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Abstract. Electronic nicotine delivery systems (ENDS) use among lesbian, gay, bisexual, and questioning (LGBQ) teenagers is over 30 percent higher than among their heterosexual counterparts. Yet little is known about how recent efforts to curb nicotine vaping through ENDS taxes impact sexual minorities. This study explores this question using data from the 2015-2021 State Youth Behavior Surveys. We find that a one-dollar (in 2021\$) per mL of e-liquid increase in ENDS taxes reduces the likelihood of any prior-month ENDS use among heterosexual teens by about 4 percentage points and the likelihood of habitual vaping (as measured by frequent and everyday use) by about two percentage points. In sharp contrast, we find no evidence that ENDS taxes reduce any of the vaping measures for queer youths. The coefficient estimates are consistently less strongly negative for LGBQ than heterosexual youths, and the differences in effects on frequent and everyday vaping are statistically significant. Therefore, taxes *widen disparities* in vaping between queer and straight teens. The estimated effect of ENDS taxes on LGBQ teens who *do not* report being depressed, suicidal, or bullied is similar to the effect among heterosexuals, suggesting that LGBQ youths' tax insensitivity may be explained by their dependence on e-cigarettes to cope with unique stress-related psychological challenges.

Keywords: ENDS taxes; youth e-cigarette use; LGBQ teens; sexual minorities

JEL codes: I12; I18

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1. Introduction

Lesbian, gay, bisexual, and questioning (LGBQ) teenagers face unique psychological challenges.¹ Religious critiques of homosexuality (Blosnich et al. 2020; Hatzenbuehler et al. 2012), societal discrimination (Badgett et al. 2021)², and family conflict surrounding sexual identity (Donahue et al. 2017; Ryan et al. 2009) generate substantial unique stresses that contribute to sharp disparities in mental health between LGBQ and heterosexual youth (Eckstrand et al. 2022; Hatzenbuehler et al. 2024). LGBQ teens are more likely to experience depressive symptoms (Irish et al. 2019) and engage in suicidal behaviors (Liang et al. 2023; Rees et al. 2022; Sun et al. 2023) than their heterosexual counterparts. These disparities likely contribute to higher rates of risky health behaviors for sexual minorities, in part as a coping mechanism for psychological trauma (Earnshaw et al. 2017; Friedman 2020; Rosario et al. 2014).

Tobacco use among LGBQ-identifying teenagers is substantially higher than among heterosexual youth. In 2021, prior-month use of electronic nicotine delivery systems (ENDS) among LGBQ teenagers was 32 percent higher (21.7 percent versus 16.4 percent) and combustible cigarette use was 118 percent higher (5.9 percent versus 2.7 percent) than among heterosexual teens (Centers for Disease Control and Prevention 2023). These differences may lead to significant disparities in mortality and morbidity later in life. Combustible tobacco use is the leading cause of preventable death in the United States, carrying with it elevated risks of cancers, heart disease, and respiratory health problems (Hall and Doran 2016; U.S. Surgeon General 2014; 2020). While ENDS are generally considered less harmful than combustible tobacco, nicotine vaping may still carry respiratory, and lung- and heart-related health risks relative to abstinence from all tobacco products (McNeill et al. 2018; Mohammadi et al. 2022; National Academies of Sciences, Engineering, and Medicine 2018; U.S. Surgeon General 2016). Moreover, nicotine consumption during the teenage years can impede brain development which continues through the mid-20s (Goriounova and Mansvelter 2012).

Curbing youth tobacco use remains a public health priority because (1) initiation into tobacco use is most common among teenagers and young adults (Barrington-Trimis et al. 2020;

¹ We use the Centers for Disease Control and Prevention Youth Risk Behavior Survey in our analysis. Over our study period, the YRBS data do not allow us to accurately measure those persons who identify as part of the larger LGBTQ+ community, for example, transgender- and asexual-identifying persons.

² See also Carpenter (2008), Drydakis (2009), Drydakis (2022), Hatzenbuehler et al. (2014), Sabia (2014), Sabia (2015), Sabia et al. (2017), Schuster et al. 2015, and Weichselbaumer (2022).

Khuder et al. 1999; U.S. Department of Health and Human Services 2014),³ and (2) youths may be more likely to make irrational decisions than adults with respect to addictive behaviors that adversely affect future health such as tobacco use (Crettez and Deloche 2021). Teenagers' (and young adults') prefrontal cortexes are not fully developed (Arian et al. 2013; Casey et al. 2008; Romer 2010; Spear 2000), which could cause them to hyperbolically discount the future costs of addiction (Gruber and Köszegi 2001). In other words, youths may inflate the importance of short-run utility gains from tobacco use (e.g., reducing the disutility of stress) and give insufficient weight to the longer-run health risks of tobacco use (Gentzke et al. 2022; U.S. Surgeon General 2016). Thus, successful policy interventions to curb disparities in youth tobacco use, especially of combustible products (National Academies of Sciences, Engineering and Medicine 2018), could generate disproportionate health and welfare benefits for groups with relatively high usage rates such as LGBTQ individuals.

With the goal of reducing youth ENDS use, 32 states, the District of Columbia (D.C.), and several large cities and counties have adopted ENDS taxes (Centers for Disease Control and Prevention 2024a; Public Health Law Center at Mitchell Hamline School of Law 2023; Tax Foundation 2024). Twelve states have implemented an excise tax per mL of “e-liquid,” 16 states and D.C. have adopted either an ad valorem tax (percent of wholesale price) or a sales tax (percent of pre-tax retail price), and four states have implemented a bifurcated tax strategy, depending on “closed” versus “open” ENDS systems.⁴ While ENDS taxation is a popular policy strategy to reduce ENDS use, there is growing evidence that by increasing the price of e-cigarettes relative to combustible cigarettes (or cigars), the policy may have the unintended consequence of inducing substitution to more harmful tobacco products among both youths and adults (Abouk et al. 2023a; Allcott and Rafkin 2022; Cotti et al. 2022; Friedman and Pesko 2022; Pesko et al. 2020). However, the distributional effects of ENDS taxes have been far less explored in the literature, particularly with respect to vulnerable, historically marginalized populations.

This study is, to our knowledge, the first to explore how ENDS taxes affect nicotine vaping among LGBTQ-identifying youths and why these effects may differ from those among their heterosexual counterparts. LGBTQ youths may be less responsive to ENDS taxes if they turn to an addictive good such as ENDS to cope with or escape from stress-related psychological trauma (Saffer and Dave 2005). Such psychological trauma may arise from (1) bullying victimization (Liang

³ See also the Committee on the Public Health Implications of Raising the Minimum Age for Purchasing Tobacco Products (2015).

