999 onward, however. We found no economically or statistically significant association between the ATOD education laws and the likelihood a grade 8 or 10 youth reported having had the DARE program.

not observe the content or enforcement of other policies toward youth substance use. Third, all of our outcomes are self-reported, though the validity of self-reported data on drug use by youths has been documented elsewhere (O’Malley et al. 1983). Desirability bias seems unlikely to fully explain our findings on reported substance use since we find effects for some substances (e.g., marijuana) but not others (e.g., tobacco). Finally, although we are using the largest dataset on youth substance use in the United States, it is possible that we do not have enough power to detect meaningful effects on the mechanisms in the same way that we have power to detect effects on use (since the substance use questions were asked to all students while the mechanisms questions were asked to less than 17 percent of the sample).

Despite these limitations, our study is the first to document that state adoption of ATOD education requirements reduced substance use rates among young adults, and as such our findings are directly relevant for the 11 states without such laws. Our results also illuminate a previously unidentified mechanism behind the steady decline in substance use over the past three decades. Future work could examine the effects of the state ATOD education policies on related sequelae, such as motor vehicle fatalities, injuries, crime, and risky sexual behavior.

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Figure 1:
Example of a State Law Requiring ATOD Education: Pennsylvania

24 P.S. § 15-1547
§ 15-1547. Alcohol, chemical and tobacco abuse program

(a) Beginning with school year 1991-1992 and each year thereafter, each public school student shall receive mandatory instruction in alcohol, chemical and tobacco abuse in every year in every grade from kindergarten through grade twelve. The instruction shall be integrated within the health course of study required in accordance with the State Board of Education regulations. In grades where health is offered, instruction may also be integrated into other appropriate courses of study. In grades where health is not offered, instruction shall be integrated into an appropriate curriculum requirement as listed in 22 Pa. Code § 5.4(b).

(1) This instruction:

- (i) Shall be age appropriate.
- (ii) Shall be sequential in method of study.
- (iii) Shall discourage the use of alcohol, tobacco and controlled substances.
- (iv) Shall communicate that the use of illicit drugs and the improper use of legally obtained drugs is wrong.

(2) School districts may utilize any appropriate public or private materials, personnel and other resources in developing and implementing this program of instruction. The Department of Health, Office of Drug and Alcohol Programs, shall make available information about appropriate curriculum materials upon request of a school district. In developing its alcohol, chemical and tobacco abuse instructional program, each school district shall consult with the single county authority designated by the Department of Health to provide drug and alcohol services in the school district's area.

(b) Each school district is hereby authorized to develop and offer programs relating to alcohol, chemical and tobacco abuse for parents of students enrolled in the public schools. If a school district does develop such programs, they shall be developed in consultation with the single county authority designated by the Department of Health to provide drug and alcohol services in the school district's area. Such programs shall be offered at no cost to parents.

(c) The Secretary of Education, in consultation with the Secretary of Health, shall develop curriculum guidelines for instruction on alcohol, chemical and tobacco abuse and the laws governing their use and misuse. These guidelines shall encourage the inclusion of the following elements where appropriate in the instruction:

- (1) Detailed factual information regarding the physiological, psychological, sociological and legal aspects of substance abuse.
- (2) Detailed information regarding the availability of help and assistance for students and their families with alcohol, chemical and tobacco dependency problems.
- (3) The goals of quality education as set forth in [22 Pa. Code § 5.13\(f\)](#).
- (4) Skills needed to evaluate advertisements for and media portrayals of alcohol, chemical and tobacco products.
- (5) Detailed instruction on the need for and the role of lawful authority and law-abiding behavior, including interaction with members of the legal and justice community.

(d) Beginning with the 1991-1992 school year and each year thereafter, the Secretary of Education, in consultation with the Secretary of Health, shall make available, to all school districts and intermediate units, in-service training programs based upon the instruction requirements established in subsection (a) and the curriculum guidelines established in subsection (c). The programs shall provide preparation for the teaching of mandated instruction in alcohol, chemical and tobacco abuse. The in-service programs may utilize the single county authorities designated by the Department of Health or such other institutions, agencies or persons as the Secretary of Education deems appropriate.

