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Do State Tobacco 21 Laws Work?

Abstract

Tobacco 21 (T-21) laws prohibit the sale of tobacco products to individuals under age 21. This study is the first to comprehensively examine the impacts of statewide T-21 laws on youth tobacco consumption, including spillovers to minor teens. Using data from the 2009-2019 Behavioral Risk Factor Surveillance Survey (BRFSS) and a difference-in-differences (DD) approach, we find that the enactment of a statewide T-21 law was associated with a 2.5 to 3.9 percentage-point decline in smoking participation among 18-to-20-year-olds. A causal interpretation of our estimates is supported by event-study analyses, pseudo-placebo tests on young adults ages 21 and older, and use of "stacked DD" estimation strategy to expunge bias due to heterogeneous dynamic treatment effects. Next, using data from the 2009-2019 State Youth Risky Behavior Surveys (YRBS), we find that statewide T-21 laws reduced tobacco cigarette and electronic cigarette (e-cigarette) consumption among 18-year-old high school students. However, descriptive evidence suggests that the negative impact of T-21 laws on e-cigarette use among 18-year-olds may be partially blunted by an increase in borrowing e-cigarettes from others. Finally, we find that T-21 laws generate important spillovers, including (i) a reduction in tobacco cigarette use among 16-to-17-year-olds, a group that relies heavily on the "social market" — including 18-year-old peers — to access tobacco, and (ii) reductions in marijuana use and frequency of alcohol consumption among older teenagers.

Keywords: minimum legal purchasing age for tobacco; tobacco 21 laws; cigarettes; e-cigarettes

JEL codes: I12, I18, K42

1. Introduction

"We should do everything we can to prevent young people from smoking and save lives. Increasing the tobacco age to 21 will help achieve these goals… Increasing the tobacco age to 21 [will also] reduce the likelihood that a high school student will be able to legally purchase tobacco products for other students and underage friends."

- Campaign for Tobacco-Free Kids (2020)

Tobacco use is the leading cause of preventable death in the United States, responsible for over 480,000 deaths each year (Centers for Disease Control and Prevention 2019). Its consumption has been linked to increased risk of heart disease, cancers of the lung, liver, head, and colon, diminished respiratory function, and stroke (U.S. Department of Health and Human Services 2014). The social costs of tobacco consumption are substantial, with estimates of the annual health care costs of treating tobacco-related illnesses totaling nearly $200 billion (2019$) (Hall and Doran 2016). Estimates of the external costs of smoking — driven by exposure to secondhand, or even thirdhand, tobacco smoke — exceed $7 billion (USDHHS 2014).[1]

The vast majority of adult smokers initiate tobacco use as minors (Everett 1999; Gilliland 2006), with a mean age of smoking initiation of 15.3 (CDC 2014). Given that youth smokers (i) are more likely than adults to have time-inconsistent preferences that give insufficient weight to future costs of addiction (Crettez and Deloche 2020)[2], (ii) often fail to account for the external costs of smoking when choosing current consumption (O'Donoghue and Rabin 2001), and (iii) typically obtain tobacco products via the informal social market (Hansen et al. 2013), policymakers have often targeted anti-smoking campaigns at youths (Lantz et al 2000).

Anti-smoking efforts of the 1990s and 2000s typically included increases in state cigarette excise taxes (Hansen et al. 2017, Carpenter and Cook 2008), enactment of clean indoor air laws (Chaloupka and Eriksen 2008), and restrictions or bans on tobacco advertising (Schroeder 2004). While these policies were largely successful in achieving their intended ends (CDC 2012), there is growing evidence that policy instruments may be less effective than they once were. For example, post-2007 increases in state excise taxes on cigarettes have had very little effect on tobacco use

[1] The Department of Health and Human Services (2014) reports an estimate of $5.6B in 2006$, which we adjust with the CPI to $7.1B in 2019$. The Hall and Doran (2016) report tobacco-related illness treatment costs of $170B in 2010$, which we adjust to $199B in 2019$.

[2] During adolescence, impulsivity rises, particularly for behaviors broadly categorized as pleasure seeking (Romer 2010). Thus, youth may have increased temporary utility associated with smoking or consuming other drugs, while also temporarily discounting the future costs of those actions.

(Anderson et al. 2020; Callison and Kaestner 2014; Carpenter and Simone 2020; Hansen et al. 2017).[3] This may be because today's marginal smoker is less price sensitive than the marginal smoker of prior decades, in part due to the success of prior tobacco control efforts (Hansen et al. 2017). Younger smokers may also be partially insulated from tobacco control policies because they rely on older peers for access to cigarettes via third-party purchases or bumming cigarettes (Hansen et al. 2013).

Moreover, electronic cigarettes (e-cigarette) have rapidly emerged as an alternative nicotine source to traditional cigarettes for an increasing number of teenagers (Creamer et al. 2019; Cullen et al. 2019; Centers for Disease Control and Prevention; 2019). The wide availability of e-cigarettes has caused policymakers to play "catch-up" in regulating this fast-emerging market (Huang et al. 2019: Jankowski et al. 2017) through enactment of minimum legal purchasing ages for e-cigarettes (Friedman 2015; Abouk and Adams 2017), e-cigarette taxes (Cotti et al. 2020; Pesko et al. 2019), and bans on e-cigarette advertising (Dave et al. 2019). However, by changing relative prices of e-cigarettes and "traditional" tobacco cigarettes, such strategies may also have unintended consequences, including substitution toward cigarettes (Dave et al. 2019; Pesko et al. 2020; Friedman 2015), which may generate worse health outcomes.[4]

In an attempt to more comprehensively limit youth access to tobacco — which could generate large health benefits by preventing long-run nicotine addiction — tobacco control advocates prioritized advancing Tobacco 21 (T-21) laws. T-21 laws raise the minimum legal purchasing age (MLPA) for *all* tobacco products, including e-cigarettes, to 21.[5] These laws enjoy the support of the American Medical Association (Parks 2016), the American Academy of Pediatrics (AAP 2015), the American Public Health Association (Lowry 2019), the Institutes of Medicine (National Academy of Medicine 2015), the American Heart Association (AHA 2019), the American Cancer Society (ACS 2020), and the American Lung Association (ALA 2020). T-21 laws also enjoy support among the vast majority of the American public, including smokers. Seventy-four percent

[3] This is despite the increase variation in cigarette taxes in later years which should make identifying cigarette tax elasticities easier than before (Lillard et al. 2013). This may be because anti-smoking policies of prior decades were effective at removing those with relatively elastic cigarette demand for from the market, leaving only "hard core smokers" whose smoking behavior is far more difficult to change through tax increases (Courtemanche and Feng 2019; Hansen et al. 2017).

[4] See Viscusi (2016) for a discussion of beliefs about the relative health costs of electronic versus traditional tobacco cigarettes relative to the best scientific evidence to date on true health costs.

[5] The 1992 Synar Amendment set the Federal minimum legal age of access to 18 years. By 1993, all states had changed their minimum legal sales age to 18 or 19 years (Alabama, Alaska, and Utah; New Jersey raised their MLPA to 19 in 2005).

of U.S. adults, including 64 percent of current smokers and 74 percent of former smokers, support raising the MLPA for all tobacco products to 21 (Gallup 2019).

Most adult smokers began experimenting with cigarettes prior to age 14 (Centers for Disease Control and Prevention 2020). However, the ages between 18 and 20 appear to be critical ages on the path of addiction. While only 46 percent of adult smokers become everyday smokers prior to age 18, nearly 80 percent do so prior to age 21 (USDHHS 2014). Delaying the age at which a youth transitions from an experimental or sporadic tobacco user to a more frequent user may reduce the risk of everyday use and increase successful quitting attempts (Khudar et al. 1999). Thus, T-21 laws may postpone tobacco exposure to age groups that are particularly vulnerable to the addictive effects of nicotine (Bonnie 2015).

While a number of municipalities — usually towns, cities, or counties — experimented with raising the minimum legal purchasing ages for tobacco to 19 or 21 beginning in the mid-2000s (American Non-Smokers' Rights Foundation 2020), the localized nature of these mandates allows young adults a relatively low cost means of circumventing these laws by traveling to nearby jurisdictions without such mandates (Friedman and Wu 2019). Statewide mandates were introduced, in part, to reduce such spillovers.

Hawaii became the first state to implement a statewide T-21 law on January 1, 2016.[6] California soon followed on July 9, 2016, followed by 15 additional states by December 19, 2019.[7] On December 20, 2019, former President Donald J. Trump signed the "Tobacco to 21 Act," which created an MLPA of 21 for all tobacco products sold nationwide. While the Federal T-21 law was largely seen as a triumph for tobacco control policy, many public health experts were alarmed that the legislation failed to regulate the sale of flavored vaping products (Howard 2019).

Proponents of T-21 laws argue that such mandates will generate substantial public health benefits. By requiring a common MLPA for all tobacco products, advocates argue that T-21 laws avoid the unintended consequence of inducing substitution among tobacco products. The National Academy of Medicine (2015) forecast that a national T-21 law would result in "approximately 223,000 fewer premature deaths, 50,000 fewer deaths from lung cancer, and 4.2 million fewer years of life lost for those born between 2000 and 2019." These public health benefits may arise not only

[6] Needham, Massachusetts was the first town to enact a T-21 law (Reynolds 2019), followed by over 540 cities and counties (Preventing Teen Addiction 2020).

[7] New Jersey enacted a statewide Tobacco 21 law in 2017; Oregon, Maine, and Massachusetts enacted such laws in 2018, and Virginia, Illinois, Delaware, Arkansas, Washington, Maryland, Vermont, Texas, Connecticut, New York, and Ohio enacted in 2019. The Federal law raising the MLPA to 21 was signed into law on December 20, 2019.

by reducing direct access to tobacco products among 18-20-year-olds, but also by reducing tobacco use among teens under the age of 18. This may occur through a number of channels. T-21 laws are expected to reduce the likelihood that minor teens who initiate smoking will be able to falsely identify themselves as meeting the MLPA (Delnovo and Steinberg 2013).

In addition, by drying up the informal "social market" on which minor teens heavily rely for access to tobacco products. Over three-quarters of 16-to-17-year-old smokers obtain their cigarettes via the social market (i.e., third-party purchase, bumming or borrowing, stealing, or some other way).[8] Many third-party purchasers and tobacco lenders (i.e., those who allow minors to "bum" a cigarette or "borrow" a vaping pen) may be 18-year-old peers (Ahmad 2005; Chen 2014; Hansen et al. 2013).[9] Local, state, and federal policymakers have explicitly argued that T-21 policy is an important tool to reduce minor teenagers' access to tobacco, especially e-cigarettes.

> *"The most serious threat involves the use of vaping devices for teens under 18 years old. Far too often, 18-year-olds, who are still in high school and can legally buy vaping devices, are sharing them with their younger classmates and the problem isn't only high schoolers. In 2018, there was a nearly 50% increase of middle school students vaping throughout the country. Raising the age limit to 21 presents fewer opportunities for children to get their hands on vaping devices."*
>
> - Senate Minority Leader Mitch McConnell (R- Kentucky, 2019)

On the other hand, opponents of T-21 laws argue that such mandates will be ineffective in deterring youth tobacco use (Males 2016) and would impose limits on individuals' consumption freedoms (Bergal 2017). They argue that 18-year-old Americans can vote, go to war, be responsible for contracts, and be tried as an adult in a court of law; thus, 18-to-20-year-olds should be trusted to make tobacco consumption decisions (Stroud 2016).[10] In addition, some opponents argue that T-21 laws would have adverse fiscal consequences by reducing state tobacco tax revenues (Bergal 2015) and have adverse distributional effects by causing disproportionate profit losses for locally owned small convenience stores (Mensik 2018).[11]

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[8] This number is reported from the 1995-2009 State Youth Risk Behavior Surveys (Hansen et al. 2013).
[9] Moreover, because many 18-year-olds attend high school with minors, reducing smoking among 18-year-olds could generate positive spillover effects to minors via behavioral role-modeling (Everett, 1999; Azagba et al., 2015).
[10] Moreover, some opponents argue that because tobacco use does not generate cross-state travel-related externalities of young adult alcohol use (i.e., drunk driving-related accidents), tobacco should be less regulated (Stroud 2016).
[11] In 1986, a Phillip Morris strategy brief stated "[R]aising the legal minimum age for cigarette purchaser to 21 could gut our key young adult market (17-20) where we sell about 25 billion cigarettes and enjoy a 70 percent market share"

This study is the first to examine the impact of statewide T-21 laws adopted nationwide on youth and young adult smoking. First, using data from the 2009-2019 Behavioral Risk Factor Surveillance Survey (BRFSS) and a difference-in-differences approach, we find that the enactment of a T-21 law led to a 2.5 to 3.9-percentage-point decline in prior 30-day smoking participation among 18-to-20-year-olds. A number of descriptive tests of the common trends assumption — including event-study analyses, falsification tests among young adults ages 21 and older, and difference-in-difference-and-differences models that control for full state-by-year interactions — provide support for a causal interpretation of these findings. Supplemental evidence also suggests that T-21 laws have reduced electronic cigarette use among 18-to-20-year-olds, suggesting that these laws reduce consumption of multiple types of tobacco products.

Our results uncover substantial heterogeneity in the effects of T-21 laws by respondent's demographic and socioeconomic characteristics. We find T-21 laws have a larger impact on smoking behavior for (i) 18-year-olds as compared to 19-to-20-year-olds, (ii) African Americans as compared to whites, and (iii) high school dropouts as compared to with a high school degree or more (or who were still attending high school).

Next, turning to the 2009-2019 State Youth Risky Behavior Surveys (YRBS), we find that T-21 laws are associated with a 3-to-7-percentage-point reduction in tobacco cigarette use among 18-year-old high school students, and a 6-to-12 percentage-point decline in electronic cigarette use among 18-year-old high school students. We find evidence that social sources for tobacco play an important role in understanding the full impacts of T-21 laws. Specifically, we show descriptive evidence that the negative impact of T-21 laws on e-cigarette use among 18-year-olds is partially blunted by an increase in borrowing e-cigarettes from others, most probably older individuals less affected by T-21 law. Moreover, we find that T-21 laws reduce tobacco cigarette use among 16-to-17-year-olds, a group that relies heavily on the "social market" — including 18-year-old peers — to access tobacco. Finally, we find that T-21 laws may have important spillover effects to other youth risky behaviors. Our results show that T-21 law adoption is associated with a reduction in marijuana use among 18-year-olds, suggesting that tobacco and marijuana are complements for some teens. We also find some evidence that T-21 laws may reduce alcohol consumption, especially on the intensive margin, for 18-to-20-year-old males. This supports the hypothesis tobacco may act as a gateway drug for other substance use.

(Morris 1986). However, tobacco companies did support T-21 perhaps to avoid regulation of flavored tobacoo products (Myers 2019).

Together, our findings suggest that statewide T-21 laws reduce tobacco consumption among teenagers and young adults and generate spillovers to other risky health behaviors. Given mounting evidence that modern cigarette tax increases have become less effective in curbing youth and young adult smoking (Hansen et al. 2017; Carpenter and Simone 2020), our findings point to a potentially more effective modern tobacco control policy.

2. Background

Tobacco control legislation — including tobacco taxes and minimum legal purchasing ages — has long been a subject of debate amongst U.S. policymakers, dating back well before the Surgeon General's 1964 warning of the adverse health effects of tobacco consumption. The first federal excise tax was proposed on "snuff" products in 1791 by Alexander Hamilton (Ali and Koplan 2010), cigarette taxes were first levied in 1864 (Smith 1914). By 1921, 5 states had completely banned the sale of cigarettes, beginning with South Dakota in 1895 (Alston et al. 2002).[12]

In 1883, New Jersey became the first state to enact a law that established a minimum legal purchasing age for tobacco (MLPA), setting it at sixteen (16) years old (Appolonio and Glants 2016). Three years later, New York followed suit and established an MLPA for tobacco purchasing and consumption of 16 (Appolonio and Glants 2016). As concerns over children smoking grew nationwide, 26 states established an MLPA for tobacco by 1890, with those restrictions ranging between 14 to 24 years old. By 1920, all but two states had passed a law enforcing a tobacco MLPA, with at least 14 states having set their age restriction at 21 years old or greater. [13]

From the 1950s to the late 1960s, many states lowered their tobacco MLPA as a result of lobbying efforts from the tobacco industry (Appolonio and Glants 2016). Massachusetts and Oregon unsuccessfully attempted to raise their MLPA to 21-years-old in 1963, a year in which five states had pending legislation to lower their MLPAs from 21- to 18-years-old.[14]. By 1971, only three states still had laws in place enforcing an MLPA of 21 years old (Tobacco Merchants Association 1971), and none by the 1980s.

In 1985, the U.S. Department of Health and Human Services considered a nationwide tobacco MLPA as a part of a broader tobacco control plan, with the American Medical Association recommending an MLPA of 21-years-old (Appolonio and Glants 2016). Eventually this effort led to

[12] By 1927, all of these laws had been repealed.
[13] Ohio and Rhode Island were the last two states to enact an MLPA, establishing them in 1939.
[14] Utah lowered their MLPA to 19 years old.

the Synar Amendment. Adopted in 1992, this law mandated states enforce a statewide MLPA of 18 years old in order to receive federal funding from the Substance Abuse and Mental Health Services Administration (DiFranza and Dussalt, 2005).[15] While the Synar Amendment has been credited with reductions in youth smoking nationwide (Ahmed et al. 2019), tobacco control advocates have suggested a further increase to age 21.

In April 2005, the town of Needham, Massachusetts became the first municipality to enact legislation raising the MLPA of tobacco to 21 years old, creating the first modern "Tobacco 21" law. Several other municipalities enacted similar laws leading up to New York City's adoption of a Tobacco 21 policy on May 18, 2014. The National Academy of Medicine released a report in 2015 that estimated raising the MLPA of tobacco to 21 years old would reduce adult smoking prevalence in the United States by 12 percent, a study cited by many state policymakers as evidence in support of adopting a T-21 policy (Bergal 2017; Aliferes 2016).

The motivation for T-21 mandates from the public health community stems from several arguments. First, tobacco is significantly less addictive when first initiated at later ages (Azagba et al. 2015; Laux 2000; Everett et al. 1999) and the 18-20 age window may be a particularly precarious time for addiction onset (Hegmann et al. 1993; Khuder et al. 1999).[16] Second, e-cigarette usage among teenagers has dramatically increased over the last decade (Centers for Disease Control and Prevention 2019). While a number of policies aimed at reducing e-cigarette consumption (i.e. minimum legal purchasing ages, e-cigarette taxes, and advertising bans) have been effective at deterring e-cigarette use (Abouk and Adams 2017; Dave et al 2019, Durta et al 2018), they also may have the unintended consequence of inducing substitution toward "traditional cigarettes (Caponnetto et al. 2015; Friedman 2015; Pesko et al 2016; Dave et al. 2019; Pesko & Currie 2019). A comprehensive T-21 law might be expected to avoid this inter-tobacco product substitution. Third, public health advocates argue that increasing the MLPA for tobacco to 21 would dry up the

[15] Alabama and Utah maintained MLPAs of 19, while Alaska chose to adopt an MLPA of 19 following the passage of the Synar Amendment.