⁴ These states implement excise taxes on closed e-cigarette systems (with prefilled cartridges) and ad valorem taxes on open e-cigarette systems (with refillable cartridges).

et al. 2023), (2) homophobia-induced societal discrimination (Pachankis et al. 2021; Hatzenbuehler et al. 2012), (3) family conflict due to coming out (Donahue et al. 2017), or (4) peer ostracism (Rosario et al. 2014). Also, compared to heterosexual teens, LGBQ teens have higher pre-tax vaping and smoking rates, earlier initiation ages (Centers for Disease Control and Prevention 2023), and greater likelihood of using tobacco as a socialization tool (Carpenter and Sansone 2021). Each of these factors suggest a stronger attachment to nicotine, implying a greater disutility from cessation and therefore a lower price elasticity.⁵ Further, similar to combustible tobacco product companies, ENDS producers actively target the LGBQ community – for example, sponsoring events tailored to the LGBQ community such as pride festivals (Truth Initiative, 2024b). These efforts may mute the response of LGBQ people to tax-induced prices increases. On the other hand, if LGBQ teens face reduced disposable income due to labor market discrimination (Sabia 2014) or estranged relationships with their families (Ryan et al. 2009), these experiences could strengthen price responsiveness.

Using data from the 2015-2021 State Youth Risk Behavior Survey (YRBS), we find robust evidence that the effect of ENDS taxes on vaping is weaker for LGBT youth than it is for heterosexual youth. In our main generalized difference-in-differences specification, a one-dollar (in 2021\$) increase in ENDS taxes is associated with a 4.2 percentage-point (20.6 percent) reduction in prior-month ENDS use among heterosexual-identifying youth. In contrast, the magnitude of the effect of ENDS taxes on nicotine vaping is approximately 40 percent smaller and statistically insignificant. An even starker pattern emerges when we examine more habitual use, as measured by frequent and everyday vaping. A one-dollar increase in ENDS taxes leads to statistically significant reductions in these outcomes among heterosexual youth, with the magnitudes representing roughly half of baseline nicotine vaping rates. In contrast, we find no evidence of any reductions in these outcomes for LGBQ youth, and the differences in the effects between the two samples are strongly statistically significant. Therefore, ENDS taxes increase the disparity in ENDS use between sexual minority and heterosexual teens.

⁵ There are other – arguably more speculative – reasons why LGBQ individuals might be differentially affected by ENDS taxes. Their unique social support networks with peers in similar stressful circumstances (McPherson et al. 2001) could increase black market access, thereby blunting the impact of taxes. Their greater investments in human capital (Badgett et al. 2021; Carpenter and Eppink, 2017) could lead to better knowledge about the relative harms of vaping and smoking that reduces the odds of switching to smoking when an ENDS tax is implemented. On the other hand, LGBQ individuals may be less likely to be exposed to information due to their lower interaction with the health care system and reduced likelihood of being insured (Badgett et al. 2021; Buchmueller and Carpenter 2010; Gonzales and Blewett 2014). For the same reasons, they might also have fewer opportunities for participation in programs to transition from combustible tobacco products to e-cigarettes and/or from e-cigarettes to abstinence from tobacco products.

Additional analyses support the hypothesis that LGBQ youths face unique stress-related adverse psychological shocks, including from bullying victimization, that increase the risk of addictive behaviors and result in a more highly inelastic demand for ENDS products. Specifically, we find that the estimated effects of ENDS taxes on LGBQ teens who *do not* report being depressed, suicidal, or bullied are more similar in magnitude to the tax effects found for heterosexuals.

Evidence for substitution toward combustible cigarettes associated with changes in ENDS taxes is mixed. In some specifications, we find stronger evidence of substitution to combustibles for heterosexuals than queer teens. However, we do not find that ENDS taxes significantly affect disparities in smoking by sexual identity.

We conduct auxiliary analyses using data from the Behavioral Risk Factor Surveillance Survey (BRFSS) to examine adults, who are more likely than teens to use e-cigarettes as a smoking cessation tool (U.S. Surgeon General 2020) and, in conjunction with alcohol, as a socializing strategy (Carpenter and Sansone 2021). The pattern of findings for young adults in their 20s is fairly similar to that observed for teenagers, with heterosexual-identifying young adults being more tax sensitive than their LGBQ counterparts. This pattern does not hold, though, for adults over 30.

Finally, we explore whether other ENDS policies — including restrictions on the sales of flavored ENDS, Tobacco-21 (T-21) laws, minimum legal purchasing ages for ENDS products, and licensure laws for ENDS retailers — are more successful than taxes at curbing e-cigarette use among LGBQ teens. In general, we find little support for net tobacco-related health gains from these ENDS access policies for LGBQ youth. For instance, our results suggest that e-cigarette flavor restrictions curb nicotine vaping among sexual minority youth, but also induce substitution to combustible cigarettes. T-21 laws appear to do the most to potentially reduce both e-cigarette and combustible tobacco use. Together, our findings highlight important challenges to policymakers wishing to curb tobacco use among queer-identifying youths and young adults.

2. Background

2.1 Rise of Electronic Nicotine Delivery Systems (ENDS)

The first commercially successful generation of nicotine-based e-cigarettes was produced in China in 2003. One year later, they were made widely available to consumers in China and often marketed as a smoking cessation tool (Demick 2009; Wang et al. 2019). In 2005, ENDS products from China began to be exported to other nations, with e-cigarettes entering the U.S. market in 2006

(CASAA 2021). Knowledge about ENDS products spread relatively quickly across the developed world. According to the International Tobacco Control Four-Country Survey (which included respondents from Australia, Canada, the United Kingdom, and the United States), by 2011, 47 percent of adult respondents were aware of the existence of ENDS, eight percent had already tried ENDS, and three percent were current users (Adkison et al. 2013). As this new market expanded, youth ENDS use steadily rose throughout the 2010s before declining during the period following 2019, in part perhaps due to the COVID-19 pandemic, but also due to policies introduced contemporaneously to curb access to e-cigarettes. While approximately seven percent of U.S. adults ages 18 and older were ENDS users in 2021 (Centers for Disease Control and Prevention 2022), among middle and high school students, the prevalence was nearly 18 percent (Centers for Disease Control and Prevention 2023).⁶

The population-level health effects of broader access to e-cigarettes are not obvious. The preponderance of medical evidence suggests that ENDS use is substantially less harmful to respiratory, heart, and cancer-related health than combustible tobacco product use (McNeill et al. 2018; National Academies of Sciences, Engineering, and Medicine 2018).⁷ However, nicotine vaping can still have some adverse respiratory (lung-related) and heart-related health effects (Balfour et al. 2021; McNeill et al. 2018; National Academies of Sciences and Medicine 2018; Sahu et al. 2023). For teens, e-cigarette use can also affect brain development (U.S. Surgeon General 2014).

The policy debate on the net public health effect of restricting access to ENDS therefore focuses on whether e-cigarettes and combustible tobacco are complements or substitutes in consumption (or perhaps both across heterogeneous consumers). ENDS use may serve as an effective tobacco harm reduction strategy for individuals who consume ENDS instead of combustible tobacco products when access to ENDS increases. Others may respond to increased ENDS access by consuming e-cigarettes when, in their absence, they would have abstained from all tobacco products. Still others could use ENDS products as a “gateway” into riskier combustible tobacco use (Etter 2018; Friedman et al. 2019a; Khouja et al. 2020).