(e) Beginning with the 1991-1992 school year, each school district shall provide, as part of its in-service training, programs on alcohol, drugs, tobacco and dangerous controlled substances for all instructors whose teaching responsibilities include courses of study in which mandated instruction concerning alcohol, chemical and tobacco abuse is integrated. To comply with this requirement, a school district may utilize the programs made available by the Department of Education or use other alternative programs.

(f) The governing board of each intermediate unit in which a nonpublic school is located shall have the authority and the duty to loan to all students attending nonpublic schools within the intermediate unit all educational materials developed by either the Department of Education or the Department of Health, pursuant to this act for the instruction of public school students on the nature and effects of

drugs, alcohol, tobacco and dangerous controlled substances. Local school boards need not expend funds which are not provided by either the Federal or State Government for drug education programs for the use or loan of these materials. A nonpublic school may utilize the in-service training programs made available by the Department of Education through the intermediate unit.

(g) On or before June 1, 1991, the Secretary of Education shall recommend to the General Assembly a plan to require and assist each school district to establish and maintain a program to provide appropriate counseling and support services to students who experience problems related to the use of drugs, alcohol and dangerous controlled substances.

(h) On or before June 1, 1992, the Secretary of Education shall report to the General Assembly concerning the 1991-1992 school year activities of the Department of Education pertaining to the provisions of this section and concerning proposed 1992-1993 school year activities of the Department of Education pertaining to this section.

(i) The State Board of Education shall adopt rules and regulations necessary for the implementation of this section.

Figure 2:

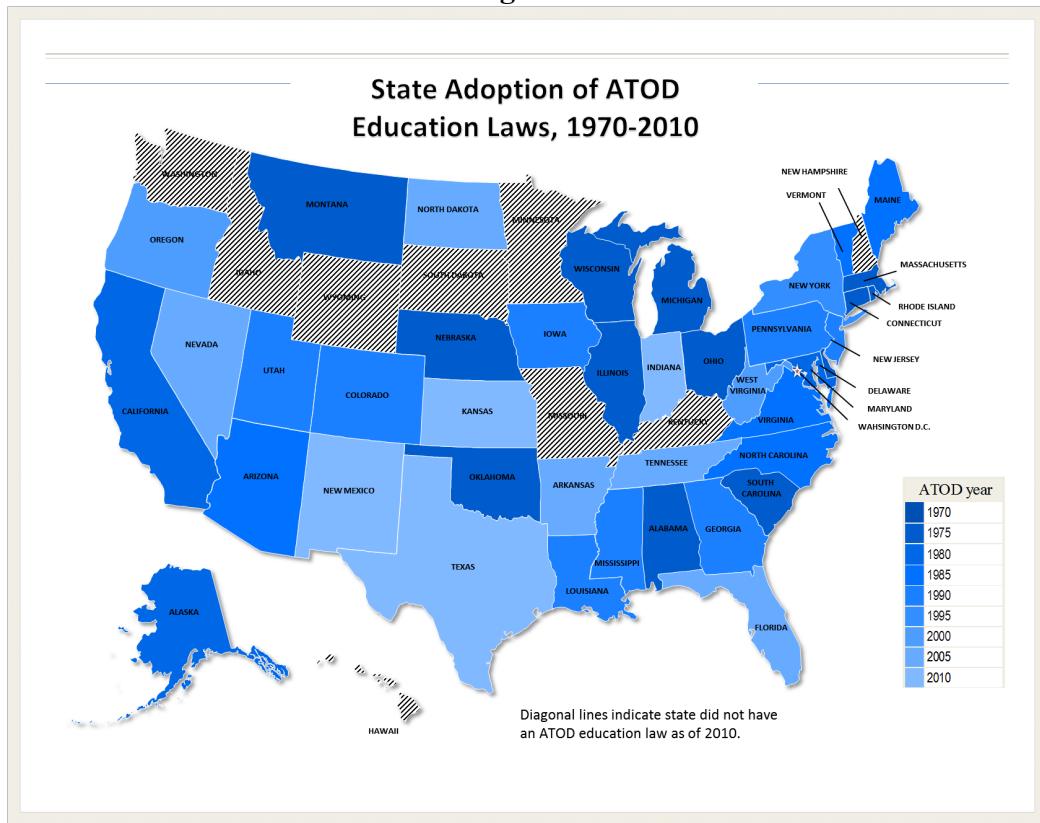


Figure 3:

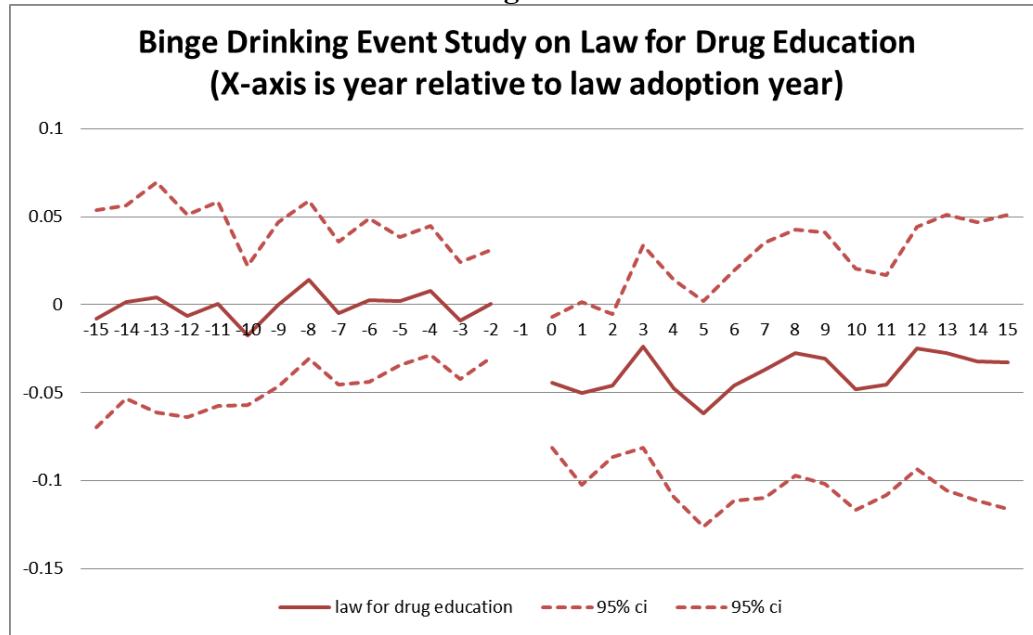


Table 1:
ATOD Education Requirements Reduced Youth Substance Use
 MTF 1976-2010, Grade 12

	(1) Drank alcohol in past month	(2) Binged in past 2 weeks	(3) Smoked in past month	(4) Used marijuana in past month
ATOD Education Required for Drugs	-0.035 [0.016]**	-0.025 [0.013]*	0.014 [0.018]	-0.021 [0.010]**
ATOD Education Required for Alcohol	0.024 [0.012]*	0.002 [0.010]	-0.021 [0.017]	0.004 [0.007]
ATOD Education Required for Tobacco	-0.016 [0.012]	-0.009 [0.013]	0.006 [0.013]	0.004 [0.010]
MLDA = 18	0.046 [0.010]***	0.037 [0.009]***	0.016 [0.008]**	0.004 [0.008]
Adjusted R-squared	.09	.07	.04	.05
N	510,466	506,848	527,491	521,662
Individual Demographics?	Y	Y	Y	Y
Other ATOD policies?	Y	Y	Y	Y
State & Year FE?	Y	Y	Y	Y
Linear state trends?	Y	Y	Y	Y

Notes: Each column shows the results from a separate regression model. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 2:

ATOD Education Requirements and Substance Use, Robustness

Coefficient Shown is on Dummy for ATOD Education Required for Drugs
 Baseline Specification with Linear State Trends, MTF 1976-2010, Grade 12

