NBER WORKING PAPER SERIES

# SMOKE GETS IN YOUR EYES: MEDICAL MARIJUANA LAWS AND TOBACCO USE

Anna Choi
Dhaval Dave
Joseph J. Sabia

Working Paper 22554
http://www.nber.org/papers/w22554

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2016

The authors thank Timothy Young, Thanh Tam Nguyen, and Brandyn Churchill for excellent research assistance. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Smoke Gets in Your Eyes: Medical Marijuana Laws and Tobacco Use
Anna Choi, Dhaval Dave, and Joseph J. Sabia
NBER Working Paper No. 22554
August 2016
JEL No. D1,I1


## ABSTRACT

This study comprehensively examines whether medical marijuana laws (MMLs) have affected the trajectory of a decades-long decline in adult tobacco use in the United States. Using data from three large national datasets — the Behavioral Risk Factor Surveillance Survey (BRFSS), the Current Population Survey Tobacco Use Supplements (CPS-TUS), and the National Survey of Drug Use and Health (NSDUH)— we estimate the relationship between MMLs and cigarette consumption. Our results show that the enactment of MMLs between 1990 and 2012 are associated with a 0.3 to 0.7 percentage-point reduction in tobacco consumption among US adults, though this estimate is somewhat sensitive to controls for state-specific linear time trends. These findings suggest that tobacco and marijuana are substitutes for many users. However, this average response masks heterogeneity in the effects of MMLs among early versus late-adopting states and across the age distribution.



Anna Choi
Organization for Economic Cooperation
and Development (OECD)
ac774@cornell.edu

Dhaval Dave
Bentley University
Department of Economics
175 Forest Street, AAC 195
Waltham, MA 02452-4705
and NBER
ddave@bentley.edu

Joseph J. Sabia
Department of Economics
University of New Hampshire
San Diego State University
Institute for the Study of Labor (IZA)
jsabia@mail.sdsu.edu

## I. Introduction

Cigarette consumption has been documented to be the number one cause of lung cancer and emphysema in the United States (CDC 2004). The annual public health costs of tobacco consumption have been estimated to be $96 billion (CDC 2009), with estimates of the external costs of secondhand smoke exposure ranging from $5 to $11 billion (Max et al. 2012; Behan et al. 2005). While a wide body of research has examined the effects of cigarette taxes (Callison and Kaestner 2014; Cebula et al. 2014; Hansen et al. 2016; Carpenter and Cook 2008), health information campaigns (Adams et al. 2011; Liu and Tan, 2009), and smoking bans (Bruderl and Ludwig 2011; Demperio, 2013; Sari 2013) on tobacco consumption, increased attention has been paid to how changes in the prices of other substances may generate spillover effects on tobacco use.[1] Understanding such policy-driven cross-price effects is critical for designing optimal tax and regulatory policy (Pacula 1997).

Recent policy reforms liberalizing access to marijuana have raised important questions about possible spillover effects in markets for related substances. One of the most common state marijuana reforms is the legalization of medical marijuana. As of July 2016, 25 states and the District of Columbia have adopted medical marijuana laws (MMLs), which legalize the possession, use, and cultivation of marijuana for allowable medical purposes. In addition, Alaska, Colorado, the District of Columbia, Oregon, and Washington have passed legislation that allow adults ages 21 and older to legally possess up to one ounce of marijuana (without intent to sell) for personal consumption, including for recreational use (Marijuana Policy Project 2015). Recent studies have documented that MMLs are associated with increased marijuana consumption among adults (Anderson and Rees 2011; Wen et al. 2015; Sabia and Nguyen

[1]See, for example, Cameron and Williams 2002; Farrelly et al. 2001; Yoruk and Yoruk, 2011, 2013.

2016).[2] These increases appear to occur not only for medicinal purposes, but also for recreational use through supply side-induced reductions in the street price of high-grade marijuana (Anderson et al. 2013). While general equilibrium effects of MMLs on other health outcomes have been studied in other contexts[3], this study is the first to comprehensively examine the effects of medical marijuana laws (MMLs) on cigarette consumption.

The effect of MMLs on tobacco consumption is theoretically ambiguous. The implementation of MMLs may reduce tobacco use if marijuana and tobacco are substitutes. For example, if marijuana and tobacco are consumed to achieve a similar objective, such as alleviating anxiety (Bambico 2007) or enhancing the taste of food (Riggs et al. 2012; Soria-Gomez et al. 2014), then the enactment of MMLs may reduce tobacco consumption. In addition, if increases in marijuana use for medical purposes lead to improvements in physical mobility (Sabia et al. 2016) or mental health, these positive health effects could increase the gains to non-smoking. Moreover, if alcohol and marijuana are substitutes (Anderson et al. 2013; Sabia et al. 2016; Crost and Guerrero 2012), and alcohol and tobacco are complements (Tauchmann et al. 2013), MMLs may reduce tobacco use. Finally, time spent consuming marijuana may crowd-out time spent smoking cigarettes.

On the other hand, MMLs could increase tobacco consumption if marijuana and tobacco are complements. This could be the case if both substances are consumed together as a "spliff" (Hammersley and Leon 2006) or if marijuana acts as a "gateway" substance for other risky health behaviors, including drinking (Wen et al. 2015; Pacula et al. 2015; Yoruk and Yoruk

[2] There is also some evidence of heterogeneous effects of MMLs on marijuana consumption by type of MML (Powell et al. 2015; Wen et al. 2015).

[3] For instance, recent studies have examined the effect of MMLs on alcohol consumption (Anderson et al. 2013; Wen et al. 2015), suicides (Anderson et al. 2014), and obesity (Sabia et al. 2016).

2011, 2013). Moreover, MML-induced improvements in health may cause individuals to indulge in compensatory unhealthy behaviors (Radtke et al. 2011). Thus, the net effect of MMLs on tobacco use depends, in part, on the mechanisms at work, the purpose of consumption (e.g. recreational versus medicinal), and the magnitudes of potentially competing effects.

Using nationally representative data available from three large surveys—the Behavioral Risk Factor Surveillance Survey (BRFSS), the Current Population Survey Tobacco Use Supplements (CPS-TUS), and the National Survey on Drug Use and Health (NSDUH) —this study examines the relationship between MMLs and tobacco consumption. Exploiting temporal variation in the adoption of MMLs across states in a difference-in-differences framework, our results show that the legalization of marijuana for medicinal purposes during the 1990 to 2012 period is associated with a 0.3 to 0.7 percentage-point decline in cigarette smoking participation. While these estimates are somewhat sensitive to the inclusion of controls for state-specific linear time trends, the results are generally consistent with the hypothesis that marijuana and cigarettes are substitutes for the average adult. However, we also uncover evidence of that the average effect of MMLs on tobacco use may mask heterogeneity in MML effects (i) across early- versus later-adopting states, and (ii) over the age distribution.

## II. Background

*Marijuana Use and Tobacco Consumption.* Consumption of tobacco cigarettes has been causally linked to respiratory health problems, heart disease, stroke, and a variety of cancers, including lung cancer, liver cancer, and colorectal cancer (U.S. Department of Health and Human Services 2014). Tobacco smokers are 25 to 26 times more likely to suffer from lung cancer—the country's most fatal cancer— than their non-smoking counterparts (Thun et al.

1997a, b; Thun et al. 2013). Tobacco use has also been documented to increase Chronic Obstructive Pulmonary Disease (COPD), a rising cause of mortality in the United States. In addition, exposure to secondhand smoke is associated with a substantial increase in the probabilities of stroke and death from cardiovascular diseases (CDC 2014).

Studies on the health effects of marijuana use, which are often (though not always) based on smaller clinical trials, produce less consistent evidence of adverse health effects relative to tobacco use. The most consistent evidence for negative health effects comes from heavier, frequent marijuana use. For instance, there is evidence that heavy marijuana use is associated with diminished respiratory health (Joshi et al. 2014; Pletcher et al. 2012), increased risk of heart disease (Hodcroft et al. 2014; Jouanjus et al. 2014), higher likelihood of amotivation syndrome (Volkow et al. 2016), and increased risk of poor psychological health (Van Ours and Williams 2011; Degenhardt et al. 2003). But in contrast to tobacco use, the link between marijuana use and risk of lung cancer has not yet been definitively established (Gates et al. 2014). Moreover, unlike tobacco use, there is evidence that marijuana consumption may generate some important health benefits. Marijuana consumption may be effective in treating psychological ailments (Bambico 2007), physical pain (Fiz et al. 2011), and side effects from cancer or HIV treatments (Hall et al. 2005; Doblin and Kleinman 1991; Vinciguerra et al. 1988). Together, the evidence suggests that the adverse health effects of tobacco use are likely larger than for marijuana use.

A substantial public health literature has documented a positive association between tobacco consumption and marijuana use (see, for example, Ramo et al. 2013, 2012; Beenstock and Tahov 2002; Bentler et al. 2002; Agrawal et al. 2007; Leatherdale et al. 2007). Young adults from ages 18 to 25 are nearly 10 times more likely to have used marijuana if they have also consumed cigarettes (Lai et al. 2000). There is also evidence that those who use marijuana in

young adulthood are more likely to initiate smoking cigarettes (Agrawal et al. 2008; Behrendt et al. 2009; Okoli et al. 2008; Timberlake et al. 2007) and are less likely to quit smoking cigarettes (Richter et al. 2002) than their counterparts who have abstained from marijuana.