This ambiguity has led to regulatory approaches to ENDS products that sharply differ across nations. Strategies include: (1) encouraging e-cigarette use among combustible tobacco users (e.g.,

⁶ The prevalence of ENDS use declined among both youths and young adults in 2020-2021 (Centers for Disease Control and Prevention 2023; Pesko 2023), though recent evidence from the National Survey on Drug Use and Health suggests that e-cigarette use may have risen in 2022 (Substance Abuse and Mental Health Services Administration 2023). Adult use stayed relatively constant during the 2010s, with small increases around 2022 (Truth Initiative 2024a).

⁷ ENDS use by the user and effect on others is estimated not to exceed five percent of the harm of cigarettes (Nutt et al. 2014). However, consumers overestimate the health risks of e-cigarettes relative to the true risks (Viscusi 2016).

United Kingdom), (2) sharply reducing teenagers' and young adults' access to e-cigarettes (e.g., United States), (3) requiring a doctor's prescription to legally purchase e-cigarettes (e.g., Australia), and (4) banning the sale of all e-cigarettes (e.g., Brazil, India, Mexico) (World Health Organization 2023). The U.S. Surgeon General's Office has lauded the sharp decline in the prevalence of combustible tobacco smoking among both teens and adults (U.S. Surgeon General 2014), which could, in part, be explained by increased access to e-cigarettes. However, the Office has also labeled high rates of ENDS use among youth an "epidemic" (U.S. Surgeon General 2018).

2.2 Sexual Minorities and Tobacco Use

While there is robust evidence from large national surveys that LGBTQ youth (Gentzke et al. 2022) and LGBTQ adults (Cornelius et al. 2023) are more likely to use tobacco products than their heterosexual counterparts, there is also evidence that LGBTQ individuals use tobacco for different reasons than heterosexuals. One of these explanations concerns "minority stress" (Meyer 1995), whereby sexual minorities use tobacco products to cope with homophobia-driven social pressures they face (Blosnich et al. 2020; Donahue et al. 2017; Ryan et al. 2009). LGBTQ individuals experience unique pressures, especially during their teenage years (Kosciw et al. 2016; Schuster et al. 2015), and that acute mental distress may be causally related to addictive behaviors, including nicotine consumption (Friedman 2020).

There is also evidence that LGBTQ young adults are more likely to use tobacco products as a means of socialization, with venues associated with smoking, like bars and clubs, being a safe haven for LGBTQ individuals and an important part of LGBTQ culture historically. This pattern of socialization could lead to more encounters with tobacco product users and greater social pressure to smoke as compared to heterosexual individuals (Jannat-Khah et al. 2018; Remafedi 2007). Whether such socialization pressures extend to nicotine vaping remains an open question.

There is very little empirical research examining the causal effects of tobacco control policies on LGBTQ-identifying persons. One notable exception is Carpenter and Sansone (2021), who study the effect of cigarette taxes on cigarette smoking for LGBTQ-coupled individuals. Using data from the 1996-2018 BRFSS, these authors use the survey's household roster to identify adults living in likely same-sex and opposite-sex relationships. Using a two-way fixed effects (TWFE) approach, they find that a one-dollar increase in cigarette excise taxes per pack leads to a 0.9 (1.2) percentage point larger reduction in the likelihood of being a current (every day) smoker for men in same-sex households as compared to men in different sex-households, with negligible differences among

women. This finding suggests that cigarette taxes reduce disparities in cigarette smoking among gay couples as compared to males in opposite-sex relationships. Carpenter and Sansone (2021) find evidence for a socialization mechanism, as cigarette taxes reduce smoking more among LGBQ men who drink (their proxy for socialization) as compared to LGBQ men who do not drink, whereas there is little difference among heterosexual men by their drinking status.⁸

2.3 ENDS Taxes

One of the most popular policy strategies to restrict access to e-cigarettes is through ENDS taxation (Public Health Law Center at Mitchell Hamline School of Law 2021). At least 54 countries have adopted a nationwide tax (Dauchy and Fuss 2023). Although the U.S. has not adopted a federal tax, state and local ENDS taxes appear to have had both intended and unintended effects on tobacco use among Americans.

First, there is evidence that adult tobacco use responds to changes in ENDS taxes. Price effects are the likely channel, as evidence from Nielsen Scanner Data suggests that approximately 90 percent of ENDS tax increases are passed through to retail prices (Cotti et al. 2022). Using data from the National Health Interview Survey and the Behavioral Risk Factor Surveillance System (BRFSS), Pesko et al. (2020) find that a one-dollar increase in ENDS tax (rate per fluid milliliter of nicotine) is associated with a 0.52 percentage point (15.3 percent) decline in nicotine vaping among adults aged 21 and older. However, the authors also find that daily cigarette use increases by around 0.59 percentage points (5.3 percent) following a one-dollar increase in the tax. Friedman and Pesko (2022) use data from the Current Population Survey's Tobacco Use Supplement and find that a one-dollar increase in ENDS taxes is associated with a 2-3 percentage-point decline in ENDS use among young adults ages 18-25. They also find that a one-dollar increase in ENDS taxes increases past-month cigarette use by 3.7 percentage points. Using data from the BRFSS, Dave et al. (2022) find that a one-dollar increase in ENDS taxes is associated with a 4.6 percent decline in ENDS use among adults ages 21-39. Abouk et al. (2023a) study the effects of ENDS taxes on pregnant women. They find that a one-dollar increase in ENDS taxes decreases pre-pregnancy vaping by 1.8 percentage points but increases pre-pregnancy smoking by 0.5 percentage points.

There is also evidence that youth tobacco use is sensitive to changes in both ENDS taxes (Abouk et al. 2023b; Dave et al. 2022) and ENDS prices (Pesko and Warman 2022). Abouk et al.

⁸ When they estimate models stratified by income, education, health insurance, and presence of children, they find little support for the hypothesis that these channels explain tax response disparities.

(2023b) use data from Monitoring the Future (MTF) survey and the YRBS and find that a one-dollar increase in ENDS taxes is associated with an approximately 15 to 30 percent decline in ENDS use among youth. The authors also find evidence for ENDS tax-induced substitution to combustible cigarettes, especially in the MTF data; Abouk et al. (2023b) find that a one-dollar increase in ENDS taxes increases current cigarette use by 20 percent and heavier use (smoking at least a half a pack of cigarettes per day) by 50 percent. Pesko and Warman’s (2022) results using the National Youth Tobacco Survey for prices imply that a 100 percent increase in the ENDS tax would increase youth cigarette smoking by about five cigarettes per 30 days. Together, the above studies provide compelling evidence that the spillover effects of ENDS taxes on youth and adult combustible tobacco use undermine the tobacco-related public health gains that policymakers wish to achieve.

2.4 Other ENDS Policies

Policymakers have also undertaken several other strategies to restrict access to ENDS. Many state and local jurisdictions (and ultimately the federal government) adopted a minimum legal purchasing age (MLPA) for e-cigarettes to match the MLPA for combustible tobacco products. While ENDS-specific MLPAs appear to induce substitution to combustible tobacco products,⁹ there is notable evidence that Tobacco-21 (T-21) laws — which raise the MLPA for *all tobacco products* from (for most jurisdictions) age 18 to 21 — reduce nicotine vaping *and* cigarette smoking among youths (Abouk et al. 2024; Friedman et al. 2019b; Friedman and Wu 2020; Hansen et al. 2023).