	(1) Drank in past month	(2) Binged in past 2 weeks	(3) Used marijuana in past month
Baseline specification, N=510,466	-.035 [.016]**	-.025 [.013]*	-.021 [.010]**
<i>Specification changes:</i>			
Add quadratic state trends	-.046 [.021]**	-.025 [.015]	-.031 [.012]**
Cluster at state-year level	-.035 [.014]**	-.025 [.012]**	-.021 [.011]*
Exclude ATOD dummies for alcohol & tobacco	-.026 [.010]**	-.030 [.010]***	-.015 [.008]*
<i>Sample restrictions:</i>			
Only states that ever adopt, N=388,317	-.044 [.020]**	-.031 [.013]**	-.030 [.008]***
Exclude 5 largest states (CA, TX, NY, FL, IL), N=337,029	-.040 [.017]**	-.031 [.013]**	-.032 [.010]***
Exclude West, N=350,206	-.058 [.022]**	-.044 [.017]**	-.007 [.020]
Exclude Midwest, N=374,520	-.028 [.015]*	-.021 [.013]	-.026 [.010]**
Exclude South, N=396,113	-.032 [.016]*	-.016 [.013]	-.011 [.010]
Exclude Northeast, N=410,559	-.032 [.017]*	-.025 [.014]*	-.034 [.009]***

Notes: Each entry shows the coefficient on the STATE REQUIRES EDUCATION ABOUT DRUGS indicator from the fully saturated specification with individual demographics, other ATOD policies, state characteristics, state and year fixed effects, and linear state trends. All models also include controls for the STATE REQUIRES EDUCATION ABOUT TOBACCO and STATE REQUIRES EDUCATION ABOUT ALCOHOL indicators (except where noted). Reported sample size is for the outcome in column 1. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 3:
ATOD Education Requirements and Substance Use, Heterogeneity
Coefficient Shown is on Dummy for ATOD Education Required for Drugs
Baseline Specification with Linear State Trends, MTF 1976-2010

	(1) Drank in past month	(2) Binged in past 2 weeks	(3) Used marijuana in past month
Full sample, Grade 12, N=510,466	-.035 [.016]**	-.025 [.013]*	-.021 [.010]**
<i>Various subsamples (Grade 12 unless otherwise noted):</i>			
1976-1990, N=234,800			
1991-2010, N=275,666	-.010 [.020]	-.035 [.020]*	-.046 [.013]***
Males, N=242,489	-.043 [.025]*	-.002 [.020]	-.015 [.015]
Females, N=258,315	-.025 [.018]	-.020 [.017]	-.012 [.017]
Whites, N=363,976	-.047 [.021]**	-.036 [.017]**	-.028 [.009]***
Non-whites, N=146,490	-.048 [.015]***	-.037 [.011]***	-.034 [.015]**
Non-whites, N=146,490	-.018 [.029]	.002 [.029]	-.006 [.018]
SMSA, N=399,161	-.016 [.014]	-.016 [.012]	-.007 [.012]
Not in an SMSA, N=111,305	-.124 [.056]**	-.080 [.052]	-.054 [.044]
Grade 8 (1991-2010), N=312,888	.007 [.012]	.003 [.010]	.012 [.008]
Grade 10 (1991-2010), N=293,148	.022 [.036]	.030 [.024]	.047 [.020]**

Notes: Each entry shows the coefficient on the STATE REQUIRES EDUCATION ABOUT DRUGS indicator from a separate regression model from the fully saturated specification with individual demographics, other ATOD policies, state characteristics, state and year fixed effects, and linear state trends. All models also include controls for the STATE REQUIRES EDUCATION ABOUT TOBACCO and STATE REQUIRES EDUCATION ABOUT ALCOHOL indicators. Reported sample size is for the outcome in column 1. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