[16] There is an extensive literature documenting tobacco consumption's propensity for physical and mental addiction (Hatsukami et al. 2008; Jha et al. 2006; Addicott 2020), with a substantial number of studies finding that tobacco may be more addictive the earlier in life that it is initiated (Laux 2000). For instance, Everett (1999) found that among college students who reported daily smoking, 81 percent had first initiated smoking before they were 18 years old. In a study of high schoolers in Canada, Azagba et al. (2015) found that each year of delaying smoking initiation lowered thse likelihood of developing a daily smoking habit by 24 percent.

social market through which many adolescent and teen smokers have obtained tobacco (Hansen et al. 2013).[17]

The nascent literature on the effectiveness of T-21 laws falls into two categories: (i) studies of local (i.e. municipal) T-21 laws (Schneider et al. 2016; Silver et al. 2016; Friedman et al. 2019; Friedman and Wu 2020), and (ii) case studies of a single state's T-21 law (Schiff et al. 2016; Boettiger and White 2020). Many are descriptive case studies with pre-post comparisons focused on particular cities (Schneider et al. 2016; Silver et al. 2016).[18]

A key insight from higher quality municipal-level studies of local T-21 policies (see, for example, Friedman et al. 2019 and Friedman and Wu 2020) is that local T-21 policies are accompanied with substantial "leakage" or spillovers. For instance, Friedman and Wu (2020) conclude if a T-21 policy only partially covered a metropolitan/micropolitan statistical areas (MMSs), the estimated decline in smoking attributed to local T-21 policies was approximately 60 percent smaller (in absolute magnitude) than that observed for a T-21 policy that covered the full MMSA. This finding suggests that many young adult smokers avoid local MLPAs by traveling to neighboring jurisdictions without such laws, resulting in smaller city or county-level policy effects relative to those enacted at the state or national level.

A handful of other studies have focused on case studies of a particular state's T-21 policy.[19] Yan (2014) studies a T-21 policy adopted in Pennsylvania between June 1992 and July 2002 to explore the impact of this law on maternal smoking and infant health.[20] Using data from the restricted Natality Detailed File from 1992 to 2002 and a regression discontinuity design (RDD), he finds that Pennsylvania's Tobacco 21 law reduces smoking among pregnant mothers. Yan's results also reveal that Pennsylvania's increase of the tobacco purchasing age lead to a 1.5 percent decline in the incidence of low birth weight of all mothers, and a 2.7 percent decline among smoking mothers [21]

[17]Following the passage of a Tobacco 21 mandate in Texas in September 2019, Rep. John Zerwas stated, "it's a very powerful thing to move tobacco products and these e-cigarettes away from susceptible adolescents who can become very quickly addicted." (Price 2019).

[18] These studies generally do not conduct appropriate statistical inference with one treated unit, such as placebo-type tests (Buchmueller et al. 2011).

[19] Schiff et al. (2020) uses a before-after estimator to study California's statewide T-21 law in southern California. Boettiger and White (2020) use a synthetic control approach to study the joint effects of California's T-21 law and a subsequently enacted cigarette tax hike and find evidence that cigarette prices rose and sales fell after both policies were enacted.

[20] Pennsylvania's mandate stated it was illegal to sell or furnish a tobacco product to any minor below age 21, also making it illegal to place a tobacco vending machine anywhere accessible by someone under the age of 21.

[21] In order to avoid confounding the effects of granting legal access to drinking with smoking at the cutoff age of 21 years old, the author conducts the analysis both before and after the policy change in order to establish a baseline effect.

While suggestive that T-21 restrictions could be effective today, this study also has a number of limitations. First, the T-21 policy for Pennsylvania was enacted prior to growth in the market for e-cigarettes. Secondly, the external validity of their research is limited due to their sample consisting entirely of pregnant mothers in Pennsylvania. Moreover, the first stage effects identified might be biased based on incentives to report illegal maternal smoking. Lastly, the first stage effects might be compromised as the regression discontinuity approach is essentially asking whether pregnant mothers in the final days of their pregnancy disproportionately initiate smoking at age 21.

This study offers the first evidence of the impact of *statewide* T-21 laws adopted nationwide on young adult smoking.[22] Statewide T-21 laws are harder to avoid by cross-border shopping (requiring out of state travel instead of within-state travel) and cover much larger shares of the state population than municipal laws studied by prior authors. Second, this study is the first to explore the impact of T-21 laws on minors, who are explicitly targeted by T-21 policies because 18-year-olds are viewed as an important "social source" for cigarettes. Third, we are the first study to analyze how a statewide T-21 law affects electronic cigarette use, whose use has exploded with JuuL's entry into the (e-cigarette) tobacco market (FDA 2018). Fourth, this study is the first to study the impact of any T-21 law on frequent and everyday smoking, which capture more addictive tobacco use. Fifth, this study is the first to descriptively explore the mechanisms through which T-21 laws may operate, in particular through teens' use of the social market for tobacco (i.e., third party purchase and borrowing). Sixth, this study is the first to examine spillover effects of T-21 laws on marijuana and alcohol consumption. Finally, given that our study considers a window close to the recent Federal "Tobacco to 21 Act" and considers statewide policies rather than local ordinances, our estimates likely represent local average treatment effects (LATEs) which are most relevant for considering the likely impact of the new Federal T-21 law.[23]

[22] While not specifically examining a T-21 policy, Yörük and Yörük (2016) use an RDD to study the effect of a minimum legal purchasing age for tobacco of 18 on tobacco consumption. Using nationally representative data from the 1998 to 2004 National Longitudinal Survey of Youth 1997, they find that granting legal access to tobacco at age 18 nationwide increases the probability of smoking participation by 1.9 to 2.9 percentage points and an increase on the number of cigarettes smoked per day of 3.7 to 6.5 percent. This study, while having important findings, does have limitations, the primary one being the difficulty of disentangling the effect on smoking behavior of granting legal tobacco access at 18 years old from the other significant "life changes" that occur at that age; including the rights to vote, apply for credit, or sign a legal contract. Another significant change likely to be happening in months leading up to or following an individual's 18th birthday is the completion of high school, which often means individuals will start working full time or begin college in the bandwidth around the cutoff of Yoruk & Yoruk's RDD.

[23] Moreover, evaluating the impact of the Federal T-21 law directly will be quite challenging given that its implementation was coincidental to the onset of the COVID-19 epidemic in the United States.

3. Data

3.1 Behavioral Risk Factor Surveillance System (BRFSS)

The first dataset we employ for our analysis is the Behavioral Risk Factor Surveillance System (BRFSS) survey. The BRFSS is a nationally representative telephone survey conducted annually by the Centers for Disease Control and Prevention (CDC) since 1984.[24] Respondents, aged 18 and older, are asked questions regarding their health and various health behaviors, including tobacco consumption. Our analysis sample uses approximately 700,000 individuals aged 18 to 28 years old from the repeated cross-sections of the BRFSS from 2009 to 2019.

We use responses from two smoking-related survey items in the BRFSS to create our three binary variables of interest (*Smoking Participation, Everyday Smoking,* and *Quit)*:

"Have you smoked at least 100 cigarettes in your entire life?"
"Do you now smoke cigarettes everyday, some days, or not at all?"

Smoking Participation is set equal to 1 if the respondent reports having smoked at least 100 cigarettes in their lifetime and is currently either smoking "everyday" or "some days"; it is set equal to 0 otherwise.[25] In our sample 12.3 percent of 18-to-20-year-olds were current smokers (see Table 1A). Between 2009 and 2019, we observe smoking participation for this age group has declined by 54.2 percent (see Figure 2). For 21-to-23-year-olds, the average smoking participation rate was 19.3 percent, and for 24-to-28-year-olds, it is 22.7 percent.

Everyday Smoking is set equal to 1 if a survey respondent reports having smoked at least 100 cigarettes in his/her lifetime and currently smokes "everyday"; *Everyday Smoking* is set equal to 0 otherwise. For 18-to-20-year-olds, we find that 7.2 percent of individuals were everyday smokers as compared to 11.9 percent for 21-to-23-year-olds and 14.6 percent for 24-to-28-year-olds. The trends in everyday smoking depicted in Figure 2 suggest a decline in everyday smoking over the sample period of approximately two-thirds among 18-to-20-year-olds.

Finally, the variable *Quit* is set equal to 1 if the survey respondent reports having smoked at least 100 cigarettes in their lifetime currently does not smoke. *Quit* equals zero if the respondent is

[24] The BRFSS has been administered via both landline and cellular phones since 2011; the survey was conducted only over landline up to that point. When we restrict our analysis sample to the 2011-2019 period, our findings are quantitatively similar.
[25] One limitation is that we are unable to identify new current smokers who do not report having smoked at least 100 cigarettes in their lifetime, since they are not asked about their current smoking behavior.

currently smoking either "everyday" or "some days." Thus, the sample for our *Quit* measure is the sample of current and former smokers. We find that 24.9 percent of 18-to-20-year-olds had successfully quit smoking when they were last observed during the sample period. Quit rates among 21-to-23-year-olds and 24-to-28-year-olds were higher at 30.3 and 36.9 percent, respectively. Between 2009 and 2019 (see Figure 2), we find that quits among 18-to-20-year-olds increased by over 80 percent, consistent with the hypothesis that the decline in smoking participation seen over the sample period is largely driven by increases in quit behavior.

3.2 State Youth Risky Behavior Survey (YRBS)

The second source of data used for our analysis is the state-level YRBS, a biennial survey coordinated by the CDC and administered by state education and health agencies, designed to be representative of all students in grades 9 through 12 in each state. These data are used by government agencies to follow trends in the behaviors of high school students including physical activity, mental health, unhealthy eating, sexual activity, and the use of tobacco, alcohol, and other illicit substances. Our analysis sample covers state YRBS survey waves from 2009 to 2019, including high school students from 43 states.

For a majority of the state YRBS surveys, trained data collectors travel to each participating school to administer the questionnaires.[26] The data collection process is designed keeping survey respondent privacy in mind by maintaining anonymity and allowing voluntary participation. Students complete the questionnaire during one class period, recording their answers in a computer-scannable booklet, while spread out throughout the classroom as much as possible in order to keep students from seeing each other's answers. When finished with the survey, student answers are sealed in an envelope and placed in a box.

We use responses to one question in the YRBS to create three binary variables (*Smoking Participation, Frequent Smoking,* and *Everyday Smoking)* pertaining to smoking status:

"During the past 30 days, on how many days did you smoke cigarettes?"

Smoking Participation is set equal to 1 if the respondent reports having smoked a cigarette in the last 30 days, and 0 otherwise; *Frequent Smoking* is set equal to 1 if the respondent reports having smoked

[26] In some states, the questionnaires are sent directly to schools, and teachers administer the survey following a standardized script (CDC 2013)

a cigarette in 20 or more of the last 30 days and 0 otherwise; and *Everyday Smoking* is set equal to1 if the respondent has smoked a cigarette every day in the last 30 days and 0 otherwise.

We find that 18.3 percent of 18-year-olds smoked cigarettes in the last 30 days (see Table 1B). This rate declined during the 2009 through 2019 period from 24.5 to 9.9 percent. For minor teens ages 16-to-17, we estimate a mean smoking rate of 12.5 and 7.3 percent for 13-to-15-year-olds.

One advantage of using the State YRBS survey, is that in 2015 they began asking survey respondents about e-cigarette use. We use responses to one question in the YRBS to create three binary variables (*E-Cigarette Participation, Frequent E-Cigarette Use,* and *Everyday E-Cigarette Use)* pertaining to e-cigarette usage.

"*During the past 30 days, on how many days did you use an electronic vapor product?"*

E-Cigarette Participation is set equal to 1 if the respondent reports having used an electronic cigarette in the last 30 days, and 0 otherwise; *Frequent E-Cigarette Use* is set equal to 1 if the respondent reports having used an electronic cigarette in 20 or more of the last 30 days, and 0 otherwise; *Everyday E-Cigarette Use* is set equal to 1 if the respondent has used an electronic cigarette every day in the last 30 days, 0 otherwise.

We find that 25.8 percent of 18-year-olds used e-cigarettes in the last 30 days (Table 1B), compared to 21 percent of 16-to-17-year-olds and 20.8 percent of 13-to-15-year-olds. Similarly, we find that 5 percent of 18-year-olds use e-cigarettes frequently, and 6.2 use them on a daily. For 16-to-17-year-olds, we find a frequent e-cigarette use rate of 8.0 percent, and a daily use rate of 3.5 percent.

4. Empirical Methods

4.1 Difference-in-Differences Estimates

We begin using data from the 2009-2019 BRFSS to estimate the impact of T-21 laws on tobacco cigarette consumption among 18-to-20-year-olds. We estimate a standard binary logit model in which an indicator of prior 30-day smoking participation, daily smoking or quit behavior (among prior smokers), Y, is equal to 1 if an unobserved variable, Y^*, is positive. Y^* is related to a set of observable variables and fixed effects by the following equation:

$$Y^*_{ismt} = \beta_0 + \beta_1 T\text{-}21\ Law_{smt} + \boldsymbol{X}_{ismt}\boldsymbol{\gamma} + \mu_s + a_m + \tau_t + \varepsilon_{ismt} \quad (1)$$

where *i* indexes survey respondents, *s* indexes states, *m* indexes months, *t* indexes years, and the distribution of ε_{ismt} is logistic.[27] Our key right-hand side variable, *T-21 Law*$_{mst}$ is an indicator set equal to 1 if a state has a statewide minimum legal purchasing age for tobacco of 21 years and 0 otherwise. Our estimates should, therefore, be interpreted as the impact of a statewide T-21 law over and above existing average state conditions, which could include a share of local jurisdictions having a T-21 law. In alternate specifications discussed below, we (i) code *T-21 Law*$_{st}$ as the share of the population of state *s* covered by any T-21 law — state or municipal policy for municipalities with population size of at least 10,000 persons) — in month-by-year *t,* and (ii) generate a separate policy variable *Local T-21 Law*$_{st}$, defined as the share of the population of state *s* covered by a local T-21 law in month-by-year *t,* and add this measure as an additional covariate along with the original statewide-only *T-21 Law*$_{st}$ variable.

In all models, we align policy effective dates with the relevant month of the interview (i.e. tobacco cigarette use measured during the month prior to the interview date). Appendix Table 1 shows effective dates for state T-21 laws and Figure 1 shows the geographic and temporal variation using a U.S. map.

The vector $\boldsymbol{X}_{ismt}$ includes a set of observable individual-level and state-level characteristics. Among the individual controls are race/ethnicity, gender, age, and age-specific linear time trends, allowing each age cohort to be on its own smoking trend. In addition, we control for macroeconomic conditions via state per capita income and the state unemployment rate. To disentangle the effects of Tobacco-21 laws from other tobacco-related policies, we control for the state excise tax on cigarettes, the presence of clean indoor air laws, whether a state has implemented an electronic cigarette tax (ad valorem or excise), and whether the state enacted a minimum legal purchasing age for electronic cigarettes of 18. Finally, we control for policies related to alcohol and marijuana, which may be substitutes or complements for tobacco: state beer taxes and indicators for whether the state has implemented a medical marijuana law or a recreational marijuana law.[28] Means of these descriptive statistics are shown in Table 1.

[27] We explore the robustness of estimated policy impacts obtained from equation (1) to the use of a linear probability model (LPM). The estimated marginal effects from an LPM are qualitatively similar to those produced with logistic regression.

[28] Sources for control variables are as follows: state-level unemployment rates (Bureau of Labor Statistics) and income per capita (Bureau of Economic Analysis), state-level cigarette taxes, e-cigarette MLSA laws and clean indoor air laws (Centers for Disease Control), state-level e-cigarette taxes and beer taxes (Tax Foundation), state-level recreational

In addition, we control for μ_s, a time-invariant state fixed effect to capture fixed unobserved differences across states as well as time fixed effects to capture common time shocks across states: a_m is a month fixed effect and τ_t, is a year fixed effect. All regressions are weighted using BRFSS-provided sample weights and standard errors are clustered at the state-level.

The estimate of our key parameter of interest, β_1 (*"Two-Way Fixed Effects" Logit Estimate*) is identified from 17 states that enacted T-21 laws over the sample period under study. We take a number of tacks to provide evidence in support of the common trends assumption underlying our main empirical specification. First, we note that the common trends assumption will be violated in the presence of (i) time-varying unobservables correlated with the enactment of Tobacco-21 laws and smoking behavior among young adults, or (ii) reverse causality. We take several tacks to address these concerns and reduce the likelihood that our estimated policy effects are biased. First, we conduct event-study analyses to ensure that pre-treatment trends in smoking participation are similar in treatment states as compared to control states in the period leading up to the enactment of T-21 laws:

$$Y^*_{ismt} = \beta_0 + \sum_{j\neq -1} \beta^j_1 \, 1\{T-21\ Law\}_{smt} * 1\{Event\ Year\}_{j(smt)} + \boldsymbol{X}_{ismt}\boldsymbol{\gamma} + \mu_s + \alpha_m + \tau_t + \varepsilon_{imst} \quad (2)$$

where the subscript *j* denotes the number of years before and after a state enacts a Tobacco-21 law ("event time"). Each β^j_1 describes the change in smoking participation among 18-to-20-year-olds in states that enacted T-21 laws compared to those that did not. Specifically, it involves a differential change from year *j* relative to the event period j(s,t) = -1, one year prior to enactment. If pre-treatment trends (up to 4 or more years prior to the enactment of T-21) are common among "treatment" and "control" states, this would tend to lend support to the claim that post-treatment breaks in smoking trends were caused by the policy. Out main post-treatment period examines up to one or more years following adoption of a T-21 law to ensure a more balanced event study, but we also experiment with a less balanced event study that explores longer-run effects for the earliest adopting states (up to two or more years following adoption).[29]

marijuana laws (Marijuana Policy Project), and state-level medical marijuana laws (National Conference of State Legislatures).

[29] A total of 17 states enacted T-21 laws between 2009 and 2019. Of the 17 states that have post-treatment smoking participation data in the BRFSS, 6 have one or more years of post-treatment data and 3 have two or more years of post-treatment data.

One concern with the identification strategy described above is that in the presence of heterogenous dynamic treatment effects, two-way fixed effects (TWFE) estimates may be biased, including those of lead and lag coefficients in event studies used to evaluate the credibility of the common trends assumption (Goodman-Bacon 2021; Sun and Abraham 2021). To expunge bias generate by heterogeneous dynamic effects of T-21 laws on tobacco use, we undertake a "stacked" DD estimation strategy (Cengiz et al. 2019; Baker et al. 2021; Gardner et al. 2021). The stacked DD approach avoids bias caused by dynamic treatment effects by selecting, for each "stack" of treatment states that adopted a T-21 law at the same time, counterfactuals comprised of states that did not enact a T-21 law over the period from 4 years prior to the treatment state's enactment date through one year after enactment ("never adopters"). This method of selecting counterfactuals ensures that earlier-adopting states do not serve as counterfactuals for later-adopting states because earlier adopters may be poor controls in the presence of dynamic treatment effects.

In addition, the stacked DD strategy addresses potential bias caused by heterogeneity in effects of T-21 laws by adoption timing by ensuring that each treatment state is restricted to four years of leads and up to one year of lagged effects of T-21 laws (note that 7 of 17 treatment states, including the District of Columbia, have at least one year of post-treatment data). This approach helps to reduce bias in the average effect of the treatment on the treated (ATT) due to heterogeneous implicit treatment weights treatment state by adoption timing.

As a third approach to ensure that our estimate of β_1 is unbiased, we explore the sensitivity of our estimates to additional controls for spatial heterogeneity. These include region-by-year fixed effects to control for common time shocks to states within census regions, thereby restricting counterfactuals for T-21 states to be geographically proximate states. In addition, we control for state-specific time trends to control for within-state unobservables trends such as anti-smoking sentiment.