While the public health literature has tended to characterize this pattern of results as evidence that marijuana and tobacco are complements, caution should be taken with such an interpretation. Because tobacco and marijuana use are jointly determined, the positive association observed could be driven, in part or in whole, by difficult-to-measure characteristics such as personal discount rates, personality, family background characteristics, or reverse causality. Credibly establishing the complementarity or substitutability of tobacco and marijuana requires estimation of cross-price effects generated from plausibly exogenous shocks in prices.

A number of studies have relied on changes in cigarette taxes to identify such cross-price effects. Using data from the National Household Survey on Drug Abuse, Farrelly et al. (2001) find that increases in cigarette taxes are negatively related to (i) the probability of marijuana use for 12 to 20 year-old males and (ii) the quantity of marijuana consumed by marijuana users. Using a similar empirical approach with data from Monitoring the Future, Chaloupka et al. (1999) find that cigarette tax hikes are negatively related to intensity of marijuana use among users.

There is mixed evidence on whether marijuana prices and decriminalization policies affect tobacco use. Using data from the Australian National Drug Strategy Household Surveys, Cameron and Williams (2001) find that higher cannabis prices are negatively related to tobacco use, but marijuana decriminalization laws have little effect on tobacco smoking behavior. Farrelly et al. (2001) find that larger marijuana possession penalties are essentially unrelated to tobacco consumption.

*Medical marijuana laws and health.* There is generally consistent evidence that MMLs are associated with increased marijuana consumption among adults (Anderson and Rees 2011; Wen et al. 2015; Sabia and Nguyen 2016), but not harder drugs (Wen et al. 2015; Choi 2015). Using data from the National Survey for Drug Use and Health, Wen et al. (2015) find that MMLs are associated with a 1 to 2 percentage-point increase in marijuana use among adults. Sabia and Nguyen (2016) and Anderson and Rees (2011) find a similar pattern of results in the NSDUH. The presence of MML-induced increases in marijuana use among demographic groups less likely to be using marijuana for medicinal purposes (those under age 30) suggests that there are recreational spillovers of MMLs. Such an interpretation is supported by Anderson et al. (2013), who find that MMLs are associated with a 10 percent reduction in street prices of marijuana and Chu (2014), who finds that MMLs are associated with a 10 to 20 percent increase in marijuana possession arrests and with a similar sized increase in marijuana-related admissions to rehabilitation centers.[4]

While no study has, to our knowledge, examined the effect of MMLs on tobacco consumption, there are a number of studies that have examined the effects of MMLs on alcohol use (Pacula et al. 2015; Anderson et al. 2014; Wen et al. 2015) and hard drugs (Wen et al. 2015; Choi 2015), which could affect the demand for tobacco.[5] However, there is mixed evidence on whether MMLs are associated with a reduction in binge drinking (Anderson et al. 2013; Sabia et

[4] These effects appear to be concentrated among adults. Using data from the Youth Risk Behavior Survey (YRBS), Anderson et al. (2014) find no evidence that MMLs are associated with changes in marijuana use among high school students.

[5] For instance, Clements et al. (2010) note:

> "Empirical studies show that marijuana is closely related in consumption to at least two other goods, tobacco and alcohol…As argued by Pacula (1997)…such interrelations imply cross-commodity impacts of policy changes, so that changes in one drug market are likely to have spillover effects in related markets." (Clements, Lan, and Zhao 2010; p. 204)

al. 2016) or with more alcohol consumption (Wen et al. 2015), which could suggest that there are heterogeneous effects of MMLs across states (Pacula et al. 2015).

The current study is the first to comprehensively examine the effect of MMLs on adult tobacco consumption. We explore the effects of MMLs on tobacco use across (i) three large national datasets, (ii) different empirical specification, (iii) the age distribution, as well as by gender, and (iv) across earlier- and later-adopting MML states.

## III. Data

Our analysis uses three national data sets containing information on smoking behavior among individuals during years when states began enforcing MMLs. We discuss the advantages and disadvantages of each data source below.

*BRFSS.* The BRFSS is a nationally representative telephone survey that has been conducted annually by the Centers for Disease Control and Prevention (CDC) since 1984. While the BRFSS was administered only via landline phones prior to 2011, beginning with the 2011 survey, the BRFSS began adding cellular phones to their sample and weighted these respondents accordingly. Respondents ages 18 and older are asked detailed questions about their health and health behaviors, including cigarette consumption. Our analysis sample consists of approximately 5.6 million observations drawn from repeated cross-sections of the BRFSS from 1990 to 2012.

We measure smoking participation in the BRFSS using responses to two sequentially asked survey items:

*"Have you smoked at least 100 cigarettes in your entire life?"*

*"Do you now smoke cigarettes everyday, some days, or not at all?"*[6]

Following CDC guidelines (2009), we generate a dichotomous measure of current smoking participation, *Participation*, set equal to 1 if the respondent reported smoking at least 100 cigarettes in his or her lifetime and smoking currently at least some of the time. A limitation of this measure is that we cannot identify new current smokers because those who do not report smoking at least 100 cigarettes in their lifetimes are not asked about current smoking. In the weighted BRFSS sample, 21.3 percent of respondents report current smoking participation (see Table 1).

In addition, we use responses to the second item above to capture frequent smokers. If respondents report that they currently smoke cigarettes every day, *Everyday Smoking* is set equal to 1; *Everyday Smoking* is set equal to 0 if the smoker reports smoking less than every day or not at all. This measure is consistently available in the BRFSS for the years 1996 to 2012. On average, 15.6 percent of the total sample smoked every day.

A chief advantage of the BRFSS is that it contains information on adult smoking participation before and after the first state enforced an MML (California in 1996). The large sample size is also crucial given that any effects of the MMLs on tobacco consumption are second-order effects, and would require substantial sample sizes in order to generate sufficient statistical power to detect small effects. However, a limitation of the BRFSS is that these data only include consistent data on (i) number of smoking days in the post-1996 period, and (ii) number of cigarettes consumed per smoking occasion in the pre-2000 period. Moreover, while a number of prior studies have established that MMLs are associated with an increase in marijuana use (Wen et al. 2015; Anderson and Rees 2011), the BRFSS does not include information on

[6]From 1990 to 1995, this item read simply, "Do you smoke cigarettes now?"

marijuana consumption to allow us to estimate the first-order effect during the 1990 to 2012 period.

*CPS-TUS.* The Tobacco Use Supplements (TUS) are sponsored by the National Cancer Institute and administered periodically as part of the Census Bureau's Current Population Survey (CPS) since 1992. The CPS-TUS is based on a large nationally-representative sample containing information on about 240,000 individuals within a given survey period; it provides a key source of national, state, and sub-state level data regarding smoking and the use of other tobacco products among adults aged 18 and older. Our analysis sample consists of approximately 1.8 million adults ages 18 and older drawn from repeated cross-sections of the CPS from 1992 to 2011.[7]

Smoking participation in the CPS-TUS is measured analogously to the BRFSS using responses to the following survey items:

*"Have you smoked at least 100 cigarettes in your entire life?"*

*"Do you now smoke cigarettes every day, some days, or not at all?"*

*Participation* is set equal to 1 if respondents answered that they have smoked at least 100 cigarettes over their lifetime and either currently smoke every day or on somedays, and is set equal to 0 otherwise. *Everyday Smoking* is also coded as above, set equal to 1 if respondents report that they currently smoke cigarettes every day and 0 if they do not smoke or smoke only on some days. In our weighted CPS sample, 19.9 percent of respondents reported smoking participation and 16.2 percent report everyday smoking (see Table 1).

[7] We use the data from the following TUS fielded in May 2010, August 2010 and January 2011; in May 2006, August 2006 and January 2007; in February, June and November 2003; in June 2001, November 2001 and February 2002; in September 1998, January 1999, and May 1999; in September 1995, January 1996, and May 1996; and in September 1992, January 1993, and May 1993. An abbreviated TUS was also conducted in January 2000 and May 2000.

An important advantage of these data is that, unlike the BRFSS, we can consistently measure smoking on the intensive margin over the full 1992 to 2011 period using the *Everyday Smoking* measure. In addition to consistent measures of smoking, the large sample sizes of the CPS-TUS permit analyses across sub-populations. The analysis sample comprises 1.8 million person-wave observations. A disadvantage of the CPS-TUS is the staggered nature of the cross-sections; the waves are not consistently fielded every year. In addition, like the BRFSS, the CPS surveys do not contain information on marijuana consumption.

*NSDUH.* To address these limitations, we supplement our BRFSS and CPS-TUS-based analyses with information from the NSDUH. The NSDUH is an annual cross-sectional survey that collects data from about 70,000 individuals, age 12 and older, randomly selected from the U.S. civilian non-institutionalized population. NSDUH collects data from residents of the households, and non-institutional group quarters (dorm, rooming houses, shelters, etc.), but does not include homeless individuals who do not use shelters or residents of institutional group quarters (jails and hospitals). The NSDUH is a well-suited dataset for this study because it contains detailed questionnaires about individual's illicit drug use including marijuana, tobacco consumption, and other health behaviors.[8] The individual-level restricted-use geocoded NSDUH is available for the 2004-2012 period. Our analysis sample consists of approximately 377,000 individuals ages 18 and older.

We generate measures of *Participation* and *Everyday Smoking* from responses to the following question:

*"How many days did you smoke cigarettes in the past 30 days?"*

[8]http://www.samhsa.gov/data/NSDUH/2012SummNatFindDetTables/NationalFindings/NSDUHresults2012.htm#ch1.1

If the respondent reports a positive number of days smoking cigarettes during the prior 30 days, we set *Participation* equal to 1 and 0 otherwise. *Everyday Smoking* is set equal to 1 if the respondent reported 30 days of prior month tobacco use and 0 otherwise. In our sample of NUSDUH adults ages 18 or older, 27.6 percent of adults reported smoking in the prior 30 days and 17.4 percent of adults smoked cigarettes daily (see Table 1).