Policymakers have also pursued supply-side channels to restrict e-cigarette access. As of March 2024, 34 states and the District of Columbia have enacted laws that require retailers to have a state-issued license to sell ENDS products over the counter (Centers for Disease Control and Prevention 2024b). License fees are used to enforce state ENDS sales regulations, including the MLPA; however, Courtemanche et al. (2024) find no evidence that these laws are effective at curbing youth or young adult ENDS use.

⁹ Initially, states and localities adopted an ENDS-specific MLPA of age 18. Then, many jurisdictions adopted a Tobacco-21 (T-21) law, which raised the MLPA for all tobacco products to age 21 and on December 20, 2019, a Federal T-21 law was adopted (Campaign for Tobacco Free Kids n.d.). While there is evidence that ENDS-specific MLPAs are effective at curbing youth ENDS use (Abouk and Adams 2017; Pesko 2023), the preponderance of the evidence suggests that such ENDS-specific MLPAs induce substitution to combustible cigarettes (Dave et al. 2019; Friedman 2015; Pesko 2023). This finding suggests that, *ceteris paribus*, reducing access to ENDS causes substitution effects that undermine policymakers’ objective of improving tobacco-related public health.

Public health advocates have expressed concern that flavored ENDS may attract youths (Campaign for Tobacco-Free Kids 2023).¹⁰ As of June 2024, seven states and over 380 local jurisdictions (i.e., counties, cities, and towns) have adopted ENDS flavor restrictions (Campaign for Tobacco-Free Kids 2024). While ENDS flavor restrictions reduce ENDS use, particularly among youths, such laws also appear to induce substitution to combustible cigarettes (Cotti et al. 2024; Saffer et al. 2024).

In the light of concerns that tobacco users may use online purchases to bypass state and local tobacco restrictions (Cullen et al. 2018; Office of Surgeon General 2018; Williams et al. 2012, 2016, 2017), over 14 states have adopted internet sales shipping bans for tobacco products, and five include restrictions on shipping ENDS (Public Health Law Center at Mitchell Hamline School of Law 2022). While there is very little causal evidence on the impact of laws, a descriptive study on Massachusetts' ENDS sales ban suggests that many online vendors do not comply with the statute or even sell to underage consumers (Nali et al. 2021).

As of March 2024, 19 states and the DC have extended clean indoor air laws to include ENDS aerosols (Centers for Disease Control and Prevention 2024a). There is some evidence that these laws have been effective at curbing ENDS and combustible tobacco use. In particular, bans on ENDS use in indoor restaurants and workplace environments are effective in decreasing the use of ENDS and cigarettes for both young and prime-age adults (Friedman et al. 2021).

2.5 Contributions

This study builds on the work of Carpenter and Sansone (2021) by being the first to estimate the impact of ENDS taxes on LGBQ youth and young adults. Given the potentially important differences in motivations for nicotine vaping among LGBQ as compared to heterosexual youth and young adults, large disparities in ENDS use between these demographic groups, and potentially substantial long-run health costs of addiction to tobacco products, examining how ENDS taxes differentially impact sexual minority teens is important. Second, we explore possible explanations for heterogeneity in ENDS tax effects across sexual minorities and majority teens – particularly the role of mental health and bullying. Third, this study is the first to explore intersectionality in the effects of ENDS taxes by gender-race/ethnicity and sexual identity. As there are unique challenges faced by

¹⁰ While flavored cigarettes were banned by the 2009 Family Smoking Prevention and Tobacco Control Act, ENDS products may legally come in a variety of flavors like fruit, mint, cream, and candy themed flavors (e.g. watermelon, lemon mint, vanilla, cotton candy). According to the National Youth Tobacco Survey, 86 percent of high school students who currently use ENDS report using flavored ENDS (Gentzke et al. 2022).

those who face added discrimination by being sexual-, racial-, and gender-minorities, the effects of ENDS taxes differ based on intersectional demographic characteristics. Finally, this study explores the relative effectiveness of taxes to alternative ENDS policies — including supply-side policies such as e-cigarette licensure laws and flavor bans — to assess potential differences in effectiveness across policies adopted to date to curb tobacco use among queer youth.

3. Data

3.1 State YRBS Data

Our primary analysis uses data from the State Youth Risk Behavior Surveillance System Surveys (YRBS). The State YRBS is a biennial, school-based survey coordinated by the Centers for Disease Control and Prevention and administered by state Departments of Education and Health and Human Services. When weighted, each state YRBS survey — which consists of hundreds, often thousands of observations (even for smaller population states) — is designed to be representative of each state’s population of high school students. The representativeness of these surveys at the state level is particularly important when examining the effect of a state policy on health disparities between majority and minority populations. Moreover, using state-by-year population data from the Surveillance of Epidemiology and Ends Research (SEER), pooled State YRBS surveys can be made approximately representative of U.S. teenagers ages 14 to 18 years old. Below, we discuss comparative analysis using the Combined Youth Risk Behavior Survey, which pools data from the National and State YRBS surveys to maximize identifying variation collected and coordinated by the CDC, in combination with the State YRBS surveys using methods established in earlier work (Anderson et al. 2020; Abouk et al. 2023b; Cotti et al. 2024).¹¹

As this study focuses on disparities in the effects of ENDS taxes on tobacco use among LGBTQ youth, we first measure youths’ self-reported sexual identity using responses to the following questionnaire item:

“Which of the following best describes you?”

[Possible answers: Heterosexual (straight), Gay or Lesbian, Bisexual, or Not Sure]

¹¹ These data include the same information on key outcomes and sexual identity (beginning in 2015) as the state YRBS. When weighted, the National YRBS sample is designed to be nationally representative but is not designed to be representative of each state. Moreover, as described below, the number of LGBTQ-identifying respondents in many treatment states in a given year is very small (mean = 70) as compared to the State YRBS (mean = 773).

If the respondent answers “heterosexual (straight)”, we classify the youth as identifying as heterosexual; if a respondent answers “gay or lesbian,” “bisexual,” or “not sure,” we classify them as identifying as lesbian, gay, bisexual, or questioning (LGBQ).¹² Appendix Figure 1 shows that from 2011-2021 there was a sizeable increase in the proportion of youth identifying as a sexual minority, especially those who identify as bisexual or questioning. Across the entire 2015-2021 sample period, 17.2 percent of youths identify as LGBQ. The majority of self-reported sexual minorities identify as bisexual (8.6 percent), followed by questioning (5.7 percent), and then gay or lesbian (2.9 percent). While these means are consistent with recent estimates of the share of the younger-aged U.S. population who identifies as LGBTQ+. For instance, a recent Gallup poll found that 22.3 percent of Generation Z identified as sexual minorities (Gallup 2024a).