Our third approach is to conduct placebo-type tests by estimating DD models identical to equation (1) for older young adults, who should be less likely to be affected by T-21 laws. Specifically, we examine the impact of T-21 laws on smoking behavior among 21-to-23-year-olds and 24-to-28-year-olds, each of whom should be less directly affected by the statutes. We expect that the estimate of β_1 for 21-through-28-year-olds to be much smaller than for our "treatment age" of 18-to-20. However, we do note that some 21-to-23-year-olds smoking behavior could be affected by T-21 laws with a lag, as "current" 21-year-old's smoking behavior one year after the implementation of T-21 could have been affected by T-21 laws when they were 20 years-old. If, for

example, a 21-year old whose state's T-21 law was enacted last year was induced to quit smoking a year ago, then his current smoking behavior at age 21 may have been affected via this lagged effect. Given that no treatment state in our sample has more than 3 years of post-treatment data, no 24-to-28-year-old should have been impacted at any point (except through indirect effects via younger peers).[30]

We also estimate a formal "difference-in-difference-in-differences" (DDD) logit model by pooling a sample of 18-to-20-year-olds and 21-to-23-year-olds (or 24-to-28-year-olds) and estimating:

$$Y^*_{ismt} = a_0 + a_1 T\text{-}21\ Law_{mst} + a_2 Age1820_{imst} + a_3 T\text{-}21\ Law_{mst} * Age1820_{imst} + \boldsymbol{X}_{imst}\boldsymbol{\alpha_4} + \boldsymbol{X}_{imst} * Age1820_{ist}\boldsymbol{\alpha_5} + v_s + v_s * Age1820_{imst} + \gamma_m + \gamma_m * Age1820_{imst} + \omega_t + \omega_t * Age1820_{imst} + \varepsilon_{imst}. \quad (2)$$

where our DDD estimate a_3 is the differential effect of a T-21 laws for 18-to-20-year-olds as compared to older young adults. Moreover, we also estimate a specification similar to equation (2) where we include a full set of state-by-year fixed effect interactions, which will control for any unmeasured common shocks that affected 18-to-20-year-olds and older young adults. Together, we expect the above descriptive tests to lend support to the common trends assumption.

Next, we turn to the State YRBS survey data, where we estimate a model very similar to equation (1) for 18-year-old U.S. high school students. The State YRBS sample from 2009 through 2019 is comprised of biennial waves (in odd numbered years). Thus, the time fixed effect is a wave fixed effect for the survey years 2009, 2011, 2013, 2015, 2017, and 2019. In addition, the State YRBS allows us to measure electronic cigarette consumption as well as traditional cigarette consumption. As noted in Appendix Table 1 and Appendix Figure 1, 12 states identify our T-21 law effects in our YRBS-based analysis.[31]

Finally, while our YRBS-based difference-in-differences analysis does not permit an examination of older young adults as a counterfactual (the data are comprised of U.S. high school

[30] As discussed below, we also attempt an alternate approach where we use state-specific birth cohort to identify treated individuals and differentiate individuals by length of exposure to the T-21 policy at any point in their lives.

[31] In the YRBS, our T-21 variable is coded as the share of the year the T-21 law is in effect. Some YRBS-based studies assume that the school-based surveys are only distributed between January and June of the survey year, though the Centers for Disease Control and Prevention (CDC) has offered mixed guidance on this point. If we recode our T-21 variable based on only policies in effect during the first two quarters of the survey year, our findings are qualitatively similar.

students), we are able to explore spillover effects to minor teens under the age of 18. Thus, we also estimate equation (1) for 16-to-17-year-olds, who may rely on some 18-year-old classmates for access to tobacco. We also examine effects of T-21 laws on 13-to-15-year-olds, who are less likely to be able to access peers around age 18, and thus may be a more appropriate "placebo" age group.

5. Results

5.1 Main BRFSS Findings

Our main BRFSS findings are shown in Tables 2A through 5. The tables report marginal effects generated from logit models, with standard errors clustered at the state level. All regressions are weighted using the sampling weight provided by the BRFSS survey.

We begin in Table 2A by showing logit estimates of the relationship between Tobacco 21 (T-21) laws and tobacco cigarette use among young adults. The first three columns show "difference-in-differences" estimates for adults ages 18-to-20. These are the individuals who are directly bound by state T-21 law changes, which raise the minimum legal purchasing age (MLPA) for tobacco from 18-to-20. Our baseline specification in column (1) includes individual demographic characteristics (gender, race/ethnicity, age, age-specific time trends), state macroeconomic conditions (unemployment rate, per capita income), and tobacco policy controls (per pack excise tax on cigarettes, clean indoor air laws). In this model, we find that T-21 laws are associated with a 2.5 percentage-point decline in current tobacco cigarette use (Panel I). Relative to the mean smoking participation rate in state-months without T-21 laws, this represents a 21.7 percent decline in smoking participation among 18-to-20-year-olds.[32] The addition of controls for electronic cigarette policies (the minimum legal purchasing age for e-cigarettes and the presence of an e-cigarette tax) in column (2) has little effect on the estimated effect of T-21 laws on smoking participation. In our fully specified model (column 3, Panel I), which also includes controls for alcohol and marijuana policies (beer taxes, medical marijuana laws, and recreational marijuana laws), we find that T-21 laws lead to a 3.9 percentage-point (33.9 percent relative to the mean) reduction in smoking participation among 18-to-20-year-olds. In addition, we find that the enactment of a T-21 law reduces the probability of everyday smoking by 1.6 to 2.4 percentage-points (Panel II), which could suggest some effect of T-21 laws on the intensive margin (days) of smoking.

[32] The pre-treatment mean is calculated as the weighted mean in treatment states prior to T-21 adoption.

Our results in Panel III suggest that the decline in smoking participation and everyday smoking likely comes from an increase in quitting behaviors, which is what we might expect given that the vast majority of 18-to-20-year-olds initiate smoking prior to age 15. While imprecisely estimated because the sample is conditioned on "ever smokers," we find that T-21 laws are associated with a statistically insignificant 4.1 to 5.3 percentage-point increase in the probability of quitting smoking (15.8 to 20.5 percent) for 18-to-20-year-olds.

To explore the credibility of the common trends assumption in columns (1) through (3), we show the results of several diagnostic tests. First, panel (a) of Figure 4 shows results from our event-study analysis for smoking participation. We find that in the four years prior to the enactment of T-21 laws, trends in smoking participation in "treatment" and "control" states appeared to be common, diverging only following with the enactment of T-21 laws.

Because state T-21 laws are relatively new, we are limited in examining their long-run impacts.[33] Moreover, the onset of COVID-19 in 2020 will make it very difficult to disentangle the effect of the Federal T-21 law from the smoking impacts of COVID-19. With these limitations in mind, difference-in-differences results suggest that T-21 laws had an immediate negative effect on smoking participation. When we extend the event study to include two or more years following enactment (4 states), the results are qualitatively similar (see Appendix Figure 2).

As noted above, one concern with the above "TWFE" logit estimates is that they may be biased due to heterogeneous dynamic treatment effects. In columns (4) through (6) of Table 2A, we show stacked DD estimates of the effect of T-21 laws on 18-to-20-year-old. Consistent with our TWFE logit estimates, stacked DD logit estimates confirm a negative relationship between the enactment of T-21 laws and tobacco cigarette consumption. This is, perhaps, unsurprising given that the TWFE sample includes 34 states that did not enact a T-21 law during the period under study. For smoking participation (panel I), the magnitudes of the estimated treatment effects are comparable to those obtained using TWFE estimates. While stacked DD estimates of the effect of T-21 laws on everyday smoking among 18-to-20-year-olds remains statistically significant and economically important (panel II), the estimated effect sizes are somewhat smaller relative to the "TWFE" estimates. Event study analyses based on the stacked DD approach, shown in Figure 5,

[33] Of the 17 states enacting T-21 laws over our sample period, only 7 states have post-treatment data a year or more following enactment. Ten (10) states have post-treatment data only for the year of enactment.

suggest common pre-treatment treatment trends and significant post-treatment declines in smoking participation in both the unbalanced (panel a) and balanced (panels b and c) stacked panels.[34]

As another test of the credibility of the common trends assumption, we explore the robustness of our estimated policy impacts to additional controls for state-specific linear time trends, and region-specific year effects. These controls capture geographic-specific time shocks that may be related to T-21 enactment and adult smoking (i.e. anti-smoking sentiment), which may ameliorate bias in our prior estimates. On the other hand, it is not obvious that states within the same census region comprise better counterfactuals for states that enact T21 laws than non-geographically proximate states. Moreover, controlling for state linear time trends may (i) reduce precision in the estimated T-21 effect, and (ii) generate bias in the estimated policy impact if there are heterogeneous treatment effects among early and later adopters. Reassuringly, our findings in Appendix Table 2 show that the estimated impact of T-21 laws on smoking participation is robust to controls for spatial heterogeneity.

Our final approach to address the common trends assumption is to estimate the impact of T-21 laws on individuals ages 21 and older who are less likely to be directly affected by these statutes. In columns (1) through (3) of Table 2B, we present logit estimates of the effect of T-21 laws on smoking behavior of 21-to-23-year-olds. While this is a credible placebo group, we note that some 21-to-23-year-olds in Tobacco-21 states were "bound" by the law when they were younger. And current smoking behavior among 21-to-23-year-olds could have been affected by prior exposure to a T-21 law.[35]

With these caveats in mind, our results in Panel I show no evidence that T-21 laws affect smoking participation among 21-to-23-year-olds. The estimated policy impact for 21-to-23-year-olds is 20 percent smaller than for 18-to-20-year-olds (0.05 to 0.8 percentage-points) and is nowhere near statistically different from zero. An event-study analysis in panel (b) of Figure 4 also suggests a null result. This result suggests that our smoking participation findings for 18-to-20-year-olds are not contaminated by unmeasured shocks that commonly affect 18-to-20 and 21-to-23-year-olds. We also find no evidence that T-21 laws impact everyday smoking or quit behavior for 21-to-23-year-olds.

[34] The unbalanced event study includes all treatment states while the balanced event study includes either (i) only treatment states that have at least one year of post-treatment data (panel b), or (ii) all treatment states, but restricts the post-treatment period to include only *event time 0*.

[35] For example, New Jersey enacted a T-21 law in 2017. Thus, 21-year-olds living in New Jersey in 2018 and 21- and 22-year-olds living there in 2019 would have been bound by the T-21 law when they were younger.

In columns (4) through (6) of Table 2B, we examine smoking behavior of 24-to-28-year-olds. This age group has the advantage that none included in it were bound by any state's T-21 law when they were younger (i.e., the first state T-21 law was adopted by Hawaii in 2016; thus, the oldest individual in our sample who was bound by a T-21 law in 2019 was age 23). The main disadvantage is that this age group is quite a bit older than "treated" individuals and hence may be a poorer control group.

Our results show no evidence that T-21 laws affect smoking participation, daily smoking, or quit behavior among 24-to-28-year-olds.[36] The estimated policy impacts for this age group are uniformly smaller (in absolute magnitude) as compared to 18-to-20-year-olds.

In Table 3, we show results from a "difference-in-difference-in-differences" specification. This is a test of whether the estimated T-21 law impacts in columns (1)-(3) of Table 2 are statistically different from the estimates in columns (4)-(6), and then (7)-(9). Our results in Panel I of Table 3 show that T-21 laws are associated with a statistically significant 3.1 to 4.0 percentage-point (27 to 35 percent) reduction smoking participation of 18-to-20-year-olds relative to 21-to-23-year-olds, and a statistically significant 3.2 to 4.8 percentage-point (28 to 42 percent) reduction smoking participation of 18-to-20-year-olds relative to 24-to-28-year-olds.

These logit estimates are comparable to those from linear probability models (Appendix Table 3) and, importantly, when we augment our "triple-differences" specification with a full set of state-by-year dummy interactions — to capture any common shocks that may have impacted smoking behavior of 18-to-20 and 21-to-23-year-olds (column 3) — we continue to find that T-21 laws reduce smoking among 18-to-20-year-olds.[37]

One concern with the above estimates is that some individuals ages 21-to-23-years-old may be impacted by T-21 laws with a lag. Thus, we attempt an alternate identification strategy where we pool individuals ages 18-to-28 from 2009 through 2019 (representing birth years 1981 through 2001). Our key "treatment variable" is the interaction of *T-21 Law* and an indicator for whether an individual was born in a year such that he/she was aged 18-to-20 (at any time) when their state had a T-21 law.[38] The results from this exercise, shown in Appendix Table 4 reflect that smoking

[36] The event-study analysis in panel (c) of Figure 4 shows no evidence that T-21 laws affect smoking participation among 24-to-28-year-olds.

[37] An event-study analysis based on triple-difference estimates, shown in Figure 6, produces results consistent with a causal impact of T-21 laws on smoking participation.

[38] This specification includes both birth cohort and age fixed effects as well as time trends for each, along with each of our controls. Because the BRFSS do not include mobility data, we are forced to assume that state of residence at the

participation decreased among 18-to-20-year-olds and individuals who were ages 18-20 when a T-21 law was implemented.

Taken together, the above results provide strong evidence that T-21 laws were effective at reducing "traditional cigarette" smoking participation among 18-to-20-year-olds. Is this result consistent across other forms of tobacco use, as proponents of T-21 laws hope? Information on electronic cigarette use is relatively new in nationwide surveys, only available in the 2016-2019 BRFSS. Nonetheless, in Appendix Table 5 we examine the effect of T-21 laws on e-cigarette use reported in the BRFSS. While imprecisely estimated, we find that T-21 laws reduce e-cigarette use among 18-to-20-year-olds by 1 to 2 percentage points. This finding is consistent with the hypothesis that T-21 laws reduce consumption of multiple types of tobacco produces.[39]

5.2 Heterogeneity in Effects of T-21 on Tobacco Use Among Young Adults

We next turn to an exploration of heterogeneity in the impacts of T-21 laws by demographic and socioeconomic characteristics of individuals ages 18-to-20. Table 4 explores whether the effects of T-21 laws differ for 18 as compared to 19-to-20-year-olds. 19-to-20-year-olds are more likely to have 21-year-old peers from whom to access cigarettes via the social market (i.e. bumming or borrowing, third-party purchase) than are 18-year-olds, many of whom are still in high school. Our results in Table 4 provide strong evidence that 18-year-olds see a much larger decline in smoking participation in response to T-21 laws than 19-to-20-year-olds. We find that T-21 laws are associated with a 6.0 to 7.6 percentage-point decline in smoking participation among 18-year-olds, and a 1.5 to 2.7 percentage-point decline in smoking participation among 19-to-20-year-olds. This highlights the potential differences in social markets to which teens and young adults have access. For example, many 19-20-year-olds are likely either in college or the labor force, providing them with access to social networks with older individuals not bound by T-21 laws.[40]

Together, the estimated effects of statewide T-21 laws presented above are somewhat larger than have been detected in studies of local T-21 policies. Indeed, for 18-year-olds, we find T-21 may reduce smoking by as much as 70 percent. This is consistent with higher travel costs of

time of the survey was the same state of residence when they were of age to be affected by a T-21 law (and similarly for "control" individuals).

[39] The BRFSS survey question on electronic cigarettes asks respondents: "Do you now use e-cigarettes or other electronic vaping products every day, some days, or not at all?" We set *E-Cigarette Participation* equal to 1 if respondents report every day or some days and 0 otherwise.

[40] This finding raises the possibility that much of the "bite" of T-21 laws could have been achieved via a "T-19" law.

avoidance associated with a statewide mandate.[41] Moreover, we find little evidence that border state T-21 laws significantly affect the marginal impact of "own" statewide T-21 laws on young adult smoking (see Appendix Table 8).[42]

In Table 5, we explore heterogeneity across an additional set of individual and household characteristics. The first five columns explore heterogeneity in the impacts of T-21 laws by gender (columns 1-2) and race/ethnicity (columns 3-5). We detect impacts of T-21 laws on both male and female young adults, with estimated marginal effects slightly larger, but not significantly different, for females. Turning to race, we find strong evidence that African Americans may be more affected by T-21 laws, especially in percentage-point terms relative to mean smoking rates (which are much lower for blacks than whites). This larger impact on African Americans could reflect that black Americans are more likely to face differential race-based enforcement of these laws (i.e., ID checks) than are non-Hispanic whites.

Next in columns (6) and (7), we explore whether the effects of T-21 laws differ by whether the 18-to-20-year-old has (i) dropped out of high school, or (ii) is currently attending high school or has received a high school diploma. We find T-21 laws reduce smoking participation for high school dropouts by 8.4 percentage points and by 3.3 percentage points for individuals with a high school degree or currently in high school. This result is consistent with the hypothesis that less-educated individuals are more affected by the policy.

Finally, in columns (8) and (9), we explore whether T-21 laws differently affect 18-to-20-year-olds from poor versus non-poor households. The results suggest that T-21 laws decrease smoking participation relatively more poor households than non-poor households; however, for everyday smoking, the pattern is reversed.

5.3 YRBS Results on Cigarette Smoking

[41] In Appendix Tables 6 and 7 we report estimates where we control for local T-21 policies, either through incorporating local policies (via the share of the state population covered by local policies) into the coding of our main T-21 policy variable (columns 1-3) or via a separate control alongside our statewide T-21 policy. Our results show that statewide policies have larger smoking reducing effects than local policies, consistent with more cross-jurisdiction shopping for local laws.

[42] In Appendix Table 8, we explore whether the effect of a statewide T-21 law depends on whether a border state also has a T-21 law. While the coefficient on the interaction between own state and border state T-21 law is negative for smoking participation and everyday smoking, it is economically small and never statistically distinguishable from zero at conventional levels.

Our analysis next turns to the State YRBS data to examine high school students. As above, standard errors are clustered at the state level, and regressions are weighted to be nationally representative of 18-year-old high school students.[43]

In Table 6, we explore the effect of T-21 laws on tobacco use of 18-year-old high school students using State YRBS data from 2009-2019, and "TWFE" logit estimates (column 1-3) as well as "Stacked DD" logit estimates (columns 4-6). The three panels show estimates of the effect of T-21 laws on smoking participation, frequent smoking (20 or more days in the prior month), and daily smoking, respectively. Consistent with "TWFE" logit results from the BRFSS, the findings in columns (1)-(3) show that T-21 laws are associated with a marginally significant 2.5 to 6.6 percentage-point reduction in smoking participation among 18-year-old high school students.[44] We find stronger evidence of T-21-induced reductions in frequent (panel II) and everyday (panel III) cigarette use. While "stacked DD" logit estimates in columns (4)-(6) suggest somewhat smaller T-21 effects on cigarette use, the findings are, in the main, consistent with the significant cigarette use declines found using "TWFE" models.

In Table 7, we show results by gender (columns 1-2) and race (columns 3-4).[45] We find that for 18-year-old high school students, the effect of T-21 laws on smoking participation is larger for males relative to females. We find a similar pattern when looking at intensive margin in panels II and III. With regard to race, there is no clear pattern, with similar sized effects of T-21 laws on smoking participation for non-Hispanic whites and Blacks (Panel I), but larger effects for whites when examining frequent smoking (Panel II).

As discussed above, an important policy rationale for T-21 laws is to reduce *minors*' (< 18 years-old) tobacco use. Minor teenagers who wish to access cigarettes often rely on 18-year-old peers to bum or borrow cigarettes or for third-party purchase (Hansen et al. 2013). By making it more difficult for 18-year-olds to access tobacco, proponents of T-21 laws aim to reduce minors' tobacco consumption.

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[43] We note that the age category available in the State YRBS survey is actually 18+, which does include a very small share of 19-year-old high school students. Our weight variable is calculated as the product of (i) each state's YRBS-provided weight (designed to make the state sample representative of the state population of 9th through 12th graders), rescaled to sum to 1, and (ii) the state-by-year intercensal population estimate of 18-year-olds from the Surveillance, Epidemiology, and End Results (SEER) program.

[44] In Appendix Table 9 we explore the evolution of our smoking participation results in event time. We find decreases in smoking participation are largest 3 years or more (2 or more waves) after the implementation of a state T-21 law.

[45] An exploration of those of "other" races and ethnicities (i.e. those of Hispanic and Asian descent) provide no evidence that T-21 laws were significantly associated with smoking behaviors. In addition, because the YRBS does not include information on household income or poverty, we cannot explore heterogeneity along these dimensions.

In Table 8, we explore the impact of T-21 laws on tobacco consumption among 16-to-17-year-olds, an age group that is likely to have access to 18-year-old peers who may attend the same grade. Our results show that T-21 laws reduced smoking participation among 16-to-17-year-olds by 2.8 percentage-points (column 1, Panel I), consistent with the hypothesis that these laws (i) reduced the likelihood that 16-17-year-olds are able to effectively use a fake ID to purchase cigarettes, and/or (ii) helped to dry up the social market for cigarettes. Importantly, when we examine the effects of T-21 laws on 13-to-15-year-olds, who have relatively less access to 18-year-old peers, we find little evidence that T-21 laws affect their smoking behavior (Appendix Table 10). A comparison of marginal effects by race suggests that the impact of T-21 laws on smoking is largest (in absolute magnitude) for 16-to-17-year-olds who are of non-Hispanic white descent (column 4).