While sample sizes in the NSDUH are smaller relative to the BRFSS and TUS and the surveys cover a smaller number of years, a key advantage is that the NSDUH asks about respondent's marijuana consumption.[9] Respondents to the NSDUH are asked:

*"How many days did you use marijuana or hashish in the past 30 days?"*

In the NSDUH data, 6.4 percent of adults reported consuming marijuana or hashish in the past month. Table 1 presents the means of tobacco consumption (and marijuana consumption from the NSDUH) across our three datasets, along with selected control variables.

## IV. Methodology

Following the MML literature, we estimate a reduced-form difference-in-differences (DD) model that captures an "intention-to-treat" effect of MMLs on cigarette consumption:

$$T_{ist} = \beta_0 + \beta_1 MML_{st} + \mathbf{X_{st}} \Phi + \mathbf{Z_{ist}} \psi + \nu_s + \omega_t + \varepsilon_{ist} \qquad (1)$$

where $T_{ist}$ measures tobacco cigarette consumption of individual *i* residing in state *s* in year *t*; $MML_{st}$ is an indicator for whether state *s* had an MML in effect in year *t*; $\mathbf{X}_{st}$is a vector of state-level time-varying controls including the state unemployment rate, the prime-age (ages 25-to-54) average wage rate, beer taxes, cigarette taxes, and the presence of a marijuana decriminalization law; $\mathbf{Z}_{ist}$is a vector of individual-level time-varying controls including age, gender,

[9] Due to disclosure protocols, all of the sample sizes are rounded to the nearest hundredths.

race/ethnicity, marital status, and indicators for educational attainment, $\nu_s$ is a time-invariant state effect, $\omega_t$ is a state-invariant year effect. We estimate equation (1) via linear probability models, though estimated marginal effects are similar across probit and logit specifications.

In addition, we also experiment with specifications that include state-specific linear time trends ($\nu_s$*t) as additional right hand-side controls:

$$T_{ist} = \beta_0 + \beta_1 MML_{st} + \mathbf{X_{st}} \Phi + \mathbf{Z_{ist}} \Omega + \nu_s + \omega_t + \nu_s*t + \varepsilon_{ist} \ . \qquad (2)$$

Our parameter of interest in equations (1) and (2) is $\beta_1$, which captures the net effect of the MML on smoking behaviors. Identification of $\beta_1$ comes from within-state over time variation in MMLs. Between 1990 and 2012, 17 states and the District of Columbia had enacted MMLs. About 45% of the observed variance in the MMLs is due to variation within states over our sample period. Table 2 shows the effective dates of MMLs enacted since 1990 as well as the sources of identifying variation across each of our three datasets.

Obtaining an unbiased estimate of $\beta_1$ requires that the common trends assumption of our difference-in-differences model to be satisfied. This may be a concern if (i) tobacco consumption was trending differently prior to the implementation of MMLs in "treatment" versus "control" states, (ii) state-specific time-varying unobservables are correlated with both the enactment of MMLs and tobacco use, and (iii) states may implement MMLs in response to risky health behaviors related to tobacco use.

We undertake several strategies to try to address this concern. First, as noted above, we control for other substance use policies in the vector $\mathbf{X}_{st}$, including beer taxes, cigarette taxes, and marijuana decriminalization laws. In addition, we add controls for state-specific linear time trends as in equation (2). Second, we test the robustness of our estimates of $\beta_1$ to the inclusion of policy leads. If trends in tobacco use were trending differently prior to the implementation of

MMLs, controls for policy leads should have a pronounced effect on our estimate of $\beta_1$. Finally, we use data from the General Social Survey (GSS) to construct a measure of state-level anti-marijuana legalization sentiment. Respondents to the GSS were asked:

*"Do you think the use of marijuana should be made legal or not?"*[10,11]

Those respondents who report that they did not believe marijuana should be made legal are coded as 1, and 0 otherwise. Adding a control for anti-marijuana legalization sentiment should help to address the possibility that our MML measure is simply capturing within-state changes in health sentiment, as well as reduce the possibility that cultural shifts can explain any MML effects observed.

Finally, we supplement the above analyses to assess heterogeneous responses to MMLs. First, we explore whether the tobacco consumption effects of MMLs differ by gender and age. Recent evidence by Sabia and Nguyen (2016) suggests that MMLs affect marijuana use not only among younger individuals under age 30, but also for individuals over age 40. Moreover, MMLs appear to increase near daily use of marijuana among younger males, but not older males or females (Sabia and Nguyen 2016). Together, this suggests heterogeneity in policy responses across the gender- and age-specific distribution, possibly driven by recreational versus medicinal use of marijuana. Second, we explore heterogeneity in the impacts of MMLs across states, given that some state provisions such as those that allow for collective cultivation of marijuana for

[10]One limitation of this measure is that it is only available for the calendar years 1990-1991, 1993, and even-numbered years between 1994 and 2000. In those years, the data are non-missing in 79 percent of state-year cells. Anti-marijuana legalization sentiment is not measured in Nevada or Nebraska in the GSS. In total, our anti-marijuana legalization sentiment measure is available for 37 percent of our full BRFSS sample.

[11] For the NSDUH data, the authors merged in the Simmons National Consumer Survey data to generate a similar measure of state-level anti-marijuana legalization sentiment as the GSS due to restricted data use protocols. The Simmons data asks the same question to the respondents. ("Do you think marijuana should be legalized or not?") The response categories are: 1) strongly agree 2) agree a little 3) neither/neutral 4) disagree a little bit 5) strongly disagree.

multiple patients (Anderson et al. 2013), for state-run dispensaries (Pacula et al. 2015), and for non-specific pain (Sabia et al. 2016) may have different behavioral impacts.

## V. Results

Tables 3 through 8 below present our main findings. We focus on estimates of $\beta_1$ for ease of presentation, but estimates on the coefficients on controls are available upon request. All regressions are weighted and standard errors are clustered at the state level (Bertrand et al. 2004).

*Main Findings.* Table 3 presents our baseline difference-in-differences (DD) estimates of the effects of MML enactment on any smoking participation and daily smoking participation. Columns (1) through (4) presents estimates from the BRFSS and columns (5) through (8) from the CPS-TUS. Across both datasets, we find that MMLs are associated with a small, but statistically significant, decline in smoking participation (Panel I). The magnitudes of the effects are remarkably stable with the addition of observable individual- and state-level policy controls, consistent with the hypothesis that MML adoption is unrelated to these characteristics. In our preferred specifications (columns 4 and 8), the magnitude of the MML-induced decline in tobacco use is on the order of 0.3 to 0.7 percentage-points (Panel I). With respect to daily smoking (Panel II), MMLs are associated with a (statistically insignificant) 0.1 percentage-point decline in everyday smoking in the BRFSS and a 0.4 percentage-point decline in the CPS-TUS. Together, these estimates translate into effect sizes of approximately 1 to 4 percent relative to sample means. These findings are consistent with the hypothesis that marijuana and tobacco are substitutes.[12] In principle, the MML-induced cigarette smoking effects we observe could reflect

[12] In unreported results available upon request, we estimate the effects of MMLs on cigarette consumption on the intensive margin, and find no consistent evidence that MMLs affect the number of days smoked or the number of cigarettes smoked per occasion among smokers.

shifts on either the initiation or cessation margin. However, given that the vast majority of ever smokers (84%) initiate tobacco use at age 18 or earlier and virtually no one initiates after age 21, our estimates likely reflects shifts on the cessation margin.

Table 4 examines the sensitivity of estimates in Table 3 to state-specific time-varying characteristics that could be correlated with the enactment of MMLs and tobacco consumption. First, columns (1) and (2) add controls for anti-marijuana legalization sentiment from the GSS to the right-hand side of equation (1). While less precisely estimated (in the case of the CPS-TUS), the results continue to point to evidence that MMLs are associated with a 0.2 to 0.7 percentage-point reduction in the probability of smoking participation, suggesting that marijuana legalization sentiment cannot fully explain our findings.

Columns (3) and (4) of Table 4 add controls for policy leads to address the concern that our estimated policy impacts could have captured pre-treatment tobacco use trends. We uncover evidence that tobacco use was actually increasing (in some specifications) prior to the implementation of MMLs. After controlling for differential pre-treatment trends, the estimated association between MMLs and cigarette consumption actually *increases* in absolute magnitude. However, the estimated declines remain small (1.9 to 5.2% relative to the mean).

The final two specifications (columns 5 and 6) present estimates from equation (2) that include state-specific linear time trends. Results from the BRFSS no longer show any economically or statistically significant effect on smoking, suggesting that prior estimates may have been contaminated by state trends that unfold linearly. However, caution should be taken given that the inclusion of state-specific time trends will reduce identifying variation available to

estimate policy impacts.[13] Moreover, findings from the CPS remain robust after controlling for state-specific linear time trends, suggesting a 0.5 to 0.7 percentage point decrease in the likelihood of any smoking and daily smoking respectively. Together, the results in Table 4 generally continue to indicate that MMLs have a small negative effect on cigarette consumption

*Heterogeneity in MMLs by Age and Gender.* In Table 5, we explore heterogeneity in the effects of MMLs on smoking participation by age and gender. This may be important given that (i) MMLs have been found to have larger effects on both younger adults under 30 (Anderson et al. 2013) and older adults over 50 (Sabia et al. 2016), and (ii) consumption of tobacco and marijuana together as a spliff is much more common among males than females (Ramo et al. 2013). Panel I presents separate models for males and females pooled across all adults. Point estimates from the BRFSS suggest somewhat larger effects among females, though the confidence intervals are wide enough that we are not able to reject the hypothesis that MML effects are statistically equivalent by gender. The CPS-TUS estimates for any smoking generally suggest similar effects, though are imprecisely estimated for both genders.