These and other summary statistics are reported in Table 1. Sexual identity is missing for 15.1 percent of the sample, and most of the missing values (84 percent) are due to states not including the question in their YRBS survey. The second column of Table 1 shows summary statistics excluding observations with missing information on sexual identity. The variable means are generally very similar to those for the unrestricted sample in the first column. Moreover, as we show below, estimated effects of ENDS taxes on youth smoking are very similar in the overall YRBS sample as compared to the sample that is restricted to include non-missing information on sexual identity.

Our primary outcome is ENDS use among youths. This measure is available in the 2015, 2017, 2019, and 2021 surveys. In these survey waves, respondents to the State YRBS are asked:

“During the past 30 days, on how many days did you use an electronic vapor product?”
[Examples include: “e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods [such as JUUL, SMOK, Suorin, Vuse, and blu]”]

Current ENDS Use is set equal to one if the respondent reports ENDS use on a positive number of days in the last 30 days, and zero otherwise. In the sample in which sexual identity is reported, we estimate that 19.4 percent of respondents (when weighted) are prior-month ENDS users. This compares to 19.2 percent of respondents in the full sample, suggesting that over the 2015-2021

¹² In 2021, the YRBS added responses to the sexual identity question, including “I describe my sexual identity some other way,” “I am not sure about my sexual identity (questioning),” or “I do not know what this question is asking.” Those responding in this way are also classified as LGBQ for our main analysis, though the findings are robust to their exclusion.

period, the selection of states that reported information on youth sexual identity was relatively similar to the full sample with respect to ENDS use. These and other summary statistics are reported in Table 1.

When we examine ENDS participation rates separately by sexual identity, we find different rates of use. Figure 1 documents trends in ENDS use among LGBQ- and heterosexual-identifying youth. We find that both groups follow a similar trend in ENDS use over the 2015-2021 period, with participation in ENDS use declining between 2015 and 2017, increasing in 2019, then decreasing slightly again in 2021. However, we find that ENDS participation rates are consistently 3.2 to 6.8 percentage-points (14.7 to 41.6 percent) higher for LGBQ-identifying youth relative to heterosexuals, with a participation differential that remains fairly constant over the period.

In addition to current use, we examine more habitual e-cigarette use, measured by whether the youth reports ENDS use on at least 20 of the prior 30 days (*Frequent ENDS Use*) or on all 30 of the prior 30 days (*Everyday ENDS Use*). We find that 5.2 percent of teenagers in our analytic sample report frequently using ENDS in the prior 30 days and 3.7 percent report daily ENDS use. Rates of frequent and everyday ENDS use are generally higher for LGBQ as compared to heterosexual youth, particularly in 2021.

Next, we measure cigarette smoking among youths. We use the same 2015-2021 period to examine spillover effects to cigarette smoking, though we are also able to expand the analysis window back to 2011 (when we have consistent measures of cigarette smoking and sexual identity). We measure cigarette smoking using responses to the following survey item:

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

Current Cigarette Smoking is then set equal to one if an individual responds that they had smoked cigarettes on a positive number of days, zero otherwise. *Frequent Cigarette Smoking* and *Everyday Cigarette Smoking* are created in a similar manner to frequent and everyday ENDS use (using 20 and 30 day prior-month cutoffs). Over the 2011-2021 period, 11.1 percent of LGBQ-identifying teens and 6.4 percent of heterosexual-identifying teens report prior-30 day cigarette smoking. Rates of frequent (everyday) cigarette smoking are 3.1 (2.3) percent for LGBQ-identifying teens and 1.6 (1.2) percent for heterosexual youth. As shown in panel (a) of Appendix Figure 2, rates of current teen cigarette smoking have declined since 2011, though significant differences by sexual identity exist

throughout the sample period. Intensive measures of frequent and everyday smoking follow similar patterns, as indicated by panels (b) and (c).¹³

Additionally, we measure *Cigarette or Cigar Smoking* among youths. Respondents are asked:

“During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?”

Current Cigarette or Cigar Smoking is then set equal to one if an individual responds that they had smoked cigarettes or cigars on a positive number of days; and is set equal to zero if an individual responds with zero days to both questions.¹⁴ *Frequent Cigarette or Cigar Smoking (Everyday Cigarette or Cigar Smoking)* is again created similarly, with the variable turning on for responses of 20 or more days (30 days) to either question. Over the 2011-2021 period, 18.7 percent of LGBQ-identifying teens and 11.8 percent of heterosexual-identifying teens report prior-30 day cigarette or cigar smoking (Table 1). Rates of frequent (everyday) cigarette or cigar smoking were 5.1 (3.7) percent for LGBQ-identifying teens and 2.6 (1.9) percent for heterosexual youth.¹⁵

3.2 ENDS Taxes

To generate a standardized measure of ENDS taxes, we follow Cotti et al. (2023), using NielsenIQ retail scanner data and assuming a 35 percent retailer markup (based on e-cigarette company purchasing forms), to convert ad valorem and sales taxes to their excise tax equivalents, allowing for comparison across states that may implement different tax schema. Our tax variable is the value for a mL of fluid nicotine. Figure 2 shows geographic, temporal and intensity of variation in real ENDS taxes (in 2021\$) from 2010 through 2021.¹⁶

4. Empirical Strategy

¹³ Appendix Figure 3 shows similar results for rates of smoking either cigarettes or cigars.

¹⁴ The variable is coded as missing if the response to both questions is missing, or if the response to one question is missing and the other is zero days.

¹⁵ Exhibiting a similar downward trend to teen cigarette smoking, Appendix Figure 3 plots the evolution of teen cigarette or cigar use by sexual orientation, and the higher rates of LGBQ combustible tobacco use are evident, especially during the earlier years of our analytic sample.

¹⁶ In 2021, Minnesota had the highest state ENDS tax (\$2.89 per mL of liquid nicotine), while Delaware, Georgia, Kansas, Louisiana, North Carolina, and Wisconsin had the smallest ENDS tax (\$0.05 per mL of liquid nicotine).

We begin by estimating a fixed effects logistic regression model in which the probability that respondent i residing in state s in year t in semester (fall or spring) p vaped nicotine in the prior 30 days:

$$Pr(Y_{istp} = 1 | \mathbf{X}) = \frac{e^{\beta_0 + \beta_1 \text{ENDS Tax}_{stp} + \mathbf{X}_{istp}\beta_2 + \gamma_s + \tau_t + \eta_p}}{1 + e^{\beta_0 + \beta_1 \text{ENDS Tax}_{stp} + \mathbf{X}_{istp}\beta_2 + \gamma_s + \tau_t + \eta_p}} \quad (1)$$

ENDS Tax_{stp} is a state-by-year-semester measure of ENDS tax per mL of liquid nicotine in 2021 dollars, \mathbf{X}_{istp} is a vector of control variables including (1) individual demographic variables (age, grade in school, race/ethnicity, gender), (2) state macroeconomic conditions (unemployment rate) and COVID-19 deaths (cumulative COVID-19 death rate), (3) e-cigarette policies (MLPAs, T-21 laws, indoor vaping bans (at bars, restaurants, or workplaces), ENDS licensure laws for retailers, ENDS flavor restrictions, and ENDS online sales delivery bans), (4) combustible tobacco control policies (cigarette taxes in 2021 dollars, indoor smoking bans, and combustible tobacco licensure laws), and (5) other substance use policies (recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes in 2021 dollars, and Good Samaritan alcohol laws). In addition, γ_s is a state fixed effect, τ_t is a year fixed effect, η_p is a semester (fall or spring) fixed effect. We present average marginal effects in all tables. We will also report coefficient estimates from linear probability models.