5.4 Electronic Cigarette Use and the Social Market

We next explore the impact of T-21 laws on e-cigarette use among teens, including the usual means by which they obtain e-cigarettes. The YRBS began collecting data on e-cigarette use beginning in 2015 and continuing through 2019. In column (1) of Table 9, we find that T-21 laws are associated with an 8.1 percentage-point decline in prior 30-day e-cigarette consumption (Panel I), a 5.3 percentage-point decline in frequent (> 19 days) prior month consumption of e-cigarettes (Panel II), and 5.2 percentage-point decline in daily e-cigarette use (Panel III). While estimated with a very limited panel (the 2015, 2017, and 2019 waves of the YRBS), the findings in Appendix Figure 3 suggest little evidence that the decline in e-cigarette use was driven by a differential pre-treatment trend.[46]

In the descriptive analysis that follows, we explore the mechanisms through which state T-21 laws reduce e-cigarette use among youths. Beginning in the 2017 State YRBS, high school students were asked about their primary means of obtaining e-cigarettes.[47] Respondents were asked:

"During the past 30 days, how did you usually get your own electronic vapor products?"

Among possible responses to this question were:

[46] In unreported results, we also explore the impact of T-21 laws on cigar use and any tobacco product use (traditional cigarettes, e-cigarettes, or cigars). For 18-year-olds, we find that T-21 laws are associated with a (statistically insignificant 7.3 percentage-point (standard error = 0.046) decline in cigar use (sample period = 2009-2019), and a statistically significant 8.7 percentage-point decline (standard error = 0.036) in any tobacco product use (sample period 2015-2019).
[47] Information on usual sources of traditional tobacco cigarette use were discontinued in the YRBS over this period.

"I did not use any electronic vapor products during the past 30 days
I bought them in a store such as a convenience store, supermarket, discount store, gas station, or vape store.
I got them on the Internet.
I gave someone else money to buy them for me.
I borrowed them from someone else.
A person 18 years old or older gave them to me.
I took them from a store or another person.
I got them some other way."

Using responses to this question, we descriptively explore how state T-21 laws affected how 18-year-old youths obtained e-cigarettes. In panel (a) of Figure 7, we document that between 2017 and 2019, e-cigarette use rose both in states that implemented T-21 laws during this period (from 17.6 to 23.6 percent) and among those states where T-21 laws were not in effect (from 20.6 to 30.8 percent). However, rates rose 4.2 percentage-points more slowly in states that enacted T-21 laws, a difference statistically significantly different from zero at the 1 percent level. When we decompose e-cigarette users by where they obtained their cigarettes, we find that the biggest relative decline occurred via direct purchase of e-cigarettes, consistent with state bans on sales (6.3 percentage point relative decline in treatment versus control states).[48] We find modest evidence of substitution toward the social market, with T-21 laws associated with a 2.5 percentage-point higher probability of borrowing e-cigarettes. This suggests that some of the T-21 law effect is offset by 18+ year-olds perhaps accessing older peers for e-cigarette use.

When we examine males (panel b), who saw relatively larger e-cigarette declines in response to T-21 laws (see Appendix Table 11), the results are even more stark. We find a larger decline in direct purchase of e-cigarettes (7.7 percentage-points) for males in T-21 states as compared to control states, as well as larger increases in borrowing 1.7 percentage-points) and third-party purchase (1.0 percentage-points). Again, this suggests evidence that some 18-year-olds may turn to informal social sources for e-cigarettes.

In panel (c) of Figure 7, we condition the sample on e-cigarette users and examine usual source of e-cigarettes among vapers. We find strong evidence that direct purchase of e-cigarettes fell more in T-21 states after enactment, but also that borrowing e-cigarettes and use of other sources to obtain cigarettes (i.e., the internet) rose after T-21 laws were adopted. These findings suggest that peers in the social market may mute the full impact of T-21 laws.

[T]We group those categories into 5 groups. Participation is defined by the first response. Direct own purchase from a store is the second possible response. "Third party purchase" corresponds to "I gave someone else money to buy them for me." "Borrowing" corresponds to "I borrowed them from some else" or "A person 18 years old or older gave them to me." We combine internet, stealing, and other into the final category due to their overall rarity.

In columns (2)-(3), Panels I-III of Table 9, we show that T-21 laws were associated with a reduction in net e-cigarette use among 18-year-olds over the shorter 2017-19 window for which we have social sources data. In Panel IV, we estimate a multinomial logit model of the effect of statewide T-21 laws on the usual source by which 18-year-olds typically obtain e-cigarettes (the omitted outcome category is "non-use"). Consistent with Figure 7, we find consistent evidence that T-21 laws reduce direct purchase of e-cigarettes among 18-year-olds, but do lead to some substitution toward borrowing e-cigarettes, blunting the policy's full effect. Turning to 16-17-year-olds (columns 4-5), we find no evidence that T-21 laws are effective at reducing e-cigarette use among this group of individuals, suggesting that T-21 laws are most effective at deterring minors' tobacco use through traditional cigarettes. However, we are careful to note that because these results are based on only three years of data (2 waves), they should be viewed as descriptive, worthy of future analyses based on a longer panel.

5.4 Spillovers on Marijuana and Alcohol

Our final tables explore the whether there are important spillover effects of T-21 laws on two youth risky behaviors of youths that may be related to tobacco use: (i) marijuana use, and (ii) alcohol consumption. With regard to the impact of tobacco policy on marijuana use, much of the literature has focused on the impact of cigarette taxes with mixed findings (Pacula 1998a, 1998b; Chaloupka et al. 1999; Farrelly et al. 2001; Anderson et al. 2020).[49] In Table 10, we draw marijuana data from the YRBS from 2009-2019[50] and find consistent evidence that T-21 laws are associated with a 3-to-5-percentage-point decline in any (Panel I) and frequent (Panel II) marijuana use in the prior 20 days. This result is consistent with the hypothesis that tobacco produces and marijuana are complements for some 18-year-old high school students. This finding may also suggest that T-21 laws reduce teens' access to products that facilitate consumption of marijuana (i.e., vaping pens).[51]

[49] In the main these studies have used cross-state variation in taxes for identification (Pacula 1998a, 1998b; Chaloupka et al. 1999). Only two papers of which we are aware have exploited within-state policy variation to identify the impact of tobacco taxes on marijuana use. Farrelly et al. (2001) use 1990-2016 data from the National Household Survey on Drug Abuse (NHSDA) and find that higher cigarette taxes are associated with decreases in the intensity of marijuana use among individuals ages 12-to-20. Anderson et al. (2020) use YRBS data from 1991-2017 and find no evidence that cigarette taxes are systematically related to high school students' marijuana use.

[50] We measure *Marijuana Use* in the last 30 days using responses to a survey item on the number of times in the last 30 days on which the high school student used marijuana (if at least once, a dichotomous variable of use is set equal to 1; =0 otherwise). *Frequent Marijuana Use* is defined as using marijuana at least 10 times in the last 30 days.

[51] Beginning in 2016, marijuana data were collected in a handful of BRFSS states (20 states). Using data from these limited BRFSS states in Appendix Table 12, we find some evidence that T-21 laws were negatively related to frequent marijuana use among 18-to-20-year-olds. We find no evidence that T-21 laws affect marijuana use among 16-to-17-year-olds (see Panels I and II of Appendix Table 13)

In Tables 12A (YRBS) and 12B (BRFSS), we present estimates of the effect of T-21 laws on any alcohol consumption at the extensive and intensive margins.[52] Our YRBS-based results in Table 10 show no evidence that T-21 laws affect drinking at the extensive margin among 18-year-olds (Panel I). However, among drinkers, there is evidence that frequency of drinking (Panels II and IV)— including number of days of binge drinking — falls following the enactment of T-21 laws.

We detect a similar pattern of evidence when we examine drinking behavior in the BRFSS. The adoption of T-21 laws is associated with a reduction in the number of drinks consumed among 18-to-20-year-old males (Panel II), driven by the intensive margin of consumption (Panel III). These results could suggest that important alcohol-related externalities associated with frequent and more heavy drinking among older teens and young adults may be curbed via T-21 laws.[53]

6. Conclusion

This study provides the first national estimates of the effects of statewide T-21 laws on young adult and minor smoking behavior. First, using data drawn from the 2019-2019 BRFSS and 2009-2019 State YRBS, we find strong evidence that T-21 laws reduce tobacco use among young adults. Difference-in-differences estimates from the BRFSS suggest that T-21 laws are associated with an approximately 3.9 percentage-point reduction in smoking participation among 18-to-20-year-olds. Event study analyses and falsification tests among older individuals ages 21-to-28 generate findings consistent with a causal interpretation of our results. Turning to the YRBS, we find that T-21 laws are associated with reductions in smoking participation and an even larger reduction in e-cigarette use. Importantly, some of the benefits of T-21 laws appear to extend to minors ages 16-to-17, suggesting that T-21 laws may help to "dry up" the social market for tobacco or may create better "role modeling" of healthy behaviors by 18-year-olds. Finally, we find that T-21 laws may have important spillover effects to other youth risky behaviors. T-21 law adoption is

[52] The prior literature on tobacco and alcohol use among youths is also mixed. Yoruk and Yoruk (2013) find little evidence of substitution or complementarity between alcohol and tobacco at the minimum legal drinking age. On the other hand, Decker and Schwartz (2000) find negative own and cross price elasticities.

[53] In Table 11A, *Alcohol Use* is set equal to one if a respondent had at least 1 drink of alcohol in the last 30 days and 0 otherwise; *Drinking > 2 Days | Drinking* is set equal to 1 if the respondent reports drinking at least 3 days of the last 30 among drinkers; = 0 otherwise. *Binge Drinking* is set equal to 1 if the respondent had 4 (5 for males) or more drinks in a row during the last 30 days; =0 otherwise; *Frequent Binge Drinking* is coded =1 if the respondent binge drinks more than 5 times in the last month and 0 otherwise. In Table 11B *Alcohol Use* is set equal to 1 if the respondent has had at least one drink of alcohol in the past 30 days and =0 otherwise; *Number of Drinking Days | Drinking* is the number of days in the last 30 that the respondent had at least one drink conditional on drinking in the past 30 days; *Binge Drinking* is set equal to 1 if the respondent has had 4 (5 for men) or more drinks in the past 30 days; = 0 otherwise. In panels II through VI of Appendix Table 13, we find little evidence that alcohol use among those under age 18 is affected by T-21 laws.

associated with a reduction in marijuana use among 18-year-olds and a reduction in alcohol consumption, especially on the intensive margin, for 18-to-20-year-old males.

Taken together, our results suggest that statewide T-21 laws have had important beneficial public health effects, which could suggest that the Federal T-21 law, signed into law by President Trump in late December 2019, will have important impacts in non-adopting states. Moreover, to the extent young smokers are more likely to have time-inconsistent preferences (Gruber and Koszegi 2001) or are more impacted by exogenous peer effects (Robalino and Macy 2018), T-21 restrictions may enhance social welfare. However, providing direct evidence on the effects of the Federal T-21 policy will be extremely challenging for future scholars given the coincident timing of the Federal change with the onset of the COVID-19 pandemic, which may have substantial effects on tobacco use given the link between respiratory illness and COVID-19-related mortality (Nowakowski 2020). Thus, the evidence provided in this study is likely to be far less contaminated than studies trying to disentangle policy from the 2020 pandemic.

At present, only a handful of other countries currently have T-21 laws: Ethiopia, Honduras, Philippines, Sri Lanka, and Uganda (Tobacco Control Laws 2020). In considering the external validity of our estimates, the United States has far lower smoking rates than other OECD countries (Greenhalg et al 2015). Thus, the comparative health benefits of effective T-21 laws in countries with higher rates of youth smoking may be larger.

More generally, the effects of T-21 laws may also depend upon other policies which interact with T-21 laws, including local tobacco prices. Moreover, most states and cities routinely use auditing programs to verify compliance with age restrictions. The level of compliance might vary depending on the size of local markets, the risk of audits, and the ensuing fines. Avoidance may take other forms as well. Prior research has demonstrated cross-state border shopping or using the internet to avoid local sales taxes (Merriman 2010; Goolsbee et al. 2010). With regard to T-21, we might expect youth to use technology and false IDs to avoid laws that restrict access to tobacco. Indeed, while the "terms and conditions" of many tobacco-selling websites state they expect people purchasing products to be over 21, most do not ask for proof of age. This may reduce the effective shadow price of these laws in the United States, and in other countries where T-21 laws may be implemented in the future.

Finally, while T-21 laws may be perceived as a public health success, it appears to have come at a cost. Many have argued that U.S.-based tobacco companies endorsed T-21 legislation to avoid regulation of flavored tobacco products (Myers 2019). Revealed preference by such firms would

suggest the benefits of the high MLPA likely came at the expense of continued unregulated flavored e-cigarettes. This even more apparent with the explosion of e-cigarette use rates among youth, which some have attributed to JuuL products containing high nicotine content, appealing flavors, and the ability to easily be concealed (FDA 2018).

Tobacco companies may have been willing to lose sales from 18-to-20-year-old smokers in the hope of retaining additional current and future smokers through flavored e-cigarettes. The Tobacco Master Settlement Agreement (MSA) is over two decades old. Just as a dramatic shift from traditional cigarette sales to e-cigarette sales has occurred, advertising and targeting to youth has evolved to incorporate social media and distribution has shifted to online markets. With this in mind, for T-21 laws to have maximum benefits in the long run, public health experts and policymakers will need to be better understand the types of new tobacco regulations or restrictions that might complement these laws intended to limit access at the lowest social cost.

References

Abouk, R., & Adams, S. (2017). Bans on electronic cigarette sales to minors and smoking among high school students. *Journal of Health Economics*, *54*, 17-24.

Addicott, M. A. (2020). Tobacco addiction: cognition, reinforcement, and mood. In *Cognition and Addiction* (pp. 129-141). Academic Press.

Ahmad, S. (2005). Closing the youth access gap: the projected health benefits and cost savings of a national policy to raise the legal smoking age to 21 in the United States. *Health Policy*, *75*(1), 74-84.

Ali, F. R. M., Rice, K., Fang, X., & Xu, X. (2020). Tobacco 21 policies in California and Hawaii and sales of cigarette packs: a difference-in-differences analysis. *Tobacco Control*, *29*(5), 588-592.

Ali, M. K., & Koplan, J. P. (2010). Promoting health through tobacco taxation. *JAMA*, *303*(4), 357-358.

Aliferes, Lisa. (2016, May 4). *Gov. Brown signs Major Tobacco Bills, Raises Legal Age to 21*. KQED. https://www.kqed.org/stateofhealth/180422/gov-brown-signs-major-tobacco-bills-raises-legal-age-to-21

Alston, L. J., Dupré, R., & Nonnenmacher, T. (2002). Social reformers and regulation: the prohibition of cigarettes in the United States and Canada. *Explorations in Economic History*, *39*(4), 425-445.

American Academy of Pediatrics. (2015, October 26). *The American Academy of Pediatrics Issues Sweeping Recommendations on Tobacco and E-Cigarettes* [Press release]. https://tobacco21.org/wp-content/uploads/2015/10/aap.org-The-American-Academy-of-Pediatrics-Issues-Sweeping-Recommendations-on-Tobacco-and-E-Cigarettes.pdf

American Heart Association. (2019, May 20). *McConnell-Kaine bill would increase tobacco sales age to 21 nationally.* https://newsroom.heart.org/news/mcconnell-kaine-bill-would-increase-tobacco-sales-age-to-21-nationally

American Lung Association. (2020, February 26). *Tobacco 21 is the Law of the Land.* Retrieved March 30, 2020, from https://www.lung.org/policy-advocacy/tobacco/prevention/tobacco-21-laws

American Medical Association. (2020). *E-cigarettes and vaping: A public health epidemic.* https://www.ama-assn.org/delivering-care/public-health/e-cigarettes-and-vaping-public-health-epidemic

American Public Health Association. (2019, April 16). *APHA Applauds Reversing the Youth Tobacco Epidemic Act of 2019* [Press release]. https://www.apha.org/news-and-media/news-releases/apha-news-releases/2019/tobacco-legislation

American Public Health Association. (2020). *Tobacco*. https://www.apha.org/topics-and-issues/tobacco

Anderson, D. Mark, Kyutaro Matsuzawa & Joseph J. Sabia. (2020). "Cigarette Taxes and Teen Marijuana Use," *National Tax Journal* 73(2): 475-510.

Azagba, S., Baskerville, N. B., & Minaker, L. (2015). A comparison of adolescent smoking initiation measures on predicting future smoking behavior. *Preventive Medicine Reports*, *2*, 174-177.

Baker, Andrew; Larcker, David F., and Charles C.Y. Wang. (2021). "How Much Should We Trust Staggered Difference-In-Differences Estimates?" Working Paper. Available at SSRN: http://dx.doi.org/10.2139/ssrn.3794018

Bergal, J. (2017, August 18). Oregon raises cigarette buying age to 21. *The Washington Post*. https://www.washingtonpost.com/national/health-science/oregon-raises-cigarette-buying-age-to-21/2017/08/18/83366b7a-811e-11e7-902a-2a9f2d808496_story.html

Boettiger, D. C., & White, J. S. (2020). Cigarette Pack Prices and Sales Following Policy Changes in California, 2011–2018. *American Journal of Public Health*, (0), e1-e4.

Bonnie, R. J., Stratton, K., & Kwan, L. Y. (Eds.). (2015). *Public health implications of raising the minimum age of legal access to tobacco products*. Washington, DC: National Academies Press.

Borio, G. (1997). *Tobacco Timeline*. The University of Dayton School of Law. Retrieved March 18, 2020, from http://academic.udayton.edu/health/syllabi/tobacco/history2.htm

Buchmueller, T. C., DiNardo, J., & Valletta, R. G. (2011). The effect of an employer health insurance mandate on health insurance coverage and the demand for labor: Evidence from Hawaii. *American Economic Journal: Economic Policy*, *3*(4), 25-51.

Campaign for Tobacco-Free Kids. (2019, December 11). *Tobacco Provisions in Congressional Health Bill Won't Stop the Youth E-Cigarette Epidemic – It's Critical to Eliminate the Flavored Products that Lure Kids* [Press release]. https://www.tobaccofreekids.org/press-releases/2019_12_11_congress_health_bill

Campaign for Tobacco Free Kids. (2020). *Tobacco control laws*. https://www.tobaccocontrollaws.org/legislation/finder/

Caponnetto, P., Saitta, D., Sweanor, D., & Polosa, R. (2015). What to consider when regulating electronic cigarettes: pros, cons and unintended consequences. *International Journal of Drug Policy*, *26*(6), 554-559.

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.

Carpenter, C., & Dobkin, C. (2011). The minimum legal drinking age and public health. *Journal of Economic Perspectives*, *25*(2), 133-56.

Chaloupka, Frank, Rosalie Pacula, Matthew Farrelly, Lloyd Johnston, Patrick O'Malley, and Jeremy Bray. (1999). "Do Higher Cigarette Prices Encourage Youth to Use Marijuana?" NBER Working Paper No. 6939.

Cengiz, Doruk; Dube, Arindrajit; Lindner, Attila, and Ben Zipperer. (2019). "The Effect of Minimum Wages on Low-Wage Jobs." *The Quarterly Journal of Economics*, 134(3): 1405-1454.

Crettez, B., & Deloche, R. (2020). Time-inconsistent preferences and the minimum legal tobacco consuming age. *Rationality and Society*, 1043463120964604.

Cullen, K. A., Gentzke, A. S., Sawdey, M. D., Chang, J. T., Anic, G. M., Wang, T. W., ... & King, B. A. (2019). E-cigarette use among youth in the United States, 2019. *JAMA*, *322*(21), 2095-2103.