Comparing patterns across age groups, there is some suggestive evidence of stronger effects among young adults of ages 18 to 24, particularly in the BRFSS, which may reflect the relatively high prevalence of marijuana use for this age group. We also find relatively stronger negative effects on smoking among adults ages 40 and older across both datasets, a population for whom MML-induced increases in marijuana use have been observed (Sabia and Nguyen 2016). The larger effects among older adults may be consistent with MML-induced marijuana consumption for medical purposes potentially improving physical mobility (Sabia et al. 2016) or

[13] The addition of state linear trends substantially reduces the identifying variation in the policy measure by almost 60%. In addition, Wolfers (2006) cautions against adding state-specific linear trends since such trends may confound both the state-specific time-varying unobservable as well as any dynamic effects of the policy itself.

mental health (Anderson et al. 2013), and in turn reducing patients' reliance on cigarettes as a form of self-medication (Saffer and Dave 2005).

Turning to Table 6, we repeat the exercise for everyday smoking. The pattern of results is similar with one exception: for 25-to-39 year-old males, there is some evidence that MMLs are associated with increases in daily smoking. That the effects are only significant for daily smoking, and not for any smoking participation, may be indicative of some adults transitioning from being a non-daily smoker to being a daily smoker, perhaps because spliff consumption is more common among young men who regularly consume marijuana. Appendix Tables 1 and 2 present estimates of Tables 5 and 6 after controlling for state-specific linear time trends. These estimates overall are less precisely estimated, as expected, but generally suggest a similar pattern of results.

*NSDUH Estimates and Heterogeneous Types of MMLs.* As noted above, one of the disadvantages of the CPS-TUS and BRFSS is the lack of information on marijuana use. The NSDUH allows us to estimate the "first-stage" effect of the MMLs on marijuana use to confirm the prior NSDUH-based literature (Wen et al. 2015). The difference-in-differences estimate in column (1) shows that the enactment of an MML is associated with an approximate one percentage-point increase in marijuana use, which is statistically distinguishable from zero at the ten percent level. While this effect is somewhat lower than those reported by Anderson and Rees (2011) and Wen et al. (2015)—perhaps due to our choice of controls——it is qualitatively similar in suggesting that MMLs did have a positive effect on marijuana consumption at the extensive margin. The effect becomes insignificant with the inclusion of state-specific linear time trends (Panel I, column 2), but new work by Sabia and Nguyen (2016) using a longer NSDUH sample period—2002 to 2014—finds evidence of MML-induced increases in marijuana

use (at both the extensive and intensive margins) on the order of 10 to 20 percent in models that include controls for state-specific linear time trends.

Thus far, our models have examined the effects of implementing and enforcing any legislation related to medical marijuana use, which captures the average policy effect across various types of MMLs and across early-adopting states vs. later-adopting states. Next, we assess heterogeneity in this average response across these margins, as well as across differing types of MMLs.

In Panels II and III of columns (1) and (2), we show the effect of MMLs on cigarette consumption in the NSDUH. Intriguingly, these estimates show that MMLs are associated with substantial *increases* in the probability of smoking participation (Panel II, columns 1 and 2) and everyday smoking (Panel II, columns 1 and 2). The effect magnitudes (up to 4 percentage-point increases) are large, particularly in comparison to the first-stage marijuana response. If we assume that any effect of MMLs on other substance use necessarily must involve a change in marijuana consumption, then second-order effects on smoking cannot be larger than the first-order effects on marijuana consumption. As prior estimates in the literature (and our own NSDUH estimates) show, MMLs may have raised marijuana consumption by at most 1 to 3 percentage points. Thus, credible smoking effects would be an order of magnitude lower than this (either in the positive or negative direction). In other words, if 1 to 3 percent of the adult population is changing their marijuana consumption because of MMLs, it is not credible to expect all of them to also change their smoking participation.[14] Further casting doubt on these findings, when we restrict the sample to the NSDUH years 2004 to 2012, we do not find similar effects in the BRFSS (columns 3 and 4) or the CPS-TUS in the baseline specification (column

[14] About 93% of current marijuana users are ever-smokers (either former smokers who have quit, or current smokers), based on the 2000 NSDUH.

5). Estimates in the CPS-TUS become positive (and implausibly large) only after adding state linear trends as additional controls (column 6).

What could explain why the effects of MMLs on smoking appear to differ over time and across datasets? Differences in results across these two data sources are not unique to this study; studies on the effects of MMLs on alcohol consumption yield (similar) discrepancies. Wen et al. (2015) find that the MMLs increased the frequency of binge drinking among adults, based on the NSDUH, while Anderson et al. (2014) and Sabia et al. (2016) find evidence of a decline in drinking in the BRFSS.

Thus, it may be that MMLs have heterogeneous effects on risky behaviors across states and over time (Pacula et al. 2014). As shown in Table 2, 10 states enacted MMLs during the 2004 to 2012 period. One reason why MMLs might have different spillover effects on tobacco use across different periods may be due to early and later adopting states implementing different types of MMLs. For example, as shown in Table 2, states which adopted MMLs prior to 2004 were somewhat less likely to legally permit dispensaries and collective cultivation but more likely to allow for general pain, relative to later-adopting states.[15]

We therefore return to our full sample period and alternately assess differential effects across these specific types of MMLs. Table 8 presents estimates for the average response to any MML implementation as well as effects for three particular dimensions of the MMLs: whether a state (i) has specific allowances for medical marijuana use for general pain rather than particular medical conditions; (ii) allows home or collective cultivation of marijuana for multiple patients; and (iii) legally permits dispensaries to operate.

[15] Limiting the sample period also substantially reduces the identifying variation in the MMLs. About 45% of the total observed variance in effective MML implementation over 1990-2012 is within-state variation, compared to only 12% over 2004-2012. This inflates the standard errors and makes is difficult to identify precise effects.

Panel I presents estimates based on the BRFSS, and Panel II presents estimates from the CPS-TUS. Columns (1) through (3) separately include effective state implementation of the three specific dimensions of the MMLs noted above. These models suggest that all three components of the MMLs are generally associated with reduced smoking participation. The estimate magnitudes are qualitatively similar across these three types in terms of direction, suggesting about a 0.7 to 1.1 percentage point decline in the likelihood of being a current smoker across both datasets. The model shown in column (4) controls for all three dimensions of the MMLs jointly. These estimates are somewhat imprecise due to a high degree of collinearity among different policy components (see Table 2 and discussion in Wen et al. 2015), particularly those that allow for use of marijuana for non-specific pain and permit marijuana dispensaries. Thus, estimates from column (4) should be interpreted with caution.

The results in column (4) suggest some divergence in estimates across the BRFSS and CPS-TUS. Findings in Panel I using the BRFSS show that MMLs that permit use of medical marijuana for general pain is associated with a significant decline in smoking participation; in contrast, for the CPS-TUS (Panel II), the declines are most notable for collective cultivation provisions.[16,17] However, we cannot reject the hypothesis that these estimates are statistically equivalent across datasets at conventional levels. Despite these differences, we conclude, conservatively, that none of our key MML provisions appears to induce greater tobacco consumption.

[16] These differences persisted even after limiting BRFSS data through January 2011, the last year available in the CPS-TUS. This suggests that dataset-specific differences in findings across heterogeneous types of MMLs cannot be explained by differences in sources of identifying variation.

[17] Estimates for daily smoking follow a similar pattern; the effects are consistently negative for both datasets when the specific components of the MMLs are included separately, but generally insignificant and variable when we control for all of these laws jointly.

## VI. Conclusions

With the proliferation of state laws allowing for medical marijuana use and several states considering similar legislation[18], public health professionals and policymakers have expressed concerns that these policies may have unintended spillovers that adversely affect health. Previous work has considered outcomes related to problematic alcohol use (Anderson and Rees 2011, 2013; Wen et al. 2015), illicit drug use (Wen et al. 2015), and body weight (Sabia et al. 2016), but this study is the first to examine the tobacco-related effects of MMLs.

Using data from the BRFSS and the CPS-TUS, we find that the enactment of MMLs is associated with a 0.3 to 0.7 percentage point reduction in cigarette consumption. The magnitude of these effects is relatively small, representing generally less than a 3% decline relative to the mean. Where we find negative effects on smoking, these are generally driven by young adult males (ages 18-24) as well as those over age 40.