We estimate equation (1) on a sample of heterosexual-identifying youths, and LGBTQ-identifying youths, with attention to differences in the parameter of interest, β_1 , across these two groups. One concern with estimating the equation separately by sexual identity is that identification as a sexual minority could plausibly be related to changes in ENDS taxes if they proxy for progressive “pro-health” policies or sentiment. Previous research suggests that genetics (Ganna et al. 2019; Pillard and Bailey 1998; Song and Zhang 2024), epigenetic responses to androgen exposures in-utero (Breedlove 2017; Rice et al. 2012), and fraternal birth order (Blanchard 2018) affect sexual orientation, although the decision to reveal one’s sexual identity — to oneself, to one’s peers, and on a survey — is endogenous (see Anderson et al. 2021). In Appendix Table 1, we present regression results showing no evidence that ENDS taxes are related to the probability of identifying as a sexual minority. Estimated coefficients are very small across all models and not statistically significant, supporting the hypothesis that sample selection bias is a relatively unimportant concern in this policy context.

We exploit within-state changes in ENDS taxes to identify β_1 . Over the sample period 2015-2021, there are 61 (non-inflation driven) year-by-quarter changes in ENDS taxes throughout the U.S., 29 of which we capture in our data. To generate an unbiased estimate of the effect of ENDS taxes on youth tobacco use, there must be no (1) time-varying unobservables associated with ENDS tax changes and with the outcome under study, (2) reverse causality, whereby youth tobacco use drives changes in ENDS taxes, and (3) parallel trends between adopting and non-adopting states.

With respect to the former two concerns, we implement several approaches. First, we include a wide set of tobacco control policies as covariates to reduce the likelihood that ENDS taxes are simply proxying for a bundle of tobacco control policies or changes in anti-tobacco sentiment that accompany ENDS tax changes. In addition, we examine the sensitivity of the estimate of β_1 across subsets of observable controls. Relative stability in the estimated treatment effect could signal that ENDS taxes are enacted exogenously to youth ENDS use.

Second, we explore the sensitivity of the estimated treatment effect to augmented controls for spatial heterogeneity. Specifically, we add controls to the right-hand side of equation (1) for census region-specific year effects to control for unmeasured shocks that commonly affect states within census regions (and could be incidentally correlated with ENDS taxes and youth tobacco use) by forcing “close controls” and controlling for a common-treatment-state linear time trend.^{17,18}

With respect to parallel trends, our primary approach to descriptively test for this concern is through estimation of an event-study model. More specifically, using the approach of Schmidheiny and Siegloch (2023), we test for whether youth ENDS use was trending differently in treatment and control states prior to changes in ENDS taxes.

Finally, recent innovations in the difference-in-differences literature suggest that in the context of staggered policy adoption and heterogeneous and dynamic treatment effects, two-way fixed effects estimators such as those described in equation (1) could result in biased estimates of β_1 (Goodman-Bacon 2021). To address this concern, we use a stacked difference-in-differences approach (Cengiz et al. 2019). This approach has been used previously in the ENDS tax literature (Abouk et al. 2023b; Dave et al. 2022; Dave et al. 2024) and expunges bias due to heterogeneous and dynamic treatment effects by relying on “never adopters” (states that never adopt an ENDS tax) or

¹⁷ A common treatment state specific linear time trend means that each treatment state does not get its own fixed effect interacted with the linear time trend, but is less restrictive in that it sets a “common” or “grouped” treatment state indicator that is interacted with a linear time variable.

¹⁸ These approaches are not without criticism and could, in fact, introduce bias in estimated treatment effects (see, for example, Neumark et al. [2014] and Burkhauser et al. [2023]).

“not yet adopters” (states that have not yet adopted an ENDS tax) as counterfactuals and choosing a common event window.¹⁹ We also explore sensitivity of findings to an alternate difference-in-differences estimator proposed by deChaisemartin and D’Haultfoeuille (dCDH) (2020).²⁰

5. Results

Our main findings appear in Tables 2 through 8 and Figures 3 through 8. Supplemental analyses appear in the appendix figures and tables.

5.1 ENDS Taxes and ENDS Use among LGBQ and Heterosexual-Identifying Teens

In panel I of Table 2, we present estimates of the effect of ENDS taxes on youth ENDS use for the State YRBS sample. To facilitate comparison with subsequent analyses that stratify by sexual identity, we exclude from the sample observations with missing information on sexual identity. In unreported regressions (available upon request), we show that the results are virtually identical without that exclusion. All regressions control for state, year, and semester fixed effects as well as excise taxes on cigarettes (in 2021\$).²¹

The first four columns of the table show the results using the indicator for current ENDS use as the outcome, gradually adding control variables. In our most parsimonious specification, which includes controls for demographic characteristics, macroeconomic conditions, and COVID-19 deaths (column 1), we find that a one-dollar increase in ENDS taxes is associated with a 3.3 percentage-point decline in youth ENDS use. The magnitude of this effect corresponds to a 15.6 percent decline relative to the pre-treatment mean. The addition of controls for a set of combustible tobacco control policies (column 2), ENDS-related policies (column 3), and drug-and alcohol-related policies (column 4) has very little effect on the estimated treatment effect. In our preferred specification that includes all the control variables, we find that a one-dollar increase in ENDS taxes

¹⁹ We construct separate datasets for “stacks” for each adoption year of ENDS taxes during our analysis period (2015, 2017, 2019), excluding states that adopt in 2021 due to an inability to observe dynamic effects. The event window for each dataset spans six years prior to two years post adoption. Treatment effects are then obtained in a pooled logistic regression similar to equation (1) that includes stack-by-state and stack-by-year fixed effects.

²⁰ As with a stacked difference-in-differences estimator, an advantage of the dCDH estimator is that it expunges potential bias from heterogeneous and dynamic treatment effects by relying on counterfactuals where ENDS taxes do not change over the sample period (“never changers”). A further advantage is that the estimator allows the continuous treatment to increase and decrease in value rather than be “all absorbing” in nature, this feature is advantageous as the state of Kansas lowered the ENDS tax from \$0.20 to \$0.05 per mL of nicotine. However, the estimator can accommodate multivalued, but not fully continuous, treatment variables. Thus, we convert our continuous tax into a multi-valued variable: states (in \$2021) with no tax, a tax of \$0.01 to \$1, \$1.01 to \$2, and \$2.01 or more.

²¹ Appendix Tables 2 and 3 show the estimated coefficients for cigarette taxes for comparison.

is associated with a 3.8 percentage-point (17.9 percent) reduction in ENDS use. This estimate translates to a tax elasticity of about -0.050.²² This finding is consistent with results in several prior studies (Abouk et al. 2023b; Dave et al. 2022; Dave et al. 2024), consistent with the hypothesis that ENDS taxes “bite” for youths.