Dave, D., Dench, D., Grossman, M., Kenkel, D. S., & Saffer, H. (2019a). Does e-cigarette advertising encourage adult smokers to quit? *Journal of Health Economics*, *68*, 102227.

Dave, D., Feng, B., & Pesko, M. F. (2019b). The effects of e-cigarette minimum legal sale age laws on youth substance use. *Health Economics*, *28*(3), 419-436.

Decker, S. L., & Schwartz, A. E. (2000). Cigarettes and alcohol: substitutes or complements? *National Bureau of Economic Research* Working Paper No. 7535.

DiFranza, J. R., & Dussault, G. F. (2005). The federal initiative to halt the sale of tobacco to children—the Synar Amendment, 1992–2000: lessons learned. *Tobacco Control*, *14*(2), 93-98.

Dutra, L. M., Glantz, S. A., Arrazola, R. A., & King, B. A. (2018). Impact of e-cigarette minimum legal sale age laws on current cigarette smoking. *Journal of Adolescent Health*, *62*(5), 532-538.

Eriksen, M., & Chaloupka, F. (2007). The economic impact of clean indoor air laws. *CA: A Cancer Journal for Clinicians*, *57*(6), 367-378.

Ertan Yörük, C., & Yörük, B. K. (2016). Do minimum legal tobacco purchase age laws work?. *Contemporary Economic Policy*, *34*(3), 415-429.

Everett, S. A., Husten, C. G., Kann, L., Warren, C. W., Sharp, D., & Crossett, L. (1999). Smoking initiation and smoking patterns among US college students. *Journal of American College Health*, *48*(2), 55-60.

Everett, S. A., Warren, C. W., Sharp, D., Kann, L., Husten, C. G., & Crossett, L. S. (1999). Initiation of cigarette smoking and subsequent smoking behavior among US high school students. *Preventive Medicine*, *29*(5), 327-333.

Faber, T., Kumar, A., Mackenbach, J. P., Millett, C., Basu, S., Sheikh, A., & Been, J. V. (2017). Effect of tobacco control policies on perinatal and child health: a systematic review and meta-analysis. *The Lancet Public Health*, *2*(9), e420-e437.

Farrelly, Matthew C., Jeremy W. Bray, Gary A. Zarkin, and Brett W. Wendling. (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.

Friedman, Abigail S. (2015). How does electronic cigarette access affect adolescent smoking? *Journal of Health Economics* 44, 300-308.

Friedman, A. S., Buckell, J., & Sindelar, J. L. (2019). Tobacco-21 laws and young adult smoking: quasi-experimental evidence. *Addiction*, *114*(10), 1816-1823.

Friedman, A. S., & Wu, R. J. (2020). Do local tobacco-21 laws reduce smoking among 18 to 20 year-olds? *Nicotine and Tobacco Research*, *22*(7), 1195-1201.

Gardner, John. (2021). "Two-stage differences in differences." Working Paper. Available at: https://jrgcmu.github.io/2sdd_current.pdf

Gentzke, A. S., Creamer, M., Cullen, K. A., Ambrose, B. K., Willis, G., Jamal, A., & King, B. A. (2019). Vital signs: tobacco product use among middle and high school students—United States, 2011–2018. *Morbidity and Mortality Weekly Report*, *68*(6), 157.

Goodman-Bacon, Andrew. (2021). "Difference-in-Differences with Variation in Treatment Timing." Forthcoming, *Journal of Econometrics*.

Goolsbee, A., Lovenheim, M. F., & Slemrod, J. (2010). Playing with fire: Cigarettes, taxes, and competition from the internet. *American Economic Journal: Economic Policy*, *2*(1), 131-54.

Greenhalgh, E. M., Bayly, M., & Winstanley, M. H. (2015). 1.3 Prevalence of smoking—adults. *Tobacco in Australia: facts and issues. Melbourne: Cancer Council Victoria.*

Gruber, J., & Köszegi, B. (2001). Is addiction "rational"? Theory and evidence. *The Quarterly Journal of Economics*, 116(4), 1261-1303.

Hall, W., & Doran, C. (2016). How much can the USA reduce health care costs by reducing smoking?. *PLoS Medicine*, *13*(5), e1002021.

Hansen, B., Sabia, J. J., & Rees, D. I. (2017). Have cigarette taxes lost their bite? New estimates of the relationship between cigarette taxes and youth smoking. *American Journal of Health Economics*, *3*(1), 60-75.

Hatsukami, D. K., Stead, L. F., & Gupta, P. C. (2008). Tobacco addiction. *The Lancet*, *371*(9629), 2027-2038.

Hegmann, K. T., Fraser, A. M., Keaney, R. P., Moser, S. E., Nilasena, D. S., Sedlars, M., ... & Lyon, J. L. (1993). The effect of age at smoking initiation on lung cancer risk. *Epidemiology*, 444-448.

Howard, J. (2019). *The US officially raises the tobacco buying age to 21.* CNN. https://www.cnn.com/2019/12/27/health/us-tobacco-age-21-trnd/index.html

Huang, J., Duan, Z., Kwok, J., Binns, S., Vera, L. E., Kim, Y., ... & Emery, S. L. (2019). Vaping versus JUULing: how the extraordinary growth and marketing of JUUL transformed the US retail e-cigarette market. *Tobacco Control*, *28*(2), 146-151.

Jankowski, M., Brozek, G., Lawson, J., Skoczynski, S., & Zejda, J. E. (2017). E-smoking: Emerging public health problem?. *International Journal of Occupational Medicine and Environmental Health*, *30*(3), 329.

Jha, P., Chaloupka, F. J., Moore, J., Gajalakshmi, V., Gupta, P. C., Peck, R., ... & Zatonski, W. (2006). Tobacco addiction. In *Disease Control Priorities in Developing Countries. 2nd edition*. The International Bank for Reconstruction and Development/The World Bank.

Khuder, S. A., Dayal, H. H., & Mutgi, A. B. (1999). Age at smoking onset and its effect on smoking cessation. *Addictive Behaviors*, *24*(5), 673-677.

Lakdawala, L. K., & Simon, D. (2017). The Intergenerational Consequences of Tobacco Policy: A Review of Policy's Influence on Maternal Smoking and Child Health. *Southern Economic Journal*, *84*(1), 229-274.

Lantz, P. M., Jacobson, P. D., Warner, K. E., Wasserman, J., Pollack, H. A., Berson, J., & Ahlstrom, A. (2000). Investing in youth tobacco control: a review of smoking prevention and control strategies. *Tobacco Control*, *9*(1), 47-63.

Laux, F. L. (2000). Addiction as a market failure: using rational addiction results to justify tobacco regulation. *Journal of Health Economics*, *19*(4), 421-437.

Lillard, D. R., Molloy, E., & Sfekas, A. (2013). Smoking initiation and the iron law of demand. *Journal of Health Economics*, *32*(1), 114-127.

Males, M. (2016, March 11). Why a 'smoking age of 21' is a bad idea. *Los Angeles Times*. https://www.latimes.com/opinion/op-ed/la-oe-0313-males-teen-smoking-20160313-story.html

Maloney, J. (2019, December 19). U.S. Raises Tobacco-Buying Age to 21. *The Wall Street Journal*. https://www.wsj.com/articles/u-s-raises-tobacco-buying-age-to-21-11576796159

Mensik, H. (2018, June 8). Bill to raise smoking age would hurt convenience stores, vape shops, retailers say. *Chicago Tribune*. https://www.chicagotribune.com/business/ct-biz-illinois-tobacco-vape-21-story.html

Merriman, D. (2010). The micro-geography of tax avoidance: evidence from littered cigarette packs in Chicago. *American Economic Journal: Economic Policy*, *2*(2), 61-84.

Morain, S. R., & Malek, J. (2017). Minimum age of sale for tobacco products and electronic cigarettes: ethical acceptability of US "tobacco 21 laws". *American Journal of Public Health*, *107*(9), 1401-1405.

Morris, Philip. (1986, January 21). *Discussion Draft Sociopolitical Strategy*. Bates no. 2043440040-2043440049. http://legacy.library.ucsf.edu/tid/aba84e00

National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. (2012). Efforts to prevent and reduce tobacco use among young people. *Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General.* U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. https://www.ncbi.nlm.nih.gov/books/NBK99240/

National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. (2014). *The health consequences of smoking—50 years of progress: a report of the Surgeon General.* U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. https://www.hhs.gov/sites/default/files/consequences-smoking-exec-summary.pdf

National Center for Chronic Disease Prevention and Health Promotion, Office and Smoking and Health. (2019). *Youth and tobacco use.* U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/youth_data/tobacco_use/index.htm

Nowakowski, A. C. (2020). Brave New Lungs: Aging in the Shadow of COVID-19. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*.

O'Donoghue, T., & Rabin, M. (2001). Risky behavior among youths: Some issues from behavioral economics. In *Risky Behavior Among Youths: An Economic Analysis* (pp. 29-68). University of Chicago Press.

Office of Majority Leader Mitch McConnell. (2019, April 18). *McConnell Announces Bill to Raise Minimum Age to Purchase Tobacco 21* [Press release]. https://www.mcconnell.senate.gov/public/index.cfm/pressreleases?ID=C7912202-0742-4404-8775-8836F261DDEF

Pacula, Rosalie. (1998a). "Does Increasing the Beer Tax Reduce Marijuana Consumption?" *Journal of Health Economics* 17(5): 557-585.

Pacula, Rosalie. (1998b). "Adolescent Alcohol and Marijuana Consumption: Is There Really a Gateway Effect?" NBER Working Paper No. 6348.

Pesko, M. F., & Currie, J. M. (2019). E-cigarette minimum legal sale age laws and traditional cigarette use among rural pregnant teenagers. *Journal of Health Economics*, *66*, 71-90.

Pesko, M. F., Hughes, J. M., & Faisal, F. S. (2016). The influence of electronic cigarette age purchasing restrictions on adolescent tobacco and marijuana use. *Preventive Medicine*, *87*, 207-212.

Price, S. (2020, February 3). *Texas 21 Pushes to Raise the Age for Tobacco Sales.* Texas Medical Association. Retrieved March 31, 2020, from https://www.texmed.org/Template.aspx?id=50016

Reynolds, M. J., Crane, R., & Winickoff, J. P. (2019). The Emergence of the Tobacco 21 Movement From Needham, Massachusetts, to Throughout the United States (2003–2019). *American Journal of Public Health*, *109*(11), 1540-1547.

Robalino, J. D., & Macy, M. (2018). Peer effects on adolescent smoking: Are popular teens more influential?. PloS one, 13(7), e0189360.

Romer, D. (2010). Adolescent risk taking, impulsivity, and brain development: Implications for prevention. Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology, 52(3), 263-276.

Schiff, S., Liu, F., Cruz, T. B., Unger, J. B., Cwalina, S., Leventhal, A., ... & Barrington-Trimis, J. (2020). E-cigarette and cigarette purchasing among young adults before and after implementation of California's tobacco 21 policy. *Tobacco Control.* http://dx.doi.org/10.1136/tobaccocontrol-2019-055417

Schneider, S. K., Buka, S. L., Dash, K., Winickoff, J. P., & O'Donnell, L. (2016). Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tobacco Control*, *25*(3), 355-359.

Schroeder, S. A. (2004). Tobacco control in the wake of the 1998 master settlement agreement. *New England Journal of Medicine*, *350*(3), 293-301.

Silver, D., Macinko, J., Giorgio, M., Bae, J. Y., & Jimenez, G. (2016). Retailer compliance with tobacco control laws in New York City before and after raising the minimum legal purchase age to 21. *Tobacco Control*, *25*(6), 624-627.

Smith, H. E. (1914). *The United States federal internal tax history from 1861 to 1871.* Boston, Houghton Mifflin Company. https://babel.hathitrust.org/cgi/pt?id=uc1.$b279462&view=1up&seq=213#

Steinberg, M. B., & Delnevo, C. D. (2013). Increasing the "smoking age": the right thing to do. *Annals of Internal Medicine. 159*(8), 558-559. https://doi.org/10.7326/0003-4819-159-8-201310150-00695

Stroud, L. (2016, April 26). *States Should Not Increase Tobacco Use Age to 21.* InsideSources. https://www.insidesources.com/states-should-not-increase-tobacco-use-age-to-21/

Tauras, J. A., & Chaloupka, F. J. (1999). *Price, clean indoor air, and cigarette smoking: Evidence from the longitudinal data for young adults* (No. w6937). National Bureau of Economic Research.

Tauras, J. A., Chaloupka, F. J., Farrelly, M. C., Giovino, G. A., Wakefield, M., Johnston, L. D., ... & Pechacek, T. F. (2005). State tobacco control spending and youth smoking. *American Journal of Public Health*, *95*(2), 338-344.

Tobacco Merchants Association. (1971, March 29). *Special report: 47 states prohibit sales of cigarettes to minors and most ban sales of other tobacco products.* Tobacco Institute. Bates no. TI54762520. Retrieved April 22, 2020, from https://www.industrydocuments.ucsf.edu/docs/lyjw0043

U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality. (2014). *National Survey on Drug Use and Health* (ICPSR 36361; Version V1; March 22, 2016) [Data set]. Ann Arbor, MI: ICPSR. https://doi.org/10.3886/ICPSR36361.v1

U.S. Food and Drug Administration. (2018). *NYTS Data: A Startling Rise in Youth E-cigarette Use.* U.S. Department of Health and Human Services. https://www.fda.gov/tobacco-products/youth-and-tobacco/2018-nyts-data-startling-rise-youth-e-cigarette-use

Viscusi, W. K. (2016). Risk Beliefs and Preferences for E-cigarettes. *American Journal of Health Economics*, *2*(2), 213-240.

Wang, T. W., Gentzke, A. S., Creamer, M. R., Cullen, K. A., Holder-Hayes, E., Sawdey, M. D., ... & Jamal, A. (2019). Tobacco product use and associated factors among middle and high school students—United States, 2019. *MMWR Surveillance Summaries*, *68*(12), 1.

Winickoff, J. P., Hartman, L., Chen, M. L., Gottlieb, M., Nabi-Burza, E., & DiFranza, J. R. (2014). Retail impact of raising tobacco sales age to 21 years. *American Journal of Public Health*, *104*(11), e18-e21.

Yan, J. (2014). The effects of a minimum cigarette purchase age of 21 on prenatal smoking and infant health. *Eastern Economic Journal*, *40*(3), 289-308.

Yörük, B. K., & Yörük, C. E. (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.

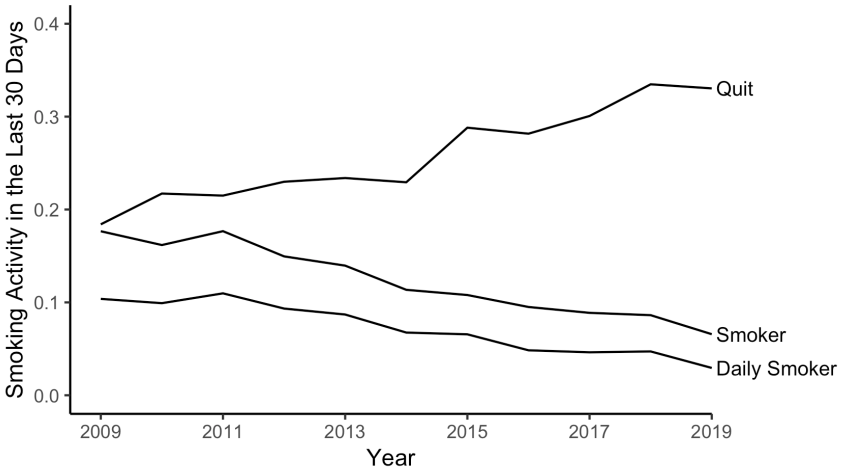
Yörük, C., & Yörük, B. K. (2016). Do minimum legal tobacco purchase age laws work? *Contemporary Economic Policy*, 34(3), 415-429.

Tables and Figures

Figure 1. Enactment of State Tobacco 21 (T-21) Laws Prior to Federal T-21 Mandate

Source: Preventing Tobacco Addiction Foundation, available at: https://tobacco21.org/

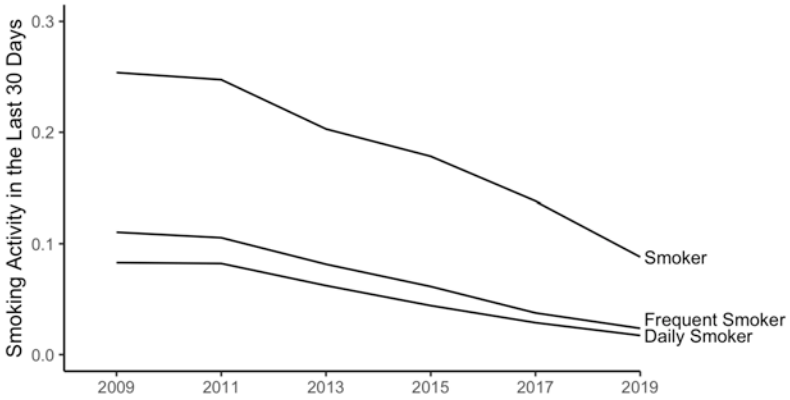
Figure 2. Current Tobacco Cigarette Smoking Behavior Among 18-to-20-Year-Olds, 2009-2019 BRFSS



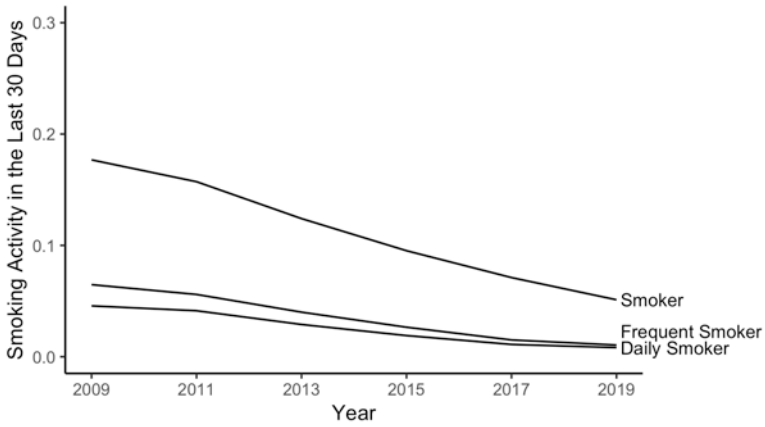
Data Source: 2009-2019 BRFSS

Figure 3. Prior 30-Day Tobacco Cigarette Smoking Behavior Among 18-Year-Olds and Minor Teens, 2009-2019 YRBS

Panel (a): 18-Year-Olds



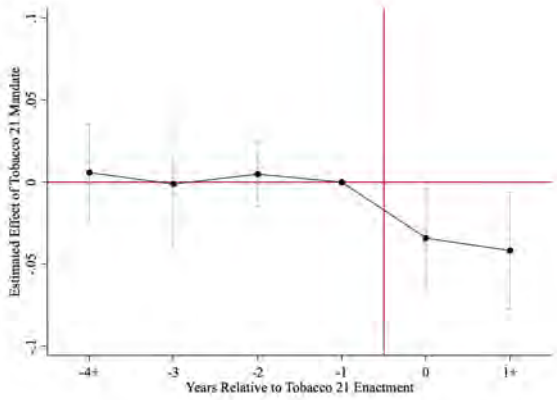
Panel (b): 16-to-17-Year-Olds



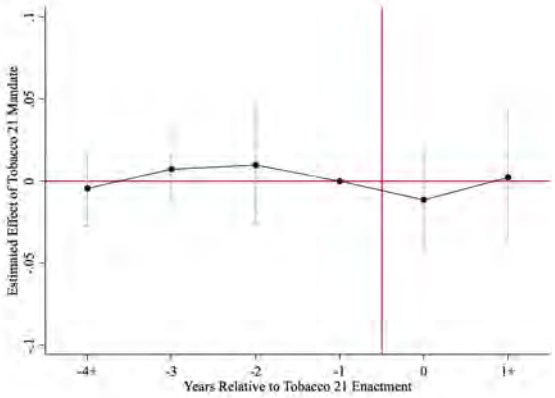
Notes: Data Source 2009-2019 State YRBS

Figure 4. Event-Study Analysis (DD Logit Models), Smoking Participation, 18-to-20-Year-Olds, BRFSS