To place our smoking magnitudes in context, it should be noted that the DD effect we estimate is an intention-to-treat (ITT) effect. Most individuals in the population would not be affected by the MMLs, and therefore the estimated reduced-form smoking effect is an average across two groups – those who are potentially affected by the MMLs and those who are not impacted.[19] It is not likely that MMLs would have a direct effect on smoking behaviors,

[18] Six states (FL, KY, MO, NE, SC, TN) have pending legislation or amended ballot measures in 2016; PA passed legislation in 2016; and similar legislation failed in nine states in 2016 (FL, GA, IN, IA, KS, MS, WV, WI, UT). A previous bill died in the FL senate, and a proposed amendment will be on the November 2016 ballot. See: http://medicalmarijuana.procon.org/view.resource.php?resourceID=002481

[19] Data from the 2011 NSDUH suggest that about 90% of current or former marijuana users had also used cigarettes (either currently or in the past). Wen et al. (2015) find that the MMLs on average raised current marijuana use among adults by 1.4 percentage points. Thus the potential "treated" adult population, who would be "at risk" of being impacted by the MMLs in terms of their smoking behaviors is 1.26% (0.90*1.4) of the population; the remaining 98.74% of adults would not be impacted, either because they were not impacted in terms of their marijuana consumption from the MMLs or because they never smoked cigarettes. Conditional on the first-stage effect, this also helps to bound the potential effect sizes for cigarette consumption. Even if all of the "treated" population changes their smoking behaviors, then the maximal predicted average MML impact on smoking would

independent of their effect on marijuana consumption. The prior literature has generally established small first-stage effects of the MMLs on marijuana consumption, on the order of 1 to 3 percentage-points for all adults. We can roughly gauge the size of the smoking effect by imputing the "treatment-on-the-treated" (TOT) effect of marijuana consumption on smoking. This is the Wald estimate, computed as the ratio of the two reduced-form estimates of the effects of MMLs on smoking to the effects of MMLs on marijuana use, which translates into a TOT estimate ranging from -0.10 to -0.30 (about -0.20 on average).[20,21] This estimate implies that, while the MMLs had a relatively small effect on marijuana use among adults and the "treated" population is thereby small, among those who were impacted about 1 out 5 may have reduced their smoking as they increased their marijuana consumption.

Together, our results suggest very little evidence that MMLs have impeded the U.S. trend of declining tobacco use. While the average tobacco use response to MMLs is likely small and negative, our results also point to considerable heterogeneity in the effects of the laws, both across later-adopters vs. the early adopters of MMLs, as well as across different dimensions of the laws, echoing work by Anderson and Rees (2014), Pacula et al. (2015) and Wen et al. (2015). These effects warrant further study of differential responses across specific state laws and specific components of the MMLs.

---

be between -1.26 to 1.26 percentage points within the adult population, which is consistent with the estimates from this study.

[20] Utilizing the lower CPS-TUS estimate of -0.003 and dividing by the average first-stage effect of 1.4 to 1.5 (found in both studies by Anderson and Rees 2011 and Wen et al. 2014) yields -0.20.

[21] Implicit TOT effects rescaled in this manner should be interpreted with caution because small changes in the denominator (in this case the first-order effect of the MMLs on marijuana use) and the underlying estimates can lead to large differences.

## References


Adams L, Faseur T, and Geuens M. (2011). The Influence of the Self-Regulatory Focus on the Effectiveness of Stop-Smoking Campaigns for Young Smokers. *Journal of Consumer Affairs 45*(2): 275-305.

Agrawal, A., Lynskey, M., Bucholz, K., Madden, P., & Heath, A. (2007). Correlates of cannabis initiation in a longitudinal sample of young women: The importance of peer influences. *Preventive Medicine, 45*, 31–34.

Agrawal, A., Madden, P., Bucholz, K., Heath, A., & Lynskey, M. (2008). Transitions to regular smoking and to nicotine dependence in women using cannabis. *Drug and Alcohol Dependence, 95*, 107–114.

Anderson, D. M., & Rees, D. I. (2011). Medical marijuana laws, traffic fatalities, and alcohol consumption. IZA working paper no 6112. Available at: http://ftp.iza.org/dp6112.pdf

Anderson, D.M., Hansen, B., & Rees, D.I. (2013). Medical marijuana laws, traffic fatalities, and alcohol consumption. *Journal of Law and Economics, 56*(2), 333-369.

Anderson, D.M., Rees, D.I., & Sabia, J.J. (2014). Medical Marijuana Laws and Suicides by Gender and Age. *American Journal of Public Health, 104*(12), 2369-2376.

Anderson, D.M., & Rees, D.I., (2014). The role of dispensaries: the devil is in the details. *Journal of Policy Analysis and Management, 33*(1): 235–240.

Bambico, F. R., Katz, N., Debonnel, G., & Gobbi, G. (2007). Cannabinoids Elicit Antidepressant-like Behavior and Activate Serotonergic Neurons through the Medial Prefrontal Cortex. *The Journal of Neuroscience 27*(43), 11700–11.

Beenstock, M., & Rahav, G. (2002). Testing Gateway Theory: Do cigarette prices affect illicit drug use? *Journal of Health Economics, 21*(4), 679–698.

Behan, D.F., Eriksen, M.P., Lin, Y. (2005). Economic Effects of Environmental Tobacco Smoke Society of Actuaries.

Behrendt, S., Wittchen, H., Höfler, M., Lieb, R., & Beesdo, K. (2009). Transitions from first substance use to substance use disorders in adolescence: Is early onset associated with a rapid escalation? *Drug and Alcohol Dependence, 99*, 68–78.

Bentler, P., Newcomb, M., & Zimmerman, M. (2002). Cigarette use and drug use progression: Growth trajectory and lagged effect hypotheses. In: Kandel D B, editor. Stages and pathways of drug involvement.Cambridge, England: Cambridge University Press, 223–253.

Bruderl, J., Ludwig, V. (2011). Does a Smoking Ban Reduce Smoking? Evidence from Germany. *SchmollersJahrbuch: Zeitschrift Fur Wirtschafts- Und Sozialwissenschaften/Journal Of Applied Social Science Studies, 131*(2), 41 9-429.

Callison, K., Kaestner, R. (2014). Do Higher Tobacco Taxes Reduce Adult Smoking? New Evidence of the Effect of Recent Cigarette Tax Increases on Adult Smoking. *Economic Inquiry, 52*(1), 155-172.

Cameron, L., & Williams, J. (2002). Cannabis, Alcohol, and Cigarettes: Substitutes or Complements? *Economic Record, 77(236),* 19-34.

Carpenter, C., Cook, P.J. (2008). Cigarette Taxes and Youth Smoking: New Evidence from National, State, and Local Youth Risk Behavior Surveys. *Journal of Health Economics, 27*(2), 287-299.

Cebula RJ, Foley M, Houmes R. (2014). "Empirical Analysis of the Impact of Cigarette Excise Taxes on Cigarette Consumption: Estimates from Recent State-Level Data." *Journal of Economics and Finance* 38(1), 164-180.

Centers for Disease Control and Prevention. (2004). National Center for Chronic Disease Prevention and Health Promotion. Tobacco Information and Prevention Source (TIPS). Tobacco Use in the United States**.**

Centers for Disease Control and Prevention. (2009). State-specific secondhand smoke exposure and current cigarette smoking among adults—United States, 2008. MMWR Morb Mortal Wkly Rep 58:1232–1235.

Centers for Disease Control and Prevention. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. (2014). Surgeon General's Report: Rockville, MD.

Choi, A. (2015). Three Essays in Health Economics (Doctoral Dissertation).

Chaloupka, F., Pacula, R., Farrelly, M., Johnston, L., O'Malley, P., & Bray, J. (1999). Do higher cigarette prices encourage youth to use marijuana? NBER working paper no 6939. Available at: http://www.nber.org/papers/w6939.pdf.

Clements, K., Lan, Y., & Zhao, X. (2010). The demand for marijuana, tobacco, and alcohol: inter-commodity interactions with uncertainty. *Empirical Economics, 39,* 203-239.

Crost, B., & Guerrero, S. (2012). The Effect of Alcohol Availability on Marijuana Use: Evidence from the Minimum Legal Drinking Age. *Journal of Health Economics, 31*(1), 112-121.

Degenhardt, L., Hall, W., & Lynskey, M. (2003). Exploring the association between cannabis use and depression. *Addiction, 98*(11), 1493-1504.

Demperio, S. (2013). Cigarette Taxes, Smoking Bans, and Smoking Behavior (Dissertation). University of Virginia, 161 pages; 3570854.

DiNardo, J., & Lemieux, T. (2001). Alcohol, Marijuana, and American Youth: The Unintended Consequences of Government Regulation. *Journal of Health Economics, 20*(6), 991–1010.

Doblin, R. E., & Kleinman, M. A. (1991). Marijuana as Antiemetic Medicine: A Survey of Oncologists' Experiences and Attitudes. *Journal of Clinical Oncology 9*(7), 1314-1319.http://www.ncbi.nlm.nih.gov/pubmed/2045870

Farrelly, M. C., Bray, J. W., Zarkin, G. A., & Wendling, B. W. (2001). The Joint Demand for Cigarettes and Marijuana: Evidence from the National Household Surveys on Drug Abuse. *Journal of Health Economics, 20*(1), 51-68.

Fiz, J., Durán, M., Capellà, D., Carbonell, J., & Farré, M. (2011). Cannabis Use in Patients with Fibromyalgia: Effect on Symptoms Relief and Health-Related Quality of Life. *PloS One, 6*(4), e18440.

Gates, P., Jaffe, A., & Copeland ,J. (2014). Cannabis smoking and respiratory health: consideration of the literature. *Respirology*, *19*(5), 655-662.

Hall, W., MacDonald, C., & Currow, D. (2005). Cannabinoids and Cancer: Causation, Remediation, and Palliation. *The Lancet Oncology 6* (1), 35–42. http://www.ncbi.nlm.nih.gov/pubmed/15629274.

Hammersley, R., Leon, V. (2006). Patterns of cannabis use and positive and negative experiences of use amongst university students. *Addiction Research & Theory, 14*(2), 189–205.

Hansen, B., Sabia, J.J., & Rees, D.I. (2016). Do Cigarette Taxes Still Bite? Updated Estimates on Youth Smoking from the YRBS. *American Journal of Health Economics*.

Hodcroft, C., Rossiter, M., Buch, A. (2014). Cannabis-associated Myocardial Infarction in a Young Man with Normal Coronary Arteries. *The Journal of Emergency Medicine, 47*(3), 227-281

Joshi, M., Joshi, A., Bartter, T. (2014). Marijuana and lung diseases. *Current Opinion in Pulmonary Medicine 20*(2), 173-9.