In the other two panels of Table 2, we explore the effect of ENDS taxes on ENDS use among heterosexual-identifying youth (panel II) and LGBTQ-identifying youth (panel III). The findings reveal a stark pattern. A one-dollar increase in ENDS taxes is associated with a 3.6 to 4.2 percentage-point (17.6 to 20.6 percent) decline in ENDS use among heterosexual-identifying teens. However, for LGBTQ-identifying teens, for whom pre-treatment ENDS use in ENDS tax-adopting states was almost 30 percent higher than for heterosexuals (26.1 percent vs. 20.4 percent), the effect of ENDS taxes is about 50 percent smaller (in absolute magnitude) and is statistically indistinguishable from zero at conventional levels. In our preferred specification (column 4), we find that a one-dollar increase in ENDS taxes is associated with a statistically insignificant 2.5 percentage-point (9.6 percent) decline in ENDS use among LGBTQ teens. In the final row, we find that these estimated coefficients are statistically different at the ten percent significance level in three out of the four models and close to statistically significant in the fourth, suggesting that a one-dollar increase in ENDS taxes widens disparities in ENDS use among LGBTQ versus heterosexual teens. These findings are consistent with a more tax-inelastic demand for e-cigarettes among LGBTQ youth.

The remaining eight columns of Table 2 explores the effects of ENDS taxes on more intensive margins of e-cigarette use. Frequent ENDS use is the outcome in columns (5) through (8) while everyday ENDS use is the outcome in columns (9) through (12). Our results in Panel II show that a one-dollar increase in ENDS taxes leads to a 1.9 to 2.1 percentage-point (48.7 to 53.8 percent) reduction in frequent use and a 1.7 to 1.9 percentage-point (60.7 to 67.9 percent) decline in everyday use among heterosexual-identifying teens. For LGBTQ teens (panel III), however, we find no evidence that ENDS taxes lead to statistically significant declines in frequent or everyday ENDS use. In fact, the estimated coefficient is *positive* in the majority of specifications. The estimates for heterosexual and LGBTQ teens are statistically different at the one percent level in five of the eight specifications, five percent level in seven, and 10 percent level in all eight. When we test for whether these coefficients are statistically different, we find that these estimated treatment effects are

²² The average ENDS tax across 2015-2021 State YRBS observations with sexual identity information is \$0.28 (in \$2021). Thus, a one-dollar tax increase represents a 358 percent increase, and this relative increase divides our estimated 17.9 percent reduction in current ENDS use.

statistically different from one another.²³ Therefore, there is robust evidence that ENDS taxes *increased disparities* in frequent and everyday ENDS use.

Table 3 explores the sensitivity of the estimates from the specification with full controls in Table 2 (columns 4, 8, and 12) to the use of a linear probability model as opposed to logistic regression. The pattern of findings is quite similar, though the effects of ENDS taxes on vaping disparities between LGBQ and heterosexual teens is statistically significant only for everyday use.

5.2 Sensitivity Checks and Tests of Parallel Trends

One concern with our difference-in-differences estimates is that they could be contaminated by heterogeneous and dynamic treatment effects. Panel I of Table 4 presents stacked difference-in-differences estimates of the effect of ENDS taxes on youth e-cigarette use. The findings are, in the main, consistent with what we obtained using our fixed effects logit model, suggesting that heterogeneous and dynamic treatment effects are not an important source of bias. If we instead address the issue of bias from heterogeneous treatment effects using a dCDH event study (see Appendix Figures 4 and 5), the confidence intervals are typically larger and we observe stronger evidence for significant disparities in the effects of ENDS taxes for more habitual (frequent and everyday) use than for any current use.

Continuing to panel II of Table 4, we explore the sensitivity of our findings to use of the Combined State and National YRBS Surveys as compared to only the State YRBS Surveys to maximize identifying variation. Our results from the Combined YRBS continue to provide consistent evidence that ENDS taxes are associated with declines in ENDS use among heterosexual, but not LGBQ teens. A one-dollar increase in ENDS taxes increases the ENDS use disparity between heterosexual- and LGBQ-identifying teens by about one to two percentage-points across the three outcomes. In Table 5, we explore the sensitivity of our estimates to controls for spatial

²³ We test for whether the difference-in-differences logit estimates are statistically equivalent for LGBQ and heterosexual youth using a fully interacted logit regression that pools LGBQ and heterosexual youth. The model fails to converge for everyday ENDS use with the two more thorough sets of controls (columns [11] and [12]). We therefore took two strategies to conduct those tests. First, we used OLS instead of logit models. Second, we omitted two controls from the specification that impeded convergence. (We show in Appendix Table 4 that these controls had no effect on the estimated treatment effect for LGBQ and heterosexual youth.) In each case, we find that ENDS taxes significantly increase disparities between sexual minority and heterosexual youths. Testing for differences in the coefficient estimates across LGBQ and heterosexual youth using a non-parametric bootstrap (400 repetitions) produced a qualitatively similar pattern of results.

heterogeneity. Specifically, columns (1) through (3) include census region-by-year fixed effects, while columns (4) through (6) include a common treatment state linear time trend. The findings continue to suggest that ENDS taxes exacerbate disparities in ENDS use between sexual minority and heterosexual teens, particularly for frequent and everyday use.^{24,25}

Finally, Figure 3 shows results from event-study analyses for heterosexual teens, while Figure 4 does the same for LGBQ teens. Both figures contain three panels, corresponding to each outcome. Each panel contains three graphs, with the first being from TWFE, the second utilizing stacked DiD, and the third using stacked DiD but with the full set of controls for other policies included. Across the 18 graphs, pre-treatment trends are relatively flat and centered around zero, suggesting that the models from Table 2 reliably estimate causal effects. For heterosexual teens, all nine graphs provide evidence of a post-ENDS tax decline in ENDS use. However, for LGBQ youth, we detect no evidence in any specification that ENDS use reduces ENDS use.²⁶

5.3 Spillover Effects to Combustible Tobacco Products

The above findings show consistent evidence that ENDS taxes reduce ENDS use among heterosexual, but not LGBQ teens. We next explore spillover effects to combustible tobacco smoking. Given our findings above, unless there are independent channels other than price effects through which ENDS taxes could affect combustible tobacco product use — for instance, by signaling relative health effects or social acceptability of e-cigarettes versus combustible tobacco products — ENDS taxes would only be expected to affect cigarette (or cigar) smoking among heterosexual-identifying teens, as there were no “first-stage” effects on tobacco use among LGBQ-identifying students.

²⁴ We present spatial heterogeneity estimates using linear probability models in Appendix Table 6.

²⁵ Results from additional sensitivity checks are reported in the appendix. In Appendix Figure 7, we explore whether our estimated treatment effects are sensitive to leaving out one treatment state at a time. The estimated ENDS tax effects are generally not sensitive to a particular treatment state, though the estimated effects are less precisely estimated when California is omitted. In Appendix Figure 8, we explore whether the null finding on LGBQ youth is masking important heterogeneity among LGBQ-identifying youth. For habitual use, there is the strongest evidence of gay/lesbian vs. heterosexual disparities, where our findings provide little support for the hypothesis that ENDS taxes reduces ENDS use among sexual minorities who identify with different LGBQ labels. In Appendix Table 7, we explore further controls for the COVID-19 pandemic by including more detailed variables related to the pandemic from Hale et al. (2021). Specifically, we include a state-specific government response index that provides an overall impression of pandemic-related government activity, as well as the percentage of fully vaccinated individuals within the state. The results offer evidence that the disparity in response by sexual orientation is not driven by pandemic-related issues.

²⁶ The event studies reported in these figures interact the time-to-treatment indicators with continuous ENDS tax. Appendix Figure 6 shows similar patterns if we dichotomize the treatment variable to indicate tax increases of larger than \$0.25.

Table 6 presents logistic regression estimates of the effects of ENDS taxes on cigarette and cigar smoking among heterosexuals and LGBTQ-identifying students for the 2011-2021 period for both the state (panel I) and combined (panels II and III) datasets. In the State YRBS, we find that logistic regression estimates provide little evidence that ENDS taxes lead to significant changes in combustible tobacco use. Estimated effects are small, occasionally negative, and not statistically distinguishable from zero. However, if we use data from the Combined State and National YRBS, we do find some evidence that e-cigarettes and combustible tobacco products are substitutes, consistent with Abouk et al. (2023), and these effects are driven by heterosexual teens. In panel II, logit estimates show that a one-dollar increase in ENDS taxes is associated with a one to two percentage-point increase in combustible cigarette (columns 1-3) and cigarette or cigar (columns 4-6) smoking among heterosexual youths. We also estimate similar magnitudes when we use a linear probability model as compared to logistic regression estimates, with differences in effects between LGBTQ and heterosexual youths being statistically significant at the 10 percent level or better in two of the six specifications (panel III).²⁷

As discussed above, our analysis of the State YRBS does not suggest that combustible tobacco product use increases substantially following an ENDS tax hike, this pattern of (null) findings is somewhat at odds with the earlier literature which demonstrates that some teens may substitute to combustible tobacco products as ENDS taxes rise. However, coefficient estimates increase in magnitude when we use the combined State and National YRBS dataset and are precise, these findings are more in line with earlier work, suggesting substitution to combustibles by teens. While investigating why these findings differ is beyond the scope of this paper, we note that Minnesota is not included in the State YRBS but is included in the National YRBS, and the differences in findings across data sets may be attributable to that state's experiences. In particular, Minnesota was the first state to adopt an ENDS tax (2010) and has set taxes at relatively high levels (vs. other states). These features suggest that Minnesota's experiences may be important to the earlier findings that teens substitute to combustibles as the price of e-cigarettes is increased by taxes.

Event-study analyses in Figure 6 (State YRBS) and Appendix Figure 9 (Combined State and National YRBS) show relatively flat pre-treatment trends and post-treatment effects consistent with

²⁷ Using data from 2015-2021 to match the period over which we have ENDS use data produces a qualitatively similar pattern of results (see Appendix Table 8).

those from the main regression results from the corresponding dataset.^{28,29} Finally, in the final row of Table 6, we test for whether ENDS taxes significantly reduce disparities in cigarette smoking between LGBQ and heterosexual teens. In most cases (five out of six specifications), the differences in the estimated treatment effects between heterosexual and LGBQ youth are not statistically distinguishable from zero; in the one case where there is a statistically significant difference (column 2), this difference is only marginally statistically significant at the 10 percent level.

5.4 Mechanism: Minority Stress for Youth

The findings from Sections 5.1 and 5.2 provide robust evidence that ENDS taxes reduce vaping among heterosexual youth more strongly than LGBQ youth. What could explain this differential effect? Homophobia-driven social pressures and unique psychological trauma faced by LGBQ teens, which contribute to “minority stress,” could lead sexual minorities to turn to ENDS use as a coping mechanism. If so, then LGBQ teens should exhibit a more inelastic demand for e-cigarettes as compared to their heterosexual counterparts.

In Table 7, we present results from analyses examining the plausibility of these mental-health-related factors as mechanisms explaining the differential impact. The basic idea is that, if sexual minorities are unresponsive to ENDS taxes because they face disproportionate mental health challenges, then LGBQ youths who *do not* face these challenges should exhibit a more similar response to heterosexual youths. Following a similar approach to Carpenter and Sansone’s (2021) analysis of cigarette taxes, we explore whether the effect of ENDS taxes on ENDS use varies with persistent sadness/depression, bullying victimization, and suicidal ideation.^{30,31} While splitting the sample based on mental health variables could be concerning given that mental health could be endogenously affected by ENDS taxes, perhaps through nicotine effects (Kutlu and Gould 2015a;

²⁸ Event studies in Appendix Figure 10 focus on spillovers to cigarettes or cigars using data from the State YRBS.

²⁹ In Appendix Figures 11 and 12, we again explore heterogeneity in the effects of ENDS taxes based on the intersection of sexual identity with both gender and race/ethnicity.

³⁰ We define individuals with persistent sadness as those who respond with “yes” to the survey question: “During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?” In-person bullying victimization status is coded using the question, “During the past 12 months, have you ever been bullied on school property,” and we include “During the past 12 months, have you ever been electronically bullied? (Count being bullied through texting, Instagram, Facebook, or other social media)” to create an indicator for an individual being bullied either in-person or electronically. We identify individuals that have considered suicide by using the question, “During the past 12 months, did you ever seriously consider attempting suicide?”

³¹ In the State YRBS data, we find that LGBQ teens are 100 percent more likely to report depression (60 percent vs. 30 percent), 189 percent more likely to report having considered suicide (40 percent vs. 14 percent), and 82 percent more likely to report bullying victimization (38 percent vs. 21 percent) than their heterosexual peers.

Kutlu et al. 2015b), auxiliary analysis results (available upon request) do not provide evidence that ENDS taxes improve youth mental health.

We begin by focusing on queer teens in columns (1) and (2). In column (1) of panel I, we find that among LGBQ individuals who report sadness for two or more weeks in a row in the last 12 months, ENDS taxes are associated with a statistically insignificant 2.2 percentage point (7.1 percent) decline in the probability of any current ENDS use. On the other hand, when we examine LGBQ individuals who do not report consistent sadness, we find that a one-dollar increase in ENDS tax is associated with a 4.6 percentage point (24.9 percent) decline in ENDS use, a magnitude similar to that seen among heterosexual teens. A test that these two coefficients are significantly different from one another yields a p -value of 0.1071.

In panel II, columns (1)-(2), we explore differential effects of ENDS taxes by bullying victimization (in-person *or* electronic). Bullying victimization has been linked to depressive symptomatology and suicidal behaviors among LGBQ youth (Liang et al. 2023; Rees et al. 2022). Our results show that ENDS taxes have larger effects on ENDS use among LGBQ youths who report not being bullied as compared to those who report bullying victimization, with the difference being statistically significant at the five percent level.

Panel III stratifies by whether teens report being *either* depressed or bullying victims, and the pattern of results is the same. The effect of ENDS taxes on the probability of any current ENDS use for LGBQ youths