Panel (a): Ages 18-to-20



Panel (b): Ages 21-to-23



Panel (c): 24-to-28

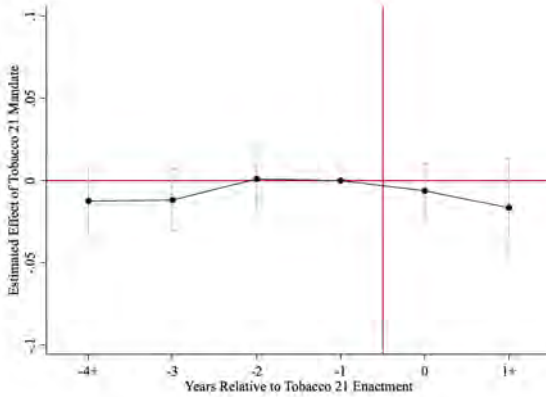
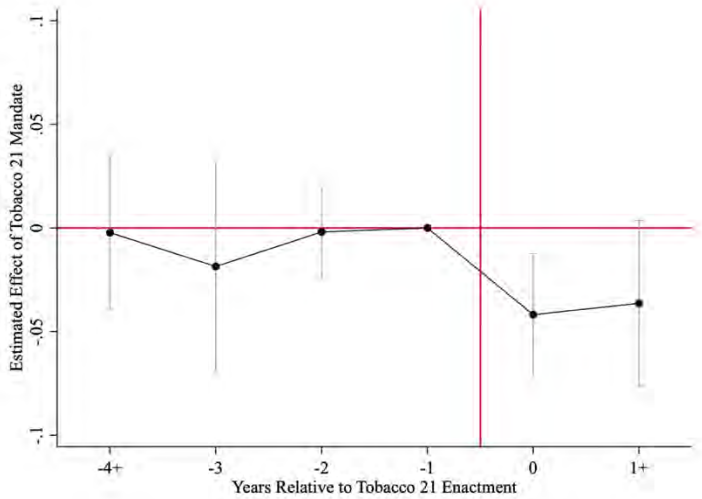
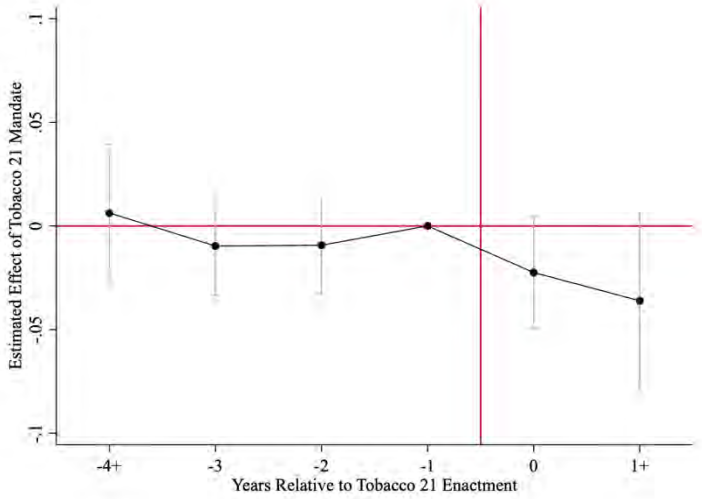


Figure 5. Event-Study Analysis Using Stacked DD Estimates

Panel (a): Unbalanced Event-Study



Panel (b): Balanced Event Study, Pre-2019 Treatment States



Panel (c): Balanced Event Study, All Treatment States

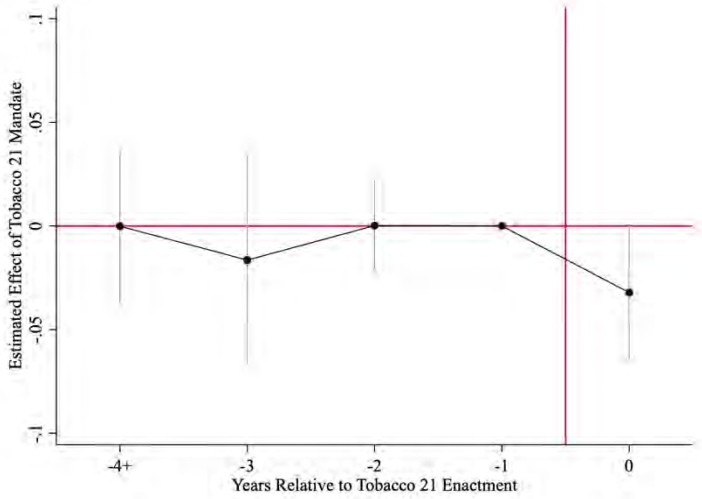


Figure 6. Event-Study Analysis (DDD Logit Models), Smoking Participation, 18-to-20-Year-Olds vs Older Young Adults, BRFSS

Ages 18-to-20 vs Ages 21-to-23

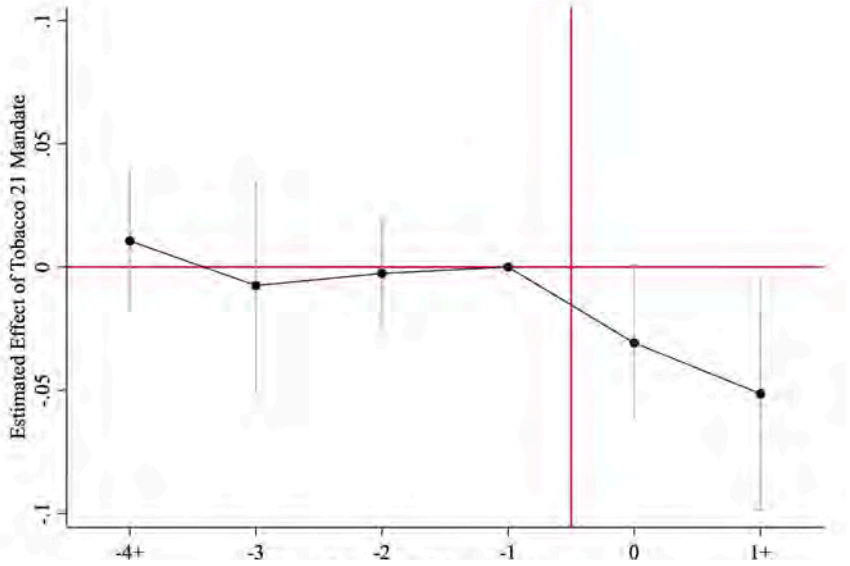
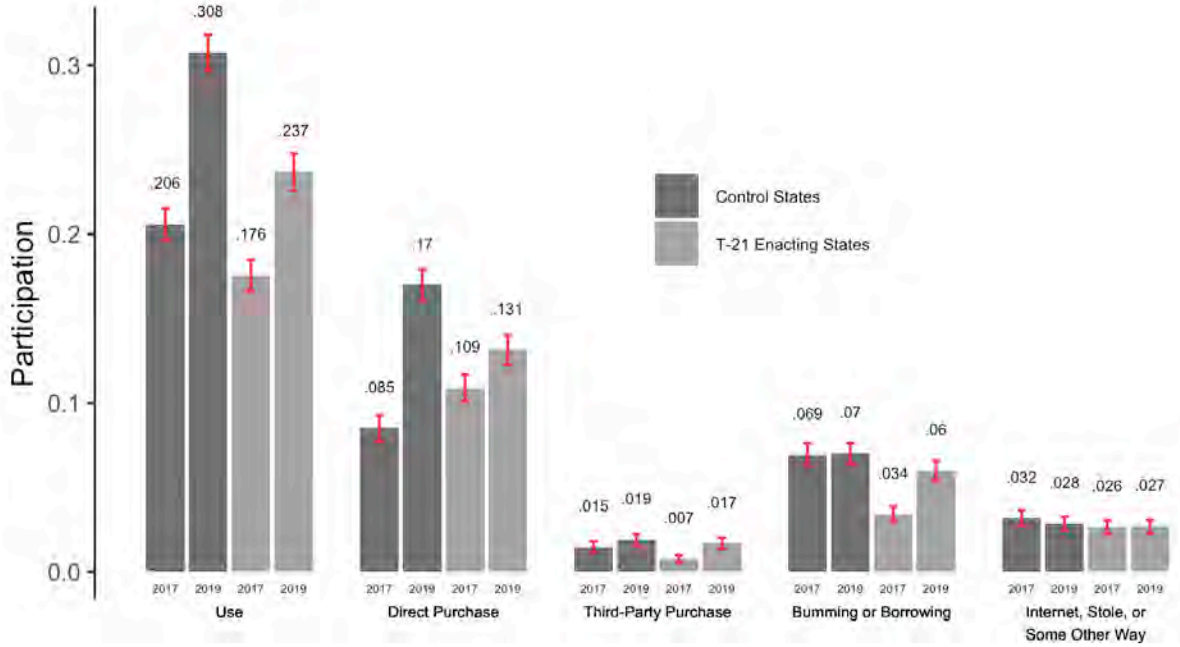


Figure 7. Descriptive Analysis, E-Cigarette Participation and Source, 18-Year-Olds, State YRBS, 2017-2019

Panel (a): E-Cigarette Use & Source



Panel (b): E-Cigarette Use & Source Among Males

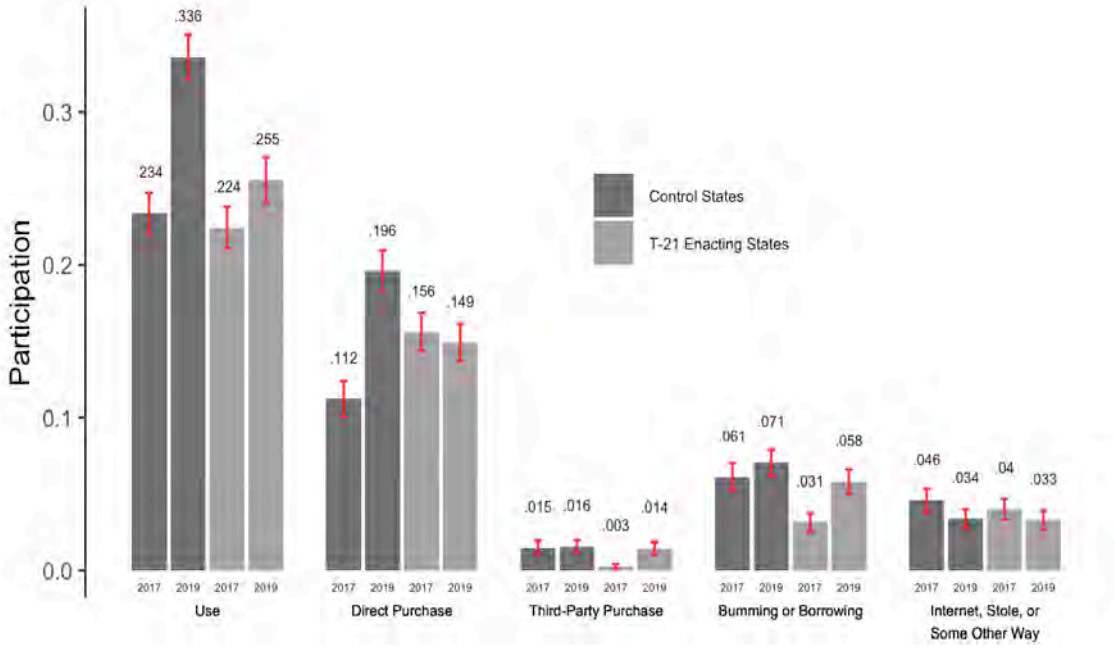


Figure 7 Continued. Descriptive Analysis, E-Cigarette Participation and Source, 18-Year-Olds, State YRBS, 2017-2019

Panel (c): E-Cigarette Use & Source Among E-Cigarette Users

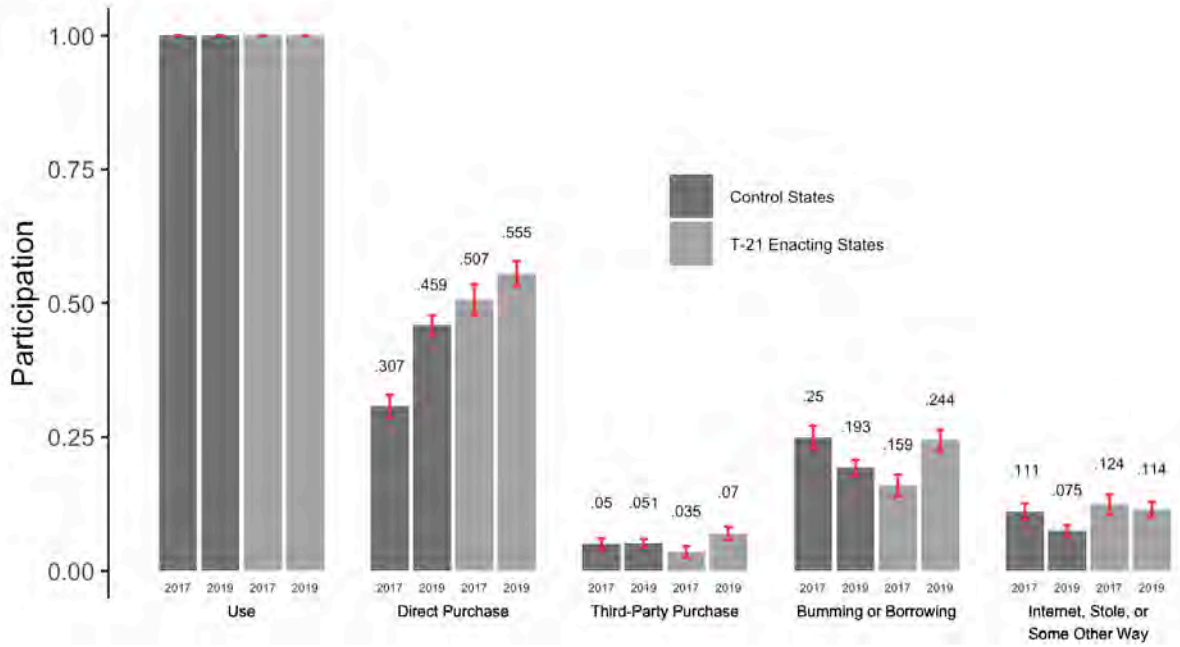


Table 2A. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Tobacco Cigarette Use Among 18-to-20-Year-Olds, BRFSS, 2009-2019

	(1)	(2)	(3)	(4)	(5)	(6)
	"TWFE" Logit Estimates			*"Stacked DD" Logit Estimates*		
	Panel I: Smoking Participation					
Tobacco 21 Law	-0.025**	-0.029**	-0.039***	-0.038***	-0.039***	-0.037***
	(0.012)	(0.012)	(0.011)	(0.010)	(0.010)	(0.009)
Pre-Treat DV Mean	0.115	0.115	0.115	0.083	0.083	0.083
Observations	95,557	95,557	95,557	434,153	434,153	434,153
	Panel II: Everyday Smoking					
Tobacco 21 Law	-0.016**	-0.020**	-0.024***	-0.012	-0.013*	-0.012*
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
Pre-Treat DV Mean	0.064	0.064	0.064	0.040	0.040	0.040
Observations	95,557	95,557	95,557	434,153	434,153	434,153
	Panel III: Quit					
Tobacco 21 Law	0.041	0.046	0.053	0.010	0.012	0.004
	(0.053)	(0.053)	(0.058)	(0.072)	(0.072)	(0.073)
Pre-Treat DV Mean	0.259	0.259	0.259	0.305	0.305	0.305
Observations	16,726	16,726	16,726	67,844	67,844	67,844
Demographic Controls?	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y	Y
E-cigarette Polices?		Y	Y		Y	Y
Alcohol and Marijuana Policies?			Y			Y

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

Notes: Weighted "TWFE" logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. "Stacked DD" logit estimates include stack-specific state FE and time FE and include controls for each of the variables described above. Each treatment state cohort (those states that enacted a T-21 law in the same year-month) includes four years of lead data and up to one year of lagged data. All regressions are weighted and standard errors are clustered at the state-level.

Table 2B. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Tobacco Cigarette Use Among Adults Ages 21-to-28, BRFSS, 2009-2019

	(1)	(2)	(3)	(4)	(5)	(6)
	Ages 21-to-23			*Ages 24-to-28*		
	Panel I: Smoking Participation					
Tobacco 21 Law	0.002	-0.0005	-0.008	-0.001	-0.001	-0.005
	(0.014)	(0.014)	(0.014)	(0.007)	(0.007)	(0.008)
Pre-Treat DV Mean	0.181	0.181	0.181	0.214	0.214	0.214
Observations	103,701	103,701	103,701	201,827	201,827	201,827
	Panel II: Everyday Smoking					
Tobacco 21 Law	0.006	0.005	0.002	-0.009	-0.011	-0.011
	(0.010)	(0.010)	(0.011)	(0.007)	(0.007)	(0.008)
Pre-Treat DV Mean	0.109	0.109	0.109	0.132	0.132	0.132
Observations	103,701	103,701	103,701	201,827	201,827	201,827
	Panel III: Quit					
Tobacco 21 Law	0.025	0.026	0.034	0.012	0.011	0.020
	(0.032)	(0.032)	(0.032)	(0.021)	(0.021)	(0.023)
Pre-Treat DV Mean	0.305	0.305	0.305	0.369	0.369	0.369
Observations	28,570	28,570	28,570	71,756	71,756	71,756
Demographic Controls?	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y	Y
E-cigarette Polices?		Y	Y		Y	Y
Alcohol and Marijuana Policies?			Y			Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Table 3. "Difference-in-Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Tobacco Cigarette Use, BRFSS, 2009-2019

	(1)	(2)	(3)	(4)	(5)	(6)
	Ages 18-to-20 vs Ages 21-to-23			*Ages 18-to-20 vs Ages 24-to-28*		
			Panel I: Smoking Participation			
Tobacco 21 Law	0.001	-0.000	-0.007	-0.001	-0.001	-0.004
	(0.012)	(0.012)	(0.012)	(0.006)	(0.006)	(0.007)
Tobacco 21 Law *18-to- 20	-0.031***	-0.034***	-0.040***	-0.032*	-0.038**	-0.048***
	(0.011)	(0.011)	(0.012)	(0.017)	(0.016)	(0.016)
Pre-Treat DV Mean	0.115	0.115	0.115	0.115	0.115	0.115
Observations	199,258	199,258	199,258	297,384	297,384	297,384
			Panel II: Everyday Smoking			
Tobacco 21 Law	0.005	0.004	0.002	-0.008	-0.009	-0.009
	(0.009)	(0.009)	(0.009)	(0.006)	(0.006)	(0.006)
Tobacco 21 Law *18-to- 20	-0.025**	-0.029***	-0.032***	-0.016	-0.020	-0.026*
	(0.011)	(0.011)	(0.012)	(0.013)	(0.013)	(0.014)
Pre-Treat DV Mean	0.064	0.064	0.064	0.064	0.064	0.064
Observations	199,258	199,258	199,258	297,384	297,384	297,384
			Panel III: Quit			
Tobacco 21 Law	0.024	0.024	0.032	0.012	0.010	0.019
	(0.030)	(0.030)	(0.031)	(0.020)	(0.020)	(0.022)
Tobacco 21 Law *18-to- 20	0.020	0.025	0.025	0.036	0.043	0.042
	(0.038)	(0.037)	(0.042)	(0.056)	(0.055)	(0.063)
Pre-Treat DV Mean	0.259	0.259	0.259	0.259	0.259	0.259
Observations	45,296	45,296	45,296	88,482	88,482	88,482
Demographic Controls?	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y	Y
E-cigarette Polices?		Y	Y		Y	Y
Alcohol and Marijuana Policies?			Y			Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Table 4. Heterogeneity in the Effects of Tobacco 21 Laws, by Age