Jouanjus, E., Lapeyre-Mestre, M., Micallef, J., & French Association of the Regional Abuse and Dependence Monitoring Centres (CEIP-A) Working Group on Cannabis Complications. (2014). Cannabis use: signal of increasing risk of serious cardiovascular disorders. *Journal of the American Heart Association, 3*(2), e000638.

Kelly, E., & Rasul, I. (2014). Policing Cannabis and Drug Related Hospital Admissions: Evidence from Administrative Records. *Journal of Public Economics, 112*, 89–114.

Lai, S., Lai, H., Page, J., McCoy, C. (2000) The association between cigarette smoking and drug abuse in the United States. *Journal of Addictive Diseases, 19*(4), 11–24.

Leatherdale, S., Hammond, D., Kaiserman, M., & Ahmed, R. (2007). Marijuana and tobacco use among young adults in Canada: Are they smoking what we think they are smoking? *Cancer Causes & Control, 18*(4), 391–397.

Liu, H., & Tan, W. (2009). The effect of anti-smoking media campaign on smoking behavior: the California experience. *Annals of economics and finance, 10*(1), 29-47.

Marijuana Policy Project. (2015). State-by-State Medical Marijuana Laws. Available at: https://www.mpp.org/issues/medical-marijuana/state-by-state-medical-marijuana-laws/

Max, W., Sung, H.Y., & Shi, Y. (2012). Deaths from secondhand smoke exposure in the United States: economic implications. *American Journal of Public Health, 102*(11), 2173-80.

Okoli, C., Richardson, C., Ratner, P., & Johnson, J. (2008). Adolescents' self-defined tobacco use status, marijuana use, and tobacco dependence. *Addictive Behaviors, 33*(11), 1491–1499.

Pacula, R.L. (1997). Economic Modelling of the Gateway Effect. *Health Economics, 6*(5), 521-524.

Pacula, R.L, Powell, D., Heaton, P., & Sevigny, E.L. (2015). Assessing the Effects of Medical Marijuana Laws on Marijuana Use: the Devil Is in the Details. *Journal of Policy Analysis and Management, 34*(1), 7-31.

Pennsylvania General Assembly. (2016). Medical Marijuana Act. Available at: http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2016&sessInd=0&act=16

Pletcher, M., Vittinghoff, E., Kalhan, R., Richman, J., Safford, M., Sidney, S., Lin, F., Kertesz, S. (2012). Association between marijuana exposure and pulmonary function over 20 years. *The Journal of the American Medical Association, 307*(2), 173-181.

Ramo, D., Delucchi, K., Hall, S., Liu, H., & Prochaska, J. (2013). Marijuana and Tobacco Co-Use in Young Adults: Patterns and Thoughts about Use. *Journal of Studies on Alcohol and Drugs, 74*(2), 301–310.

Ramo, D., Liu, H., & Prochaska, J. (2012). Tobacco and marijuana use among adolescents and young adults: A systematic review of their co-use. *Clinical Psychology Review, 32*(2), 105–121.

Radtke, T., Scholz, U., Keller, R., Knäuper, B., & Hornung, R. (2011). Smoking-Specific Compensatory Health Beliefs and the Readiness to Stop Smoking in Adolescents. *British Journal of Health Psychology, 16*, 610-625. doi:10.1348/2044-8287.002001

Richter, K., Ahluwalia, H., Mosier, M., Nazir, N., & Ahluwalia, J. (2002). A population-based study of cigarette smoking among illicit drug users in the United States. *Addiction, 97*(7), 861–869

Riggs, P.K., Vaida, F., Rossi, S.S, Sorkin, L.S., Gouaux, B., Grant, I., Ellis, R.J. (2012). A Pilot Study of the Effects of Cannabis on Appetite Hormones in HIV-Infected Adult Men. *Brain Research 1431*(11), 46–52.

Sabia, J.J., J. Swigert J., T. Young. (2016, in press). The Effect of Medical Marijuana Laws on Body Weight. *Health Economics.*

Sabia, J.J. & T.T. Nguyen. (2016). The Effect of Medical Marijuana Laws on Labor Market Outcomes. Working Paper, San Diego State University.

Saffer, H., & Dave, D. (2005). Mental Illness and the Demand for Alcohol, Cocaine, and Cigarettes. *Economic Inquiry, 43*(2), 229-246.

Sari, N. (2013). On Anti-smoking Regulations and Tobacco Consumption. *Journal of Socio-Economics*, 4360-67. doi:http://dx.doi.org.libproxy.sdsu.edu/10.1016/j.socec.2013.01.006

Soria-Gómez, E., Bellocchio, L., Reguero, L., Lepousez, G., Martin, C., Bendahmane, M., Ruehle, S. et al. (2014). The Endocannabinoid System Controls Food Intake via Olfactory Processes. *Nature Neuroscience, 17*(3) (March): 407–15.

Tauchmann, H., Lenz, S., Requate, T., Schmidt, C.M. (2013). Tobacco and Alcohol: Complements or Substitutes? A Structural Model Approach to Insufficient Price Variation in Individual-Level Data. *Empirical Economics, 45*(1), 539-566.

Thun, M., Carter, B., Feskanich, D., Freedman, N., Prentice, R., Lopez, A., Hartge, P., & Gapstur, S. (2013). 50-year trends in smoking-related mortality in the United States. *New England Journal of Medicine, 368*(4), 351–364.

Thun, M., & Heath, C. Jr. (1997a). Changes in mortality from smoking in two American Cancer Society prospective studies since 1959. *Preventive Medicine, 26* (4), 422–426

Thun, M., Lally, C., Flannery, J., Calle E., Flanders, W., & Heath, C. Jr. (1997b).Cigarette smoking and changes in the histopathology of lung cancer. *Journal of the National Cancer Institute, 89*(21), 1580–1586.

Timberlake, D., Haberstick, B., Hopfer, C., Bricker, J., Sakai, J., Lessem. J., & Hewitt, J. (2007). Progression from marijuana use to daily smoking and nicotine dependence in a national sample of U.S.adolescents. *Drug and Alcohol Dependence, 88*, 272–281

U.S. Department of Health and Human Services. (2014). The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Printed with corrections, January 2014.

Van Ours, J., & Williams, J. (2011). Cannabis use and mental health problems. *Journal of Applied Econometrics*, 26 (7), 1137-1156.

Volkow, N., Swanson, J., Evins, A., DeLisi, L., Meier, M., Gonzalez, R., Bloomfield, M., Curran, H., & Baler, R. (2016). Effects of cannabis use on human behavior, including cognition, motivation, and psychosis: a review. *JAMA Psychiatry, 73*, 292–297.

Wen, H., Hockenberry, J.M., & Cummings, J.R. (2015). The Effect of Medical Marijuana Laws on Adolescent and Adult use of Marijuana, Alcohol, and Other Substances. *Journal of Health Economics, 42*(3), 64-80.

Wolfers, J. (2006). Did Unilateral Divorce Laws Raise Divorce Rates? A Reconciliation and New Results. *American Economic Review*, *96*(5), 1802-1820.

Yoruk, B. K., & Yoruk, C. (2011). The Impact of Minimum Legal Drinking Age Laws on Alcohol Consumption, Smoking, and Marijuana Use: Evidence from a Regression Discontinuity Design Using Exact Date of Birth. *Journal of Health Economics 30*(4), 740–52.

Yoruk, B. K., & Yoruk, C. (2013). The Impact of Minimum Legal Drinking Age Laws on Alcohol Consumption, Smoking, and Marijuana Use Revisited. *Journal of Health Economics, 32*(2), 477-479.

Vinciguerra, V., Moore, T., & Brennan, E. (1988). Inhalation Marijuana as an Antiemetic for Cancer Chemotherapy. *New York State Journal of Medicine, 88*(10), 525–527.

**Table 1. Means of Tobacco Use and Selected Controls, BRFSS, CPS-TUS and NSDUH**

| | BRFSS (1990-2012[a]) (1) | CPS-TUS (1992-2011) (2) | NSDUH (2004-2012) (3) |
|---|---|---|---|
| *Tobacco Use Measures* | | | |
| Participation | 0.213 (0.410) [N=5,656,644] | 0.199 (0.399) [N=1,781,311] | 0.276 (0.447) [N=377,300] |
| Everyday Smoking | 0.156 (0.362) [N=5,070,737] | 0.162 (0.368) [N=1,781,311] | 0.174 (0.379) [N=377,300] |
| *Selected Controls* | | | |
| MML | 0.146 (0.351) | 0.124 (0.330) | 0.042 (0.196) |
| Cigarette Taxes (2012 $) | 0.851 (0.702) | 0.789 (0.617) | 1.245 (0.84) |
| Beer Taxes (2012 $) | 0.340 (0.266) | 0.301 (0.213) | 0.262 (0.184) |
| Marijuana Decriminalization Law | 0.332 (0.471) | 0.328 (0.469) | 0.342 (0.474) |
| Zero Tolerance Law | 0.793 (0.398) | 0.832 (0.369) | 1 (0) |
| BAC08 Law | 0.630 (0.475) | 0.580 (0.481) | 0.996 (0.055) |
| Per capita income ($2012) | 39,559.2 (6,241.7) | 39,500.3 (5,966.1) | 42,688.6 (5,873.7) |
| Unemployment Rate | 6.14 (2.04) | 5.89 (2.06) | 6.899 (2.38) |
| Age | 45.38 (17.65) | 45.17 (17.51) | 45.89 (17.64) |
| HS Degree | 0.309 (0.462) | 0.326 (0.468) | 0.307 (0.461) |
| Black | 0.106 (0.307) | 0.116 (0.320) | 0.115 (0.319) |
| Hispanic | 0.117 (0.321) | 0.134 (0.338) | 0.136 (0.343) |
| N | [N=5,656,644] | [N=1,781,311] | [N=410,600] |
| *Marijuana Consumption* | | | |
| Marijuana | N/A | N/A | 0.064 (0.245) [N=613,100] |

Notes: Weighted means obtained using data drawn from the Behavioral Risk Factor Surveillance Survey (1990-2012), the Current Population Survey Tobacco-Use Supplements (1992-2011), and the National Survey for Drug Use and Health (2004 to 2012).
[a]Data on *Participation* are available between 1990-2012 and for *Everyday Smoking* between 1996-2012.