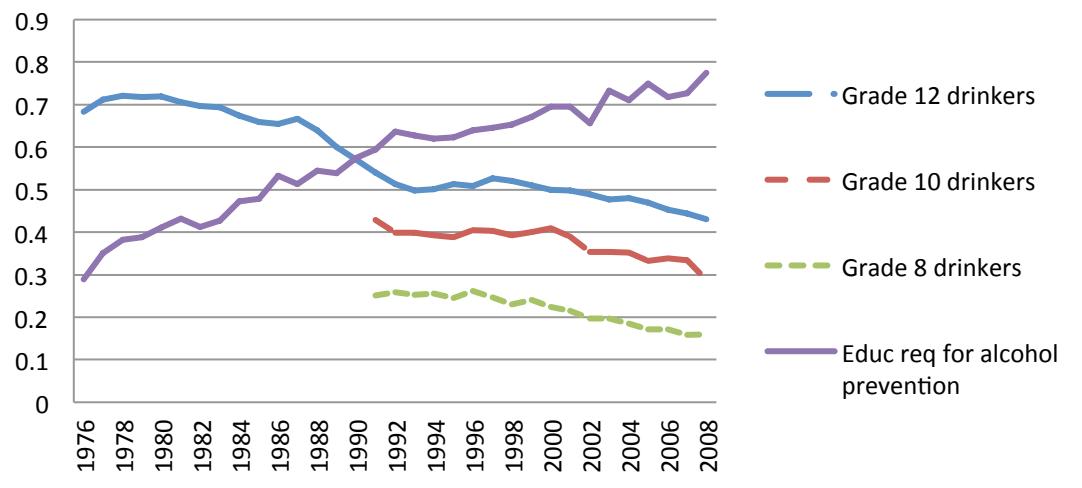
Table 4:
ATOD Education Requirements and Drug Education
 MTF 1976-2010, Grade 12

	(1) Ever had drug education (e.g. films, lectures, discussions)	(2) Had drug education in a regular course	(3) Had drug education, but not in a regular course	(4) Had drug education in a special course about drugs	(5) Had drug education in special discussions about drugs
ATOD Education Required for Drugs	.026 [.021]	.015 [.004]	.044 [.019]**	-.020 [.020]	-.006 [.021]
Adjusted R-squared	.04	.04	.03	.03	.02
N	78,888	78,888	78,888	78,888	78,888
Individual Demographics?	Y	Y	Y	Y	Y
Other ATOD policies?	Y	Y	Y	Y	Y
State & Year FE?	Y	Y	Y	Y	Y
Linear state trends?	Y	Y	Y	Y	Y

Notes: Each column shows the results from a separate regression model from the fully saturated specification with individual demographics, other ATOD policies, state characteristics, state and year fixed effects, and linear state trends. All models also include controls for the STATE REQUIRES EDUCATION ABOUT TOBACCO and STATE REQUIRES EDUCATION ABOUT ALCOHOL indicators. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

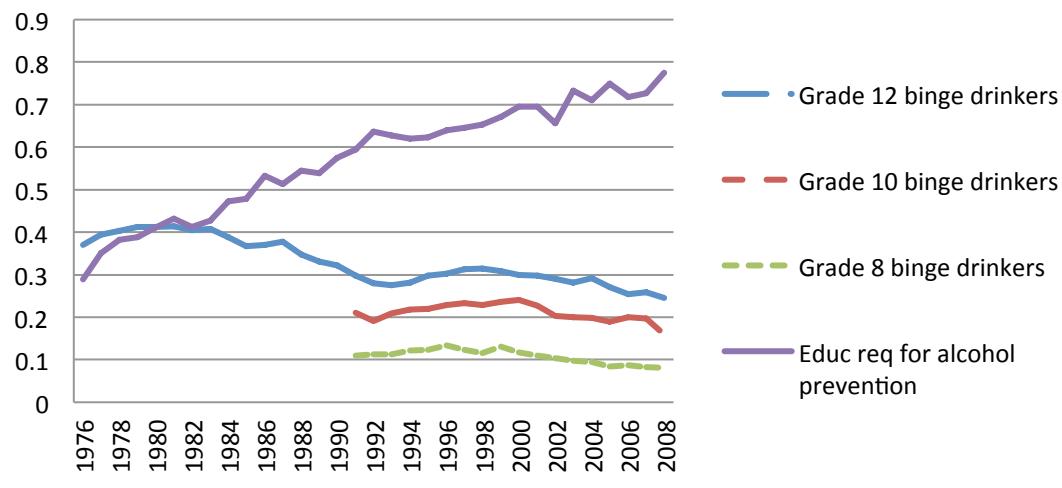
Appendix Figure 1:

State Education Requirements for Alcohol Prevention and Past Month Drinking



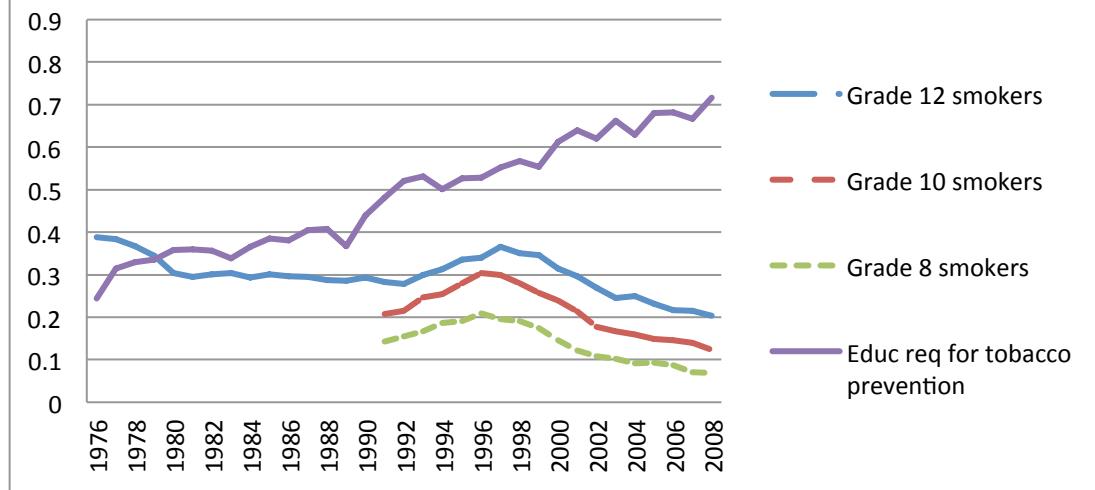
Appendix Figure 2:

State Education Requirements for Alcohol Prevention and Past 2 Week Binge Drinking



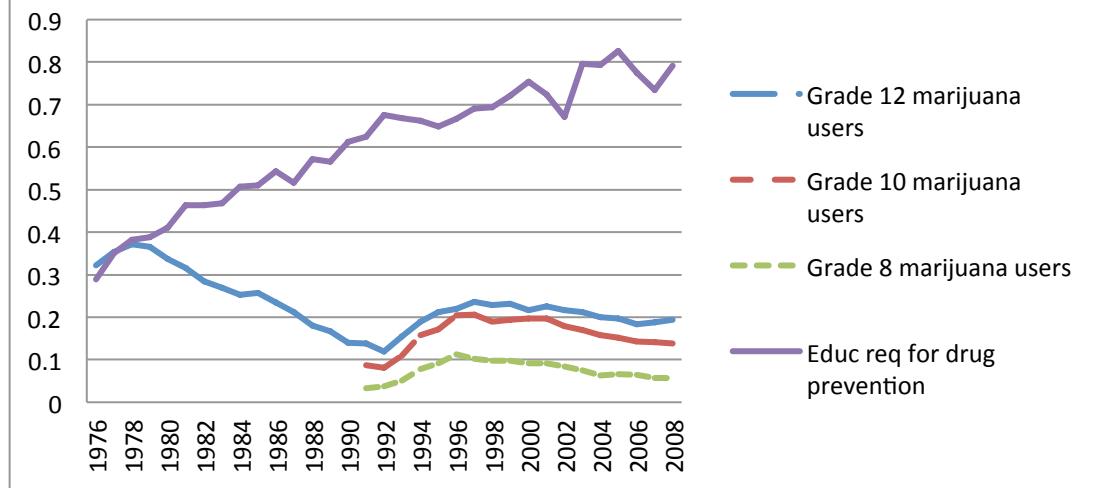
Appendix Figure 3:

State Education Requirements for Tobacco Prevention and Past Month Smoking



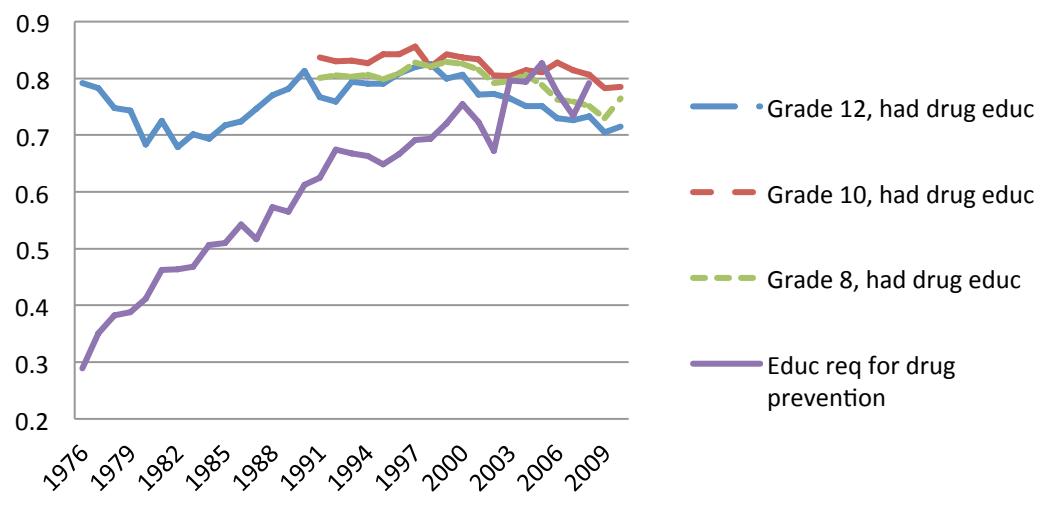
Appendix Figure 4:

State Education Requirements for Drug Prevention and Past Month Marijuana Use



Appendix Figure 5:

State Education Requirements for Drug Prevention and Reports of Drug Education



Appendix Table 1:
Descriptive Statistics, Monitoring the Future Data

	(1) Grade 12 (1976-2010)	(2) Grade 10 (1991-2010)	(3) Grade 8 (1991-2010)
ATOD education required for drugs	.630 (.489)	.774 (.418)	.751 (.432)
ATOD education required for alcohol	.602 (.490)	.751 (.432)	.716 (.451)
ATOD education required for tobacco	.519 (.500)	.673 (.469)	.639 (.480)
MLDA=18	.113 (.316)	.001 (.028)	.001 (.026)
Beer tax	1.21 (.412)	1.17 (.287)	1.20 (.303)
Zero Tolerance law	.411 (.487)	.778 (.407)	.749 (.423)
Graduated driver licensing law	.266 (.442)	.505 (.500)	.477 (.499)
False ID law with scanner provision	.073 (.260)	.132 (.339)	.137 (.344)
Vertical ID card required for minors	.161 (.368)	.302 (.459)	.299 (.458)
Cigarette tax	.648 (.517)	.853 (.625)	.815 (.614)
NCLB-related accountability policy	.336 (.472)	.633 (.482)	.609 (.488)
Age in months	216.1 (6.31)	192.3 (6.76)	168.7 (7.48)
Male	.462 (.499)	.474 (.499)	.469 (.499)
Mom has BA or more	.193 (.394)	.378 (.485)	.369 (.483)
Dad has BA or more	.191 (.393)	.365 (.481)	.348 (.476)

Notes: Weighted means (standard deviations).

Appendix Table 2:
ATOD Education Requirements Had No Effects on the Intensive Margin of Substance Use
 MTF 1976-2010, Grade 12

	(1) # times drank alcohol in past month	(2) # times binged in past 2 weeks	(3) # cigarettes smoked in past month	(4) # times used marijuana in past month
<i>Full sample</i>				
ATOD Education Required for Drugs	-.291 [.272]	-.071 [.062]	5.11 [4.57]	-.159 [.217]
Adjusted R-squared	.05	.06	.05	.04
N	510,466	506,848	527,491	521,662
<i>Intensity among users</i>				
	<i>Among past month drinkers</i>	<i>Among past 2 week bingers</i>	<i>Among past month smokers</i>	<i>Among past month marijuana users</i>
ATOD Education Required for Drugs	.014 [.355]	-.004 [.112]	3.46 [7.92]	.548 [.578]
Adjusted R-squared	.04	.04		.05
N	293,414	164,981	152,572	122,818
Individual Demographics?	Y	Y	Y	Y
Other ATOD policies?	Y	Y	Y	Y
State & Year FE?	Y	Y	Y	Y
Linear state trends?	Y	Y	Y	Y

Notes: Each column shows the results from a separate regression model. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.