	(1)	(2)	(3)	(4)	(5)	(6)
	DD	*DDD*	*DDD*	*DD*	*DDD*	*DDD*
	Age 18	*Age 18 vs. Age 21-to-23*	*Age 18 vs. Age 24-to-28*	*Ages 19-to-20*	*Age 19-to-20 vs. Age 21-to-23*	*Age 19-to-20 vs. Age 24-to-28*
			Panel I: Smoking Participation			
Tobacco 21 Law	-0.074***	-0.060***	-0.076***	-0.027**	-0.015**	-0.017
	(0.017)	(0.014)	(0.016)	(0.014)	(0.007)	(0.011)
Pre-Treat DV Mean	0.094	0.094	0.094	0.127	0.127	0.127
Observations	33,399	137,100	235,226	62,158	165,859	263,985
			Panel II: Everyday Smoking			
Tobacco 21 Law	-0.045***	-0.080***	-0.101***	-0.020**	-0.015**	-0.018**
	(0.013)	(0.014)	(0.018)	(0.010)	(0.007)	(0.008)
Pre-Treat DV Mean	0.052	0.052	0.052	0.071	0.071	0.071
Observations	33,399	137,100	235,226	62,158	165,859	263,985
			Panel III: Quit			
Tobacco 21 Law	0.019	-0.042	-0.046	0.064	-0.007	0.003
	(0.118)	(0.091)	(0.097)	(0.072)	(0.025)	(0.036)
Pre-Treat DV Mean	0.219	0.219	0.219	0.276	0.276	0.276
Observations	4,292	32,862	76,048	12,434	41,004	84,190
Demographic Controls?	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y	Y
E-cigarette Polices?	Y	Y	Y	Y	Y	Y
Alcohol and Marijuana Policies?	Y	Y	Y	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Table 5. Heterogeneity in the Effects of Tobacco 21 Laws, by Demographic Group

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Male	*Female*	*White*	*Black*	*Other*	*HSD*	*No HSD*	*Below Poverty Line*	*Above Poverty Line*
					Panel I: Smoking Participation				
Tobacco 21 Law	-0.034**	-0.045**	-0.056**	-0.064**	-0.015	-0.033***	-0.084**	-0.053**	-0.034***
	(0.015)	(0.018)	(0.024)	(0.032)	(0.019)	(0.010)	(0.034)	(0.024)	(0.010)
Pre-Treat DV Mean	0.137	0.090	0.146	0.084	0.088	0.101	0.193	0.152	0.101
Observations	51,081	44,440	59,180	9,434	26,904	83,536	12,021	25,362	70,195
					Panel II: Everyday Smoking				
Tobacco 21 Law	-0.016*	-0.034**	-0.045**	-0.089*	0.005	-0.018*	-0.063	0.000	-0.031***
	(0.009)	(0.015)	(0.019)	(0.050)	(0.011)	(0.009)	(0.039)	(0.024)	(0.010)
Pre-Treat DV Mean	0.073	0.054	0.091	0.046	0.038	0.052	0.127	0.084	0.057
Observations	51,081	44,440	59,166	9,208	26,904	83,536	12,021	25,362	70,195
					Panel III: Quit				
Tobacco 21 Law	0.031	0.102	0.094	0.072	0.028	0.050	0.097	0.016	0.059
	(0.067)	(0.069)	(0.087)	(0.178)	(0.055)	(0.063)	(0.076)	(0.074)	(0.060)
Pre-Treat DV Mean	0.253	0.271	0.239	0.253	0.297	0.285	0.176	0.252	0.264
Observations	9,992	6,724	11,478	882	4,315	13,395	3,328	5,739	10,976
Demographic Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
E-cigarette Polices?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Alcohol/Marijuana Policies?	Y	Y	Y	Y	Y	Y	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Table 6. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Tobacco Use Among 18-Year-Olds, YRBS, 2009-2019

	(1)	(2)	(3)	(4)	(5)	(6)
	"TWFE" Logit Estimate			*"Stacked DD" Logit Estimate*		
	Panel I: Smoking Participation					
Tobacco 21 Law	-0.021	-0.030*	-0.025	-0.018	-0.022	-0.009
	(0.017)	(0.016)	(0.016)	(0.022)	(0.021)	(0.019)
Pre-Treat DV Mean	0.209	0.209	0.209	0.197	0.197	0.197
Observations	87,612	87,612	87,612	121,972	121,972	121,972
	Panel II: Frequent Smoking					
Tobacco 21 Law	-0.069**	-0.069***	-0.065***	-0.036*	-0.036*	-0.034*
	(0.027)	(0.026)	(0.024)	(0.019)	(0.019)	(0.019)
Pre-Treat DV Mean	0.077	0.077	0.077	0.073	0.073	0.073
Observations	87,612	87,612	87,612	121,972	121,972	121,972
	Panel III: Everyday Smoking					
Tobacco 21 Law	-0.051**	-0.051**	-0.048*	-0.038*	-0.039*	-0.039
	(0.026)	(0.026)	(0.025)	(0.023)	(0.023)	(0.024)
Pre-Treat DV Mean	0.056	0.056	0.056	0.054	0.054	0.054
Observations	87,612	87,612	87,612	121,972	121,972	121,972
Demographic Controls?	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y	Y
E-cigarette Polices?		Y	Y		Y	Y
Alcohol and Marijuana Policies?			Y			Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and grade; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. "Stacked DD" logit estimates include stack-specific state FE and time FE and include controls for each of the variables described above. Each treatment state cohort (those states that enacted a T-21 law in the same year-month) includes four years of lead data and up to one year of lagged data. Regressions are weighted and standard errors are clustered at the state-level.

Table 7. Heterogeneity in Effects of Tobacco-21 Laws on 18-Year-Old High School Students, by Gender and Race, YRBS, 2009-2019

	(1)	(2)	(3)	(4)
	Male	*Female*	*White*	*Black*
			Panel I: Smoking Participation	
Tobacco 21 Law	-0.055**	0.009	-0.043	-0.066*
	(0.023)	(0.024)	(0.031)	(0.040)
Pre-Treat DV Mean	0.249	0.166	0.252	0.130
Observations	47,120	40,492	49,563	11,934
			Panel II: Frequent Smoking	
Tobacco 21 Law	-0.101**	-0.021	-0.113**	-0.045
	(0.041)	(0.031)	(0.052)	(0.052)
Pre-Treat DV Mean	0.096	0.056	0.112	0.051
Observations	47,120	40,295	49,495	11,845
			Panel III: Everyday Smoking	
Tobacco 21 Law	-0.072**	-0.021	-0.074*	-0.076*
	(0.034)	(0.049)	(0.043)	(0.043)
Pre-Treat DV Mean	0.070	0.041	0.083	0.040
Observations	47,120	40,295	49,495	11,845
Demographic Controls?	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y
E-cigarette Polices?	Y	Y	Y	Y
Alcohol & Marijuana Policies?	Y	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and grade; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Table 8. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Tobacco Use Among 16-to-17-Year-Olds, YRBS, 2009-2019

	(1)	(2)	(3)	(4)	(5)
	All	*Male*	*Female*	*White*	*Black*
			Panel I: Smoking Participation		
Tobacco 21 Law	-0.028*	-0.028	-0.028**	-0.035**	-0.024
	(0.014)	(0.020)	(0.014)	(0.017)	(0.027)
Pre-Treat DV Mean	0.135	0.151	0.118	0.164	0.068
Observations	440,145	214,478	225,667	248,547	59,343
			Panel II: Frequent Smoking		
Tobacco 21 Law	-0.011	-0.012	-0.014	-0.053**	-0.028
	(0.008)	(0.015)	(0.009)	(0.027)	(0.029)
Pre-Treat DV Mean	0.042	0.051	0.034	0.060	0.018
Observations	440,145	214,478	225,667	248,547	59,254
			Panel III: Everyday Smoking		
Tobacco 21 Law	-0.005	-0.006	-0.005	-0.040**	-0.006
	(0.005)	(0.011)	(0.007)	(0.019)	(0.025)
Pre-Treat DV Mean	0.031	0.038	0.024	0.045	0.014
Observations	440,145	214,478	225,667	248,547	59,254
Demographic Controls?	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y
E-cigarette Polices?	Y	Y	Y	Y	Y
Alcohol and Marijuana Policies?	Y	Y	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and grade; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Table 9. Estimates of the Effect of Tobacco 21 Laws on E-Cigarette Use and Usual Source of E-Cigarettes, YRBS

	(1)	(2)	(3)	(4)	(5)
	18-Year-Olds			*16-to-17-Year-Olds*	
	Panel I: E-Cigarette Participation				
Tobacco 21 Law	-0.081*	-0.117**	-0.063	0.090	0.083
	(0.042)	(0.047)	(0.047)	(0.062)	(0.064)
Pre-Treat DV Mean	0.243	0.176	0.176	0.126	0.126
	Panel II: Frequent E-Cigarette Use				
Tobacco 21 Law	-0.053*	-0.069	-0.073*	0.029	0.027
	(0.030)	(0.042)	(0.041)	(0.037)	(0.039)
Pre-Treat DV Mean	0.054	0.048	0.048	0.024	0.024
	Panel III: Everyday E-Cigarette Use				
Tobacco 21 Law	-0.052**	-0.058	-0.067*	0.034	0.029
	(0.024)	(0.036)	(0.037)	(0.035)	(0.035)
Pre-Treat DV Mean	0.043	0.037	0.037	0.014	0.014
	Panel IV: Usual Source of E-Cigarettes (Multinomial Logit)				
	Direct Purchase				
Tobacco 21 Law		-0.157***	-0.170***	0.030	0.047
	-	(0.029)	(0.041)	(0.029)	(0.035)
Pre-Treat DV Mean		0.109	0.109	0.018	0.018
	Third-Party Purchase				
Tobacco 21 Law		-0.018	-0.028*	0.020	0.002
	-	(0.014)	(0.016)	(0.021)	(0.023)
Pre-Treat DV Mean		0.007	0.007	0.014	0.014
	Borrowing				
Tobacco 21 Law		0.105	0.176**	0.063*	0.045
	-	(0.064)	(0.072)	(0.033)	(0.032)
Pre-Treat DV Mean		0.035	0.035	0.059	0.059
	Internet, Stole, or Some Other Way				
Tobacco 21 Law	-	0.007	-0.001	0.003	-0.007
		(0.047)	(0.050)	(0.007)	(0.010)
Pre-Treat DV Mean		0.026	0.026	0.025	0.025
Observations	42,324	23,110	23,110	125,657	125,657
Years	2015-19	2017-19	2017-19	2017-19	2017-19
Policy Controls?	Y	N	Y	N	Y

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

Notes: Panels I-III present weighted logit estimates. Panel IV presents weighted multinomial logit estimates. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and grade; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Table 10. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Marijuana Use Among 18-Year-Olds, 2009-2019 YRBS

	(1)	(2)	(3)
	Panel I: Marijuana Use		
Tobacco 21 Law	-0.035	-0.052***	-0.052***
	(0.022)	(0.020)	(0.019)
Pre-Treat DV Mean	0.276	0.276	0.276
Observations	86,563	86,563	86,563
	Panel II: Frequent Marijuana Use		
Tobacco 21 Law	-0.035**	-0.041**	-0.049***
	(0.018)	(0.019)	(0.019)
Pre-Treat DV Mean	0.129	0.129	0.129
Observations	86,563	86,563	86,563
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Tobacco Policy Controls?	Y	Y	Y
Marijuana Polices?		Y	Y
Alcohol Policies?			Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and educational attainment; economic controls include state unemployment rate and state per capita income, tobacco policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; marijuana policies indicators for legalized medical marijuana, and legalized recreational marijuana; alcohol controls include state beer tax. All regressions are weighted and standard errors are clustered at the state-level.

Table 11A. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Alcohol Use Among 18-Year-Olds, YRBS

	(1)	(2)	(3)
	All	*Males*	*Females*
		Panel I: Alcohol Use	
Tobacco 21 Law	0.052	0.045	0.060
	(0.049)	(0.045)	(0.064)
Pre-Treat DV Mean	0.460	0.477	0.442
Observations	81,283	43,669	37,614
	Panel II: Alcohol Use > 2 Days in Last 30 Days | Drinking = 1		
Tobacco 21 Law	-0.085*	-0.147**	-0.021
	(0.047)	(0.069)	(0.053)
Pre-Treat DV Mean	0.598	0.661	0.522
Observations	34,032	18,353	15,679
	Panel III: Binge Drinking		
Tobacco 21 Law	0.017	0.008	0.027
	(0.035)	(0.043)	(0.033)
Pre-Treat DV Mean	0.287	0.325	0.244
Observations	76,577	41,241	35,336
	Panel IV: Frequent Binge Drinking | Binge Drinking = 1		
Tobacco 21 Law	-0.100**	-0.097	-0.109*
	(0.045)	(0.065)	(0.060)
Pre-Treat DV Mean	0.222	0.244	0.188
Observations	19,254	11,218	8,036
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Tobacco Policy Controls?	Y	Y	Y
Marijuana Polices?	Y	Y	Y
Alcohol Policies?	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and educational attainment; economic controls include state unemployment rate and state per capita income, tobacco policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; marijuana policies indicators for legalized medical marijuana, and legalized recreational marijuana; alcohol controls include state beer tax. All regressions are weighted and standard errors are clustered at the state-level.

Table 11B. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Alcohol Use, BRFSS

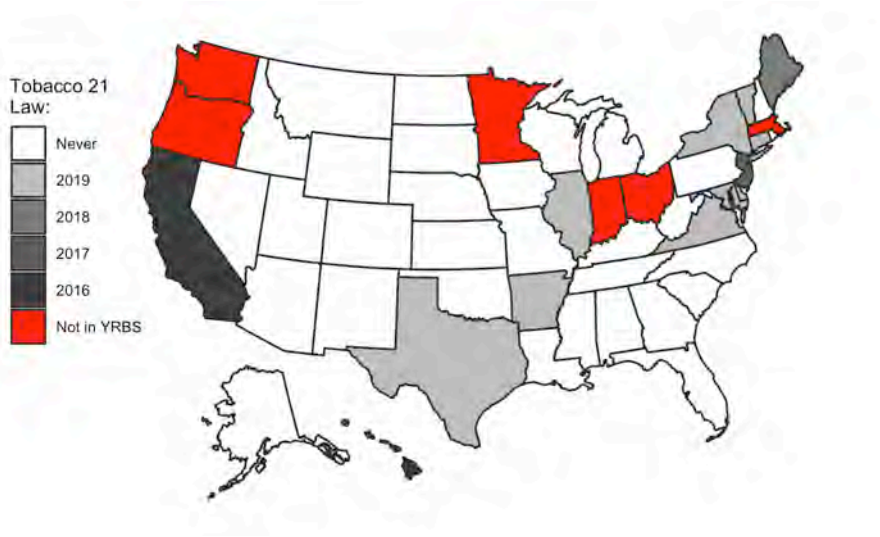
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All			*Males*			*Females*		
	18-to-20-Year-Olds	*18-Year-Olds*	*19-to-20-Year-Olds*	*18-to-20-Year-Olds*	*18-Year-Olds*	*19-to-20-Year-Olds*	*18-to-20-Year-Olds*	*18-Year-Olds*	*19-to-20-Year-Olds*
				Panel I: Alcohol Use					
Tobacco 21 Law	-0.018	-0.018	-0.018	-0.016	-0.032	-0.010	-0.017	-0.003	-0.022
	(0.016)	(0.018)	(0.024)	(0.018)	(0.025)	(0.025)	(0.029)	(0.041)	(0.037)
Pre-Treat DV Mean	0.353	0.276	0.398	0.370	0.292	0.418	0.334	0.256	0.377
Observations	93,333	32,641	60,692	49,908	17,833	32,075	43,389	14,797	28,592
				Panel II: Number of Days of Alcohol Use					
Tobacco 21 Law	-0.214	-0.256	-0.201	-0.385**	-0.542	-0.317	-0.005	0.014	-0.031
	(0.143)	(0.206)	(0.169)	(0.189)	(0.340)	(0.191)	(0.232)	(0.334)	(0.248)
Pre-Treat DV Mean	1.989	1.406	2.333	2.316	1.616	2.750	1.608	1.143	1.866
Observations	93,333	32,641	60,692	49,908	17,833	32,075	43,389	14,797	28,592
				Panel III: Number of Days of Alcohol Use / Drinking = 1					
Tobacco 21 Law	-0.329	-0.715	-0.324	-0.820*	-1.467	-0.671	0.190	-0.098	0.133
	(0.337)	(0.722)	(0.375)	(0.475)	(1.165)	(0.490)	(0.408)	(0.970)	(0.526)
Pre-Treat DV Mean	5.644	5.111	5.861	6.269	5.552	6.579	4.832	4.480	4.964
Observations	31,119	8,128	22,991	17,691	4,696	12,995	13,417	3,429	9,988
				Panel IV: Binge Drinking					
Tobacco 21 Law	-0.014	-0.037	-0.003	-0.015	-0.017	-0.017	-0.012	-0.065**	0.020
	(0.014)	(0.023)	(0.019)	(0.017)	(0.028)	(0.023)	(0.022)	(0.029)	(0.027)
Pre-Treat DV Mean	0.176	0.131	0.202	0.200	0.149	0.231	0.147	0.109	0.169
Observations	92,599	32,409	60,190	49,485	17,698	31,787	43,078	14,700	28,378
All Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, tobacco policy controls include state cigarette tax; state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; marijuana policies include indicators for legalized medical marijuana, and legalized recreational marijuana; alcohol policies include state beer tax. All regressions are weighted and standard errors are clustered at the state-level.

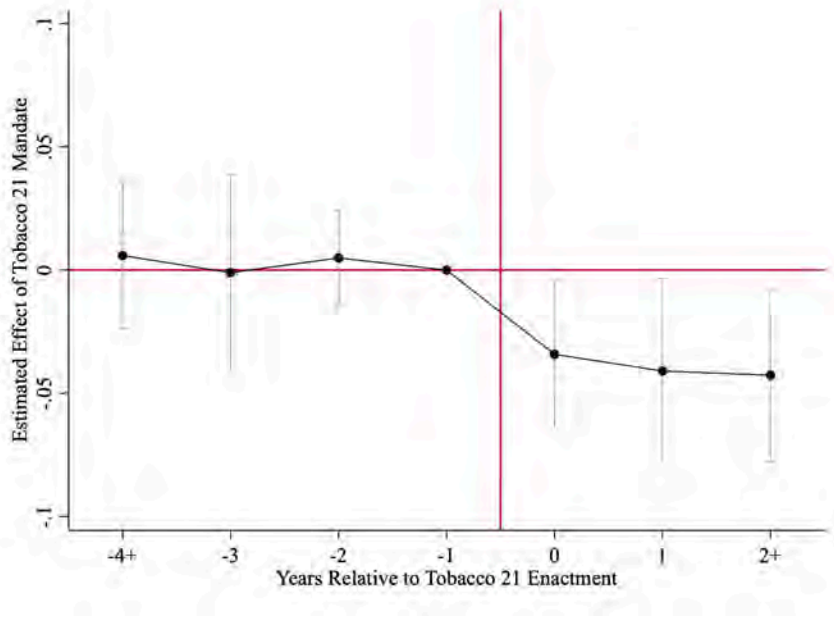
Appendix Tables and Figures

Appendix Figure 1. States Identifying Tobacco-21 Effects in State YRBS

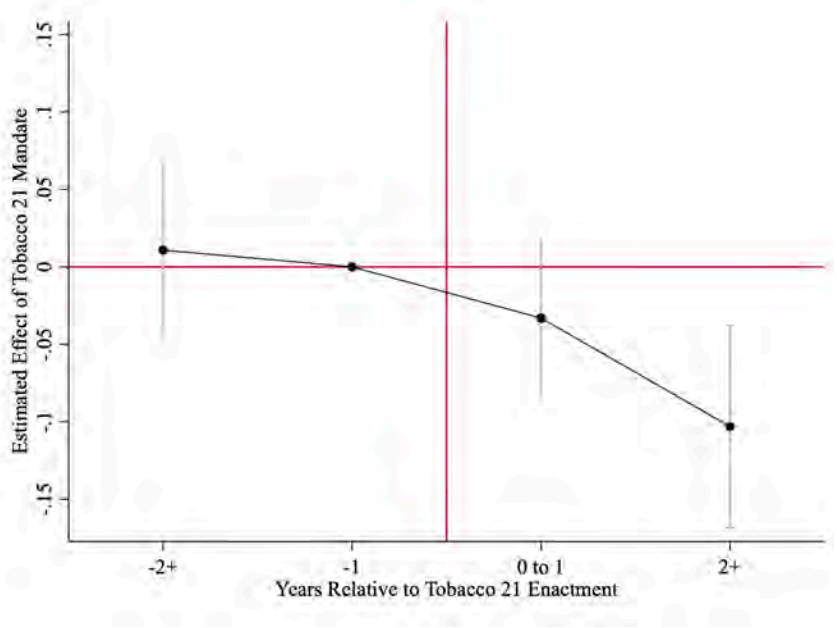


Notes: Grey and black states represent T-21 states where the state YRBS included both before and after data on smoking participation.