## Table 2. Effective Dates of Medical Marijuana Laws

| State | MML | MML Key Provisions | | |
|---|---|---|---|---|
| | | Pain | Collective Cultivation | Dispensary |
| Alaska [B, C] | 03/1999 | 03/1999 | n/a | n/a |
| Arizona [B, C, N] | 04/2011 | 04/2011 | 04/2011 | 04/2011 |
| California [B, C] | 11/1996 | 11/1996 | 11/1996 | 11/1996 |
| Colorado [B, C] | 06/2001 | 06/2001 | 06/2001 | 06/2001 |
| Connecticut [B, N] | 05/2012 | n/a | n/a | n/a |
| Delaware [B, C, N] | 07/2011 | 07/2011 | n/a | 07/2011 |
| Washington, D.C. [B, C, N] | 07/2010 | n/a | n/a | 07/2010 |
| Hawaii [B, C] | 12/2000 | 12/2000 | n/a | n/a |
| Illinois | 01/2014 | n/a | n/a | 01/2014 |
| Maine [B, C] | 12/1999 | n/a | n/a | 12/2009 |
| Maryland | 06/2014 | 06/2014 | n/a | 06/2014 |
| Massachusetts | 01/2013 | n/a | n/a | 01/2013 |
| Michigan [B, C, N] | 12/2008 | 12/2008 | 12/2008 | n/a |
| Minnesota | 05/2014 | n/a | n/a | 05/2014 |
| Montana [B, C, N] | 11/2004 | 11/2004 | 11/2004 | n/a |
| Nevada [B, C] | 10/2001 | 10/2001 | 10/2001 | 04/2014 |
| New Hampshire | 07/2013 | 07/2013 | n/a | 07/2013 |
| New Jersey [B, C, N] | 10/2010 | 10/2010 | n/a | 10/2010 |
| New Mexico [B, C, N] | 07/2007 | n/a | n/a | 07/2007 |
| New York | 07/2014 | n/a | n/a | 07/2014 |
| Oregon [B, C] | 12/1998 | 12/1998 | 12/1998 | 08/2013 |
| Pennsylvania | 05/2016 | 05/2016 | n/a | 05/2016 |
| Rhode Island [B, C, N] | 01/2006 | 01/2006 | 01/2006 | 07/2009 |
| Vermont [B, C, N] | 07/2004 | 07/2007 | n/a | n/a |
| Washington [B, C] | 11/1998 | 11/1998 | 07/2011 | n/a |

Notes: These are the effective dates of MMLs and updated from Anderson et al. (2013) and Wen et al. (2015) using Marijuana Project Policy (2015) and Pennsylvania General Assembly (2016).
[B], [C], and [N] indicate that the state contributes to the identifying variation in the BRFSS, the CPS-TUS and the NSDUH respectively.

**Table 3. Difference-in-Difference Estimates of Relationship between MMLs and Tobacco Consumption**

| | BRFSS[a] | | | | CPS-TUS | | | |
|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| | | | | *Panel I: Participation* | | | | |
| MML | -0.009*** | -0.009*** | -0.009*** | -0.007*** | -0.004* | -0.004* | -0.004* | -0.003* |
| | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| N | 5,656,644 | 5,656,644 | 5,656,644 | 5,656,644 | 1,779,921 | 1,779,921 | 1,779,921 | 1,779,921 |
| | | | | *Panel II: Everyday Smoking* | | | | |
| MML | -0.001 | -0.002 | -0.001 | -0.001 | -0.005** | -0.005** | -0.005** | -0.004* |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) |
| N | 5,070,737 | 5,070,737 | 5,070,737 | 5,070,737 | 1,779,921 | 1,779,921 | 1,779,921 | 1,779,921 |
| State & year FEs? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Demographic controls? | No | Yes | Yes | Yes | No | Yes | Yes | Yes |
| State economic controls? | No | No | Yes | Yes | No | No | Yes | Yes |
| State policy controls? | No | No | No | Yes | No | No | No | Yes |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (1990 to 2012) and the Current Population Survey Tobacco-Use Supplements (1992 to 2011). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects.

[a] Data on *Participation* are available between 1990-2012, and on *Everyday Smoking* between 1996-2012 in the Behavioral Risk Factor Surveillance Survey.

**Table 4. Sensitivity of Estimates to Controls for Anti-Marijuana Legalization Sentiment, Controls for Policy Leads, and State-Specific Time Trends**

| | *Added Controls for Sentiment* | | *Added Controls for Policy Leads* | | *Added Controls for State Linear Trends* | |
|---|---|---|---|---|---|---|
| | **BRFSS[a] (1)** | **CPS-TUS (2)** | **BRFSS[a] (3)** | **CPS-TUS (4)** | **BRFSS[a] (5)** | **CPS-TUS (6)** |
| | | | *Panel I: Participation* | | | |
| MML | -0.007** | -0.002 | -0.011** | -0.008** | 0.001 | -0.005** |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) |
| N | 5,428,990 | 1,726,630 | 5,656,644 | 1,779,921 | 5,656,644 | 1,779,921 |
| | | | *Panel II: Everyday Smoking* | | | |
| MML | 0.001 | -0.003 | -0.003 | -0.005* | 0.001 | -0.007* |
| | (0.003) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) |
| N | 4,859,922 | 1,726,630 | 5,070,737 | 1,779,921 | 5,070,737 | 1,779,921 |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (1990 to 2012) and the Current Population Survey Tobacco-Use Supplements (1992 to 2011). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects.

[a] Data on *Participation* are available between 1990-2012, and on *Everyday Smoking* between 1996-2012 in the Behavioral Risk Factor Surveillance Survey.

**Table 5. Gender- and Age-Specific Estimates of the Effect of MMLs on *Participation***

| | BRFSS | | | CPS-TUS | | |
|---|---|---|---|---|---|---|
| | **Pooled (1)** | **Males (2)** | **Females (3)** | **Pooled (4)** | **Males (5)** | **Females (6)** |
| | | | *Panel I: All ages* | | | |
| MML | -0.007*** | -0.002 | -0.013*** | -0.003* | -0.004 | -0.002 |
| | (0.002) | (0.003) | (0.003) | (0.002) | (0.003) | (0.003) |
| N | 5,656,644 | 2,223,520 | 3,433,124 | 1,779,921 | 831,874 | 948,047 |
| | | | *Panel II: Ages 18-to-24* | | | |
| MML | -0.019*** | -0.018** | -0.019*** | -0.002 | -0.009 | 0.006 |
| | (0.006) | (0.008) | (0.006) | (0.004) | (0.007) | (0.005) |
| N | 327,887 | 146,367 | 181,520 | 201,223 | 97,133 | 104,090 |
| | | | *Panel III: Ages 25-to-39* | | | |
| MML | 0.001 | 0.007 | -0.006* | 0.004 | 0.006 | 0.001 |
| | (0.003) | (0.005) | (0.004) | (0.003) | (0.004) | (0.005) |
| N | 1,228,821 | 495,321 | 733,500 | 543,162 | 258,197 | 284,,965 |
| | | | *Panel IV: Ages 40-to-54* | | | |
| MML | -0.010*** | -0.000 | -0.020*** | -0.005 | -0.006 | -0.003 |
| | (0.003) | (0.004) | (0.005) | (0.004) | (0.005) | (0.005) |
| N | 1,577,826 | 644,455 | 933,371 | 512,272 | 245,948 | 266,324 |
| | | | *Panel V: Ages 55+* | | | |
| MML | -0.011*** | -0.009** | -0.013*** | -0.011*** | -0.011*** | -0.012*** |
| | (0.004) | (0.004) | (0.004) | (0.002) | (0.003) | (0.003) |
| N | 2,578,593 | 926,066 | 1,552,527 | 552,814 | 244,541 | 308,273 |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (1990 to 2012), the Current Population Survey Tobacco-Use Supplements (1990 to 2012), the National Survey for Drug Use and Health (2004 to 2012), and the State and National Youth Risk Behavior Surveys (1991 to 2011). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects.