Appendix Figure 2. Event-Study Analysis Extended to Two or More Years Post-Treatment, "Difference-in-Differences" Logit Estimates for Smoking Participation for 18-to-20-Year-Olds, BRFSS



Appendix Figure 3. Event-Study Analysis, "Difference-in-Differences" Logit Estimates for E-Cigarette Participation for 18-Year-Olds, YRBS



Appendix Table 1. Effective Dates of State Tobacco-21 Laws and Identifying Variation Across Two National Datasets

State	*Effective Date*	*Contributes to Identification in BRFSS*	*Contributes to Identification in State YRBS*
Hawaii	1-01-2016	Y	Y
California	6-09-2016	Y	Y
District of Columbia	2-18-2017	Y	N
New Jersey	11-01-2017	Y	Y
Oregon	1-01-2018	Y	N
Maine	7-01-2018	Y	Y
Massachusetts	12-31-2018	Y	N
Illinois	7-01-2019	Y	Y
Virginia	7-01-2019	Y	Y
Delaware	7-16-2019	Y	N
Arkansas	9-01-2019	Y	Y
Texas	9-01-2019	Y	Y
Vermont	9-01-2019	Y	Y
Connecticut	10-01-2019	Y	Y
Maryland	10-01-2019	Y	Y
Ohio	10-16-2019	Y	N
New York	11-13-2019	Y	Y

Sources: Preventing Tobacco Addiction Foundation, available at: https://tobacco21.org/

Appendix Table 2. Sensitivity of Estimated Tobacco-21 Effects to Controls for Spatial Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
	Ages 18-to-20		Ages 21-to-23		Ages 24-to-28	
	Panel I: Smoking Participation					
Tobacco 21 Law	-0.037***	-0.037***	-0.006	-0.008	-0.009	-0.017
	(0.010)	(0.010)	(0.012)	(0.015)	(0.009)	(0.010)
Pre-Treat DV Mean	0.115	0.115	0.181	0.181	0.214	0.214
Observations	95,557	95,557	103,701	103,701	201,827	201,827
	Panel II: Everyday Smoking					
Tobacco 21 Law	-0.019**	-0.013	0.002	0.011	-0.013	-0.021**
	(0.008)	(0.008)	(0.011)	(0.017)	(0.008)	(0.009)
Pre-Treat DV Mean	0.064	0.064	0.109	0.109	0.132	0.132
Observations	95,557	95,557	103,701	103,701	201,827	201,827
	Panel III: Quits					
Tobacco 21 Law	0.054	0.009	0.043	0.016	0.025	0.035
	(0.055)	(0.050)	(0.031)	(0.032)	(0.027)	(0.032)
Pre-Treat DV Mean	0.259	0.259	0.305	0.305	0.369	0.369
Observations	16,726	16,726	28,570	28,570	71,756	71,756
Region-by-Year FE	Y	Y	Y	Y	Y	Y
State Specific Time Trend		Y		Y		Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 3. Ordinary Least Squares (LPM) Estimates of the Effect of Tobacco 21 Laws on Tobacco Cigarette Use, BRFSS, 2009-2019

	(1)	(2)	(3)
	DD Age 18-to-20	*DDD Age 18-to-20 vs. Age 21-to-23*	*DDD Age 18-to-20 vs. Age 21-to-23*
		Panel I: Smoking Participation	
Tobacco 21 Law	-0.025***	-0.003	-0.001
	(0.007)	(0.011)	(0.014)
Tobacco 21 Law *18-to-20		-0.022**	-0.024**
		(0.010)	(0.010)
Pre-Treat DV Mean	0.115	0.115	0.115
Observations	95,557	199,258	199,258
		Panel II: Everyday Smoking	
Tobacco 21 Law	-0.011**	0.005	0.011
	(0.005)	(0.009)	(0.009)
Tobacco 21 Law *18-to-20		-0.016*	-0.016*
		(0.008)	(0.009)
Pre-Treat DV Mean	0.064	0.064	0.064
Observations	95,557	199,258	199,258
		Panel III: Quit	
Tobacco 21 Law	0.061	0.039	-0.057
	(0.070)	(0.038)	(0.039)
Tobacco 21 Law *18-to-20		0.021	0.045
		(0.046)	(0.058)
Pre-Treat DV Mean	0.259	0.259	0.259
Observations	16,726	45,296	45,296
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y
E-cigarette Polices?	Y	Y	Y
Alcohol and Marijuana Policies?	Y	Y	Y
State-by-Year FE			Y

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

Notes: Weighted OLS estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 4. Sensitivity of Estimates to Use of Birth Cohort Instead of Age Group to Define Affected Individuals, BRFSS, 2009-2019

	(1)	(2)	(3)
	Panel I: Smoking Participation		
Tobacco 21 Law	-0.011	-0.013	-0.015
	(0.008)	(0.008)	(0.010)
Tobacco 21 Law * Affected Birth Cohort	-0.039*	-0.039*	-0.042*
	(0.022)	(0.022)	(0.023)
Pre-Treat DV Mean	0.115	0.115	0.115
Observations	401,085	401,085	401,085
	Panel II: Everyday Smoking		
Tobacco 21 Law	-0.010	-0.012*	-0.008
	(0.006)	(0.007)	(0.008)
Tobacco 21 Law * Affected Birth Cohort	-0.028	-0.028	-0.028*
	(0.018)	(0.017)	(0.017)
Pre-Treat DV Mean	0.064	0.064	0.064
Observations	401,085	401,085	401,085
	Panel III: Quit		
Tobacco 21 Law	0.017	0.017	0.029
	(0.023)	(0.023)	(0.027)
Tobacco 21 Law * Affected Birth Cohort	-0.027	-0.027	-0.025
	(0.019)	(0.019)	(0.021)
Pre-Treat DV Mean	0.259	0.259	0.259
Observations	117,052	117,052	117,052
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Cigarette Policy Controls?		Y	Y
E-cigarette Polices?		Y	Y
Alcohol and Marijuana Policies?			Y
State Specific Time Trend?			Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 5. The Effects of Tobacco 21 Laws on E-Cigarette Participation, BRFSS 2016-2018

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	DD	*DDD*	*DDD*	*DD*	*DDD*	*DDD*	*DD*	*DDD*	*DDD*
	Age 18-to 20	*Age 18-to-20 vs. Age 21-to-23*	*Age 18-to-20 vs. Age 24-to-28*	*Age 18*	*Age 18 vs. Age 21-to-23*	*Age 18 vs. Age 24-to-28*	*Ages 19-to-20*	*Age 19-to-20 vs. Age 21-to-23*	*Age 19-to-20 vs. Age 24-to-28*
Tobacco 21 Law	-0.015	-0.014	-0.018**	-0.080***	-0.024*	-0.030***	0.012	-0.009	-0.012
	(0.038)	(0.010)	(0.009)	(0.024)	(0.013)	(0.012)	(0.033)	(0.009)	(0.008)
Pre-Treat DV Mean	0.102	0.102	0.102	0.095	0.095	0.095	0.105	0.105	0.105
Observations	19,698	41,475	61,214	6,687	28,465	48,204	13,010	34,787	54,526
Demographic Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
E-cigarette Polices?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Alcohol and Marijuana Policies?	Y	Y	Y	Y	Y	Y	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2016-2018 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 6. Sensitivity of Estimates Measure of Tobacco-21 Law that Includes Both Statewide and Local Laws, 2009-2019

	Ages 18-to-20	*Ages 21-to-23*	*Ages 24-to-28*
	(1)	(2)	(3)
	Panel I: Smoking Participation		
Any Tobacco 21 Law	-0.033***	-0.010	0.0001
	(0.012)	(0.015)	(0.006)
Pre-Treat DV Mean	0.115	0.181	0.214
Observations	95,557	103,701	201,827
	Panel II: Everyday Smoking		
Any Tobacco 21 Law	-0.006	-0.008	0.000
	(0.010)	(0.009)	(0.008)
Pre-Treat DV Mean	0.064	0.109	0.132
Observations	95,557	103,701	201,827
	Panel III: Quit		
Any Tobacco 21 Law	0.037	0.027	-0.003
	(0.045)	(0.035)	(0.018)
Pre-Treat DV Mean	0.259	0.305	0.369
Observations	16,726	28,570	71,756
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y
E-cigarette Polices?	Y	Y	Y
Alcohol and Marijuana Policies?	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 7. Heterogeneity in the Effects of T-21 Laws by Whether a Statewide or Local Mandate, BRFSS, 2009-2019

	Ages 18-to-20	*Ages 21-to-23*	*Ages 24-to-28*
	(1)	(2)	(3)
	Panel I: Smoking Participation		
State Only Tobacco 21 Law	-0.041***	-0.009	-0.004
	(0.012)	(0.015)	(0.008)
Local Only Tobacco 21 Law	-0.012	-0.012	0.014
	(0.023)	(0.030)	(0.015)
Pre-Treat DV Mean	0.115	0.181	0.214
Observations	95,557	103,701	201,827
	Panel II: Everyday Smoking		
State Only Tobacco 21 Law	-0.021**	-0.001	-0.008
	(0.009)	(0.010)	(0.008)
Local Only Tobacco 21 Law	0.029	-0.028	0.026*
	(0.019)	(0.023)	(0.014)
Pre-Treat DV Mean	0.064	0.109	0.132
Observations	95,557	103,701	201,827
	Panel III: Quit		
State Only Tobacco 21 Law	0.052	0.034	0.013
	(0.057)	(0.033)	(0.022)
Local Only Tobacco 21 Law	-0.007	0.004	-0.061*
	(0.056)	(0.072)	(0.037)
Pre-Treat DV Mean	0.259	0.305	0.369
Observations	16,726	28,570	71,756
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y
E-cigarette Polices?	Y	Y	Y
Alcohol and Marijuana Policies?	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 8. Exploration of Border State T-21 Laws, BRFSS, 2009-2019

	(1)	(2)	(3)
		Ages 18-to-20	
		Panel I: Smoking Participation	
Tobacco 21 Law	-0.024**	-0.028**	-0.038***
	(0.012)	(0.011)	(0.011)
Tobacco 21 Law *Border state Tobacco 21 Law	-0.003	-0.003	-0.004
	(0.017)	(0.017)	(0.016)
Pre-Treat DV Mean	0.115	0.115	0.115
Observations	95,557	95,557	95,557
		Panel II: Everyday Smoking	
Tobacco 21 Law	-0.011	-0.015*	-0.019**
	(0.008)	(0.008)	(0.009)
Tobacco 21 Law * Border state Tobacco 21 Law	-0.021	-0.021	-0.022
	(0.016)	(0.016)	(0.016)
Pre-Treat DV Mean	0.064	0.064	0.064
Observations	95,557	95,557	95,557
		Panel III: Quit	
Tobacco 21 Law	0.055	0.059	0.066
	(0.052)	(0.052)	(0.056)
Tobacco 21 Law * Border state Tobacco 21 Law	-0.055	-0.054	-0.055
	(0.042)	(0.041)	(0.040)
Pre-Treat DV Mean	0.259	0.259	0.259
Observations	16,726	16,726	16,726
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y
E-cigarette Polices?		Y	Y
Alcohol and Marijuana Policies?			Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 9. Lead and Lagged Effects of T-21 laws on Smoking Participation, 2009-2019 YRBS

	(1)	(2)
	Age 18	*Age 16-to-17*
2+ waves prior to T21	0.024	0.017
	(0.016)	(0.012)
1 wave prior to T21	-	-
	-	-
First wave with T21	0.005	-0.002
	(0.015)	(0.008)
Second wave with T21	-0.036**	-0.037**
	(0.014)	(0.018)
Observations	87,612	440,145
Demographic Controls?	Y	Y
Economic Controls?	Y	Y
Cigarette Policy Controls?	Y	Y
E-cigarette Polices?	Y	Y
Alcohol and Marijuana Policies?	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and educational attainment; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 10. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Tobacco Use Among 13-to-15-Year-Olds, YRBS, 2009-2019

	(1)	(2)	(3)
	Panel I: Smoking Participation		
Tobacco 21 Law	-0.006	-0.010	-0.009
	(0.008)	(0.008)	(0.009)
Pre-Treat DV Mean	0.079	0.079	0.079
Observations	373,776	373,776	373,776
	Panel II: Frequent Smoking		
Tobacco 21 Law	-0.007	-0.009	-0.007
	(0.007)	(0.007)	(0.007)
Pre-Treat DV Mean	0.019	0.019	0.019
Observations	373,776	373,776	373,776
	Panel III: Everyday Smoking		
Tobacco 21 Law	-0.003	-0.004	-0.002
	(0.007)	(0.007)	(0.006)
Pre-Treat DV Mean	0.013	0.013	0.013
Observations	373,776	373,776	373,776
Demographic Controls?	Y	Y	Y
Economic Controls?	Y	Y	Y
Cigarette Policy Controls?	Y	Y	Y
E-cigarette Polices?		Y	Y
Alcohol and Marijuana Policies?			Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and grade; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 11. Multinomial Logit Estimates of the Effect of Tobacco 21 Laws on Source of E-Cigarette Among Males, YRBS, 2017-2019

	(1)	(2)	(3)	(4)
	18-Year-Olds	16-to-17-Year-Olds	18-Year-Olds	16-to-17-Year-Olds
		Panel I: E-Cigarette Participation		
Tobacco 21 Law	-0.123**	0.127	-0.111***	0.099
	(0.053)	(0.087)	(0.032)	(0.073)
Pre-Treatment DV Mean	0.230	0.137	0.230	0.137
	Panel II: Usual Source of E-Cigarettes (Multinomial Logit)			
	Direct Purchase			
Tobacco 21 Law	-0.165***	0.011	-0.223***	0.044
	(0.064)	(0.027)	(0.037)	(0.034)
Pre-Treatment DV Mean	0.156	0.028	0.156	0.028
	Third-Party Purchase			
Tobacco 21 Law	0.047*	-0.004	0.036	-0.016
	(0.028)	(0.015)	(0.043)	(0.017)
Pre-Treatment DV Mean	0.002	0.018	0.002	0.018
	Bumming or Borrowing			
Tobacco 21 Law	0.012	0.093**	0.200	0.060*
	(0.064)	(0.044)	(0.141)	(0.031)
Pre-Treatment DV Mean	0.032	0.054	0.032	0.054
	Internet, Stole, or Some Other Way			
Tobacco 21 Law	-0.0003	0.022	0.015	-0.001
	(0.039)	(0.018)	(0.072)	(0.022)
Pre-Treatment DV Mean	0.039	0.037	0.039	0.037
Observations	12,565	62,105	12,565	62,105
Demographic Controls?	Y	Y	Y	Y
Economic Controls?			Y	Y
Cigarette Policy Controls?			Y	Y
E-cigarette Polices?			Y	Y
Alcohol and MJ Policies?			Y	Y

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

Notes: Weighted multinomial logit estimates are generated using data from the 2017-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 12. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Marijuana Use, 2016-2019 BRFSS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	18-Year-Olds			*19-to-20-Year-Olds*			*18-to-20-Year-Olds*		
	Panel I: Marijuana Use								
Tobacco 21 Law	-0.042	-0.042	-0.042	-0.010	-0.010	-0.009	-0.029	-0.029	-0.029
	(0.061)	(0.061)	(0.061)	(0.047)	(0.047)	(0.047)	(0.044)	(0.044)	(0.044)
Pre-Treat DV Mean	0.120	0.120	0.120	0.152	0.152	0.152	0.139	0.139	0.139
Observations	2,623	2,623	2,623	4,832	4,832	4,832	7,466	7,466	7,466
	Panel II: Frequent Marijuana Use								
Tobacco 21 Law	-0.077*	-0.077*	-0.077*	0.019	0.019	0.019	-0.029	-0.029	-0.029
	(0.040)	(0.040)	(0.040)	(0.036)	(0.036)	(0.035)	(0.025)	(0.025)	(0.025)
Pre-Treat DV Mean	0.056	0.056	0.056	0.092	0.092	0.092	0.077	0.077	0.077
Observations	2,585	2,585	2,585	4,832	4,832	4,832	7,466	7,466	7,466
Demographic Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Economic Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tobacco Policy Controls?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Marijuana Polices?		Y	Y		Y	Y		Y	Y
Alcohol Policies?			Y			Y			Y

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

Notes: Weighted logit estimates are generated using data from the 2016-2019 BRFSS. All models include state FE, month FE, and year FE. Demographic controls include indicators for sex, race, educational attainment, and household income; economic controls include state unemployment rate and state per capita income, cigarette policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; and alcohol and marijuana policies include state beer tax, indicators for legalized medical marijuana, and legalized recreational marijuana. All regressions are weighted and standard errors are clustered at the state-level.

Appendix Table 13. "Difference-in-Differences" Logit Estimates of the Effect of Tobacco 21 Laws on Marijuana and Alcohol Use Among 16-to-17-Year-Olds, YRBS

	All	*Males*	*Females*
	(1)	(2)	(3)
	Panel I: Marijuana Use		
Tobacco 21 Law	-0.004	0.007	-0.014
	(0.013)	(0.016)	(0.015)
Pre-Treat DV Mean	0.233	0.247	0.218
Observations	431,546	210,176	221,370
	Panel II: Frequent Marijuana Use		
Tobacco 21 Law	-0.009	-0.010	-0.009
	(0.007)	(0.013)	(0.008)
Pre-Treat DV Mean	0.092	0.117	0.067
Observations	431,546	210,176	221,370
	Panel III: Alcohol Use		
Tobacco 21 Law	0.012	0.018	0.006
	(0.018)	(0.019)	(0.020)
Pre-Treat DV Mean	0.376	0.361	0.391
Observations	408,860	198,627	210,233
	Panel IV: Alcohol Use > 2 Days / Alcohol Use = 1		
Tobacco 21 Law	0.041*	0.041	0.042
	(0.021)	(0.030)	(0.029)
Pre-Treat DV Mean	0.503	0.535	0.473
Observations	139,477	65,076	74,401
	Panel V: Binge Drinking		
Tobacco 21 Law	0.007	0.016	-0.003
	(0.015)	(0.018)	(0.019)
Pre-Treat DV Mean	0.211	0.217	0.204
Observations	388,324	188,814	199,510
	Panel VI: Frequent Binge Drinking / Binge Drinking = 1		
Tobacco 21 Law	0.010	-0.005	0.021
	(0.034)	(0.041)	(0.035)
Pre-Treat DV Mean	0.167	0.192	0.140
Observations	73,654	36,926	36,728
All Controls?	Y	Y	Y

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

Notes: Weighted logit estimates are generated using data from the 2009-2019 YRBS. All models include state FE and wave FE. Demographic controls include indicators for sex, race, and educational attainment; economic controls include state unemployment rate and state per capita income, tobacco policy controls include state cigarette tax; e-cigarette policy controls include state e-cigarette tax and an indicator for the sale of e-cigarettes being over 18; marijuana policies indicators for legalized medical marijuana, and legalized recreational marijuana; alcohol controls include state beer tax.