**Table 6. Gender- and Age-Specific Estimates of the Effect of MMLs on *Everyday Smoking***

| | BRFSS | | | CPS-TUS | | |
|---|---|---|---|---|---|---|
| | **Pooled (1)** | **Males (2)** | **Females (3)** | **Pooled (4)** | **Males (5)** | **Females (6)** |
| | | | *Panel I: All ages* | | | |
| MML | -0.001 | 0.005 | -0.006* | -0.004* | -0.004 | -0.004* |
| | (0.003) | (0.004) | (0.003) | (0.002) | (0.003) | (0.002) |
| N | 5,070,737 | 1,978,022 | 3,092,715 | 1,779,921 | 831,874 | 948,047 |
| | | | *Panel II: Ages 18-to-24* | | | |
| MML | -0.006 | -0.001 | -0.012 | -0.002 | -0.002 | -0.001 |
| | (0.009) | (0.011) | (0.009) | (0.005) | (0.008) | (0.004) |
| N | 269,682 | 120,004 | 149,678 | 201,223 | 97,133 | 104,090 |
| | | | *Panel III: Ages 25-to-39* | | | |
| MML | 0.008* | 0.013** | 0.004 | 0.005 | 0.012*** | -0.001 |
| | (0.005) | (0.004) | (0.007) | (0.004) | (0.004) | (0.005) |
| N | 1,031,182 | 408,743 | 622,439 | 513,612 | 244,252 | 269,360 |
| | | | *Panel IV: Ages 40-to-54* | | | |
| MML | -0.004 | 0.004 | -0.012*** | -0.009** | -0.013*** | -0.005 |
| | (0.003) | (0.005) | (0.003) | (0.004) | (0.005) | (0.004) |
| N | 1,430,534 | 579,280 | 851,254 | 512,272 | 245,948 | 266,324 |
| | | | *Panel V: Ages 55+* | | | |
| MML | -0.002 | 0.003 | -0.006 | -0.012*** | -0.013*** | -0.011** |
| | (0.002) | (0.004) | (0.004) | (0.002) | (0.004) | (0.002) |
| N | 2,298,567 | 859,303 | 1,439,264 | 552,814 | 244,541 | 308,273 |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (1990 to 2012), the Current Population Survey Tobacco-Use Supplements (1990 to 2012), the National Survey for Drug Use and Health (2004 to 2012), and the State and National Youth Risk Behavior Surveys (1991 to 2011). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects.

**Table 7. Estimates of the Effect of MMLs on Marijuana Consumption and Tobacco Consumption, 2004-2012**

| | NSDUH | | BRFSS | | CPS-TUS | |
|---|---|---|---|---|---|---|
| | *Baseline* | *Add State Time Trends* | *Baseline* | *Add State Time Trends* | *Baseline* | *Add State Time Trends* |
| | **(1)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| | | | *Panel I: Marijuana* | | | |
| MML | 0.007* | 0.003 | | | | |
| | (0.003) | (0.006) | n/a | n/a | n/a | n/a |
| N | 410,500 | 410,500 | | | | |
| | | | *Panel II: Smoking Participation* | | | |
| MML | 0.025*** | 0.039*** | 0.001 | -0.001 | 0.001 | 0.021** |
| | (0.010) | (0.010) | (0.001) | (0.003) | (0.007) | (0.008) |
| N | 377,200 | 377200 | 3,632,043 | 3,632,043 | 624,606 | 624,606 |
| | | | *Panel III: Everyday Smoking* | | | |
| MML | 0.008** | 0.008 | -0.001 | -0.005 | 0.009 | 0.023** |
| | (0.0032) | (0.006) | (0.001) | (0.003) | (0.009) | (0.010) |
| N | 377,200 | 377200 | 3,632,043 | 3,632,043 | 624,606 | 624,606 |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (2004 to 2012), the Current Population Survey Tobacco-Use Supplements (2003 to 2011), and the National Survey for Drug Use and Health (2004 to 2012). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects.

**Table 8. Exploring the *Participation* Effects of Heterogeneous Types of MMLs**

| | | | | |
|---|---|---|---|---|
| | ***Panel I: BRFSS (1990-2012)*** | | | |
| | (1) | (2) | (3) | (4) |
| MML-Pain | -0.008*** | | | -0.011** |
| | (0.002) | | | (0.004) |
| MML-Collective Cultivation | | -0.007*** | | 0.004 |
| | | (0.002) | | (0.005) |
| MML-Dispensaries | | | -0.007*** | 0.000 |
| | | | (0.002) | (0.004) |
| N | 5,656,644 | 5,656,644 | 5,656,644 | 5,656,644 |
| | ***Panel II: CPS-TUS (1992-2011)*** | | | |
| MML-Pain | -0.009* | | | 0.001 |
| | (0.005) | | | (0.005) |
| MML-Collective Cultivation | | -0.011* | | -0.011* |
| | | (0.007) | | (0.006) |
| MML-Dispensaries | | | -0.010 | -0.002 |
| | | | (0.008) | (0.008) |
| N | 1,779,921 | 1,779,921 | 1,779,921 | 1,779,921 |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (2004 to 2012), the Current Population Survey Tobacco-Use Supplements (2003 to 2011), and the National Survey for Drug Use and Health (2004 to 2012). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects.

**Appendix Table 1. Gender- and Age-Specific Estimates of the Effect of MMLs on *Participation*, Controlling for State Linear Time Trends**

| | BRFSS | | | CPS-TUS | | |
|---|---|---|---|---|---|---|
| | **Pooled (1)** | **Males (2)** | **Females (3)** | **Pooled (4)** | **Males (5)** | **Females (6)** |
| | | | *Panel I: All ages* | | | |
| MML | 0.001 | 0.007 | -0.005* | -0.005** | -0.006* | -0.004 |
| | (0.002) | (0.004) | (0.003) | (0.002) | (0.003) | (0.005) |
| N | 5,656,644 | 2,223,520 | 3,433,124 | 1,779,921 | 831,874 | 948,047 |
| | | | *Panel II: Ages 18-to-24* | | | |
| MML | -0.006 | 0.006 | -0.019*** | 0.005 | -0.015 | 0.005 |
| | (0.007) | (0.010 | (0.005) | (0.009) | (0.012) | (0.008) |
| N | 327,887 | 146,367 | 181,520 | 201,223 | 97,133 | 104,090 |
| | | | *Panel III: Ages 25-to-39* | | | |
| MML | 0.004 | 0.012** | -0.006 | 0.002 | 0.003 | 0.002 |
| | (0.003) | (0.004) | (0.005) | (0.004) | (0.005) | (0.005) |
| N | 1,228,821 | 495,321 | 733,500 | 513,612 | 244,252 | 269,360 |
| | | | *Panel IV: Ages 40-to-54* | | | |
| MML | -0.002 | 0.001 | -0.006 | -0.005 | -0.005 | -0.004 |
| | (0.003) | (0.004) | (0.004) | (0.005) | (0.006) | (0.007) |
| N | 1,577,826 | 644,455 | 933,371 | 512,272 | 245,948 | 266,324 |
| | | | *Panel V: Ages 55+* | | | |
| MML | 0.000 | 0.003 | -0.003 | -0.010*** | -0.008* | -0.012*** |
| | (0.003) | (0.004) | (0.004) | (0.003) | (0.005) | (0.004) |
| N | 2,478,593 | 926,066 | 1,552,527 | 552,814 | 244,541 | 308,273 |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (1990 to 2012) and the Current Population Survey Tobacco-Use Supplements (1992 to 2011). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects. All regressions include state fixed effects and year fixed effects.

**Appendix Table 2. Gender- and Age-Specific Estimates of the Effect of MMLs on *Everyday Smoking*, Controlling for State Linear Time Trends**

| | BRFSS | | | CPS-TUS | | |
|---|---|---|---|---|---|---|
| | **Pooled (1)** | **Males (2)** | **Females (3)** | **Pooled (4)** | **Males (5)** | **Females (6)** |
| | | | *Panel I: All ages* | | | |
| MML | 0.001 | 0.007 | -0.004 | -0.007 | -0.007 | -0.007** |
| | (0.003) | (0.005) | (0.003) | (0.003) | (0.005) | (0.003) |
| N | 5,070,737 | 1,978,022 | 3,092,715 | 1,779,921 | 831,874 | 948,047 |
| | | | *Panel II: Ages 18-to-24* | | | |
| MML | -0.000 | 0.008 | -0.008 | -0.012 | -0.009 | -0.013 |
| | (0.010) | (0.013) | (0.009) | (0.0140 | (0.016) | (0.013) |
| N | 269,682 | 120,004 | 149,678 | 201,223 | 97,133 | 104,090 |
| | | | *Panel III: Ages 25-to-39* | | | |
| MML | 0.007 | 0.010** | 0.004 | 0.002 | 0.005 | -0.001 |
| | (0.004) | (0.003) | (0.008) | (0.005) | (0.006) | (0.004) |
| N | 1,031,182 | 408,743 | 622,439 | 513,612 | 244,252 | 269,360 |
| | | | *Panel IV: Ages 40-to-54* | | | |
| MML | -0.003 | 0.001 | -0.008** | -0.009* | -0.010 | -0.008 |
| | (0.004) | (0.007) | (0.003) | (0.005) | (0.006) | (0.005) |
| N | 1,430,534 | 579,280 | 851,254 | 512,272 | 245,948 | 266,324 |
| | | | *Panel V: Ages 55+* | | | |
| MML | -0.000 | 0.009* | -0.008* | -0.010*** | -0.011* | -0.010 |
| | (0.002) | (0.005) | (0.004) | (0.003) | (0.006) | (0.004) |
| N | 2,298,567 | 859,303 | 1,439,264 | 552,814 | 244,541 | 308,273 |

***Significant at 1% level **at 5% level *at 10% level

Notes: Weighted difference-in-difference estimates obtained from the Behavioral Risk Factor Surveillance Survey (1990 to 2012) and the Current Population Survey Tobacco-Use Supplements (1992 to 2011). State-specific time-varying controls include beer taxes, cigarette taxes, zero tolerance laws, blood alcohol content (.08) driving laws, marijuana decriminalization laws, state per capita income, and the unemployment rate. Demographic controls include age, educational attainment, race/ethnicity, and marital status. All regressions include state fixed effects and year fixed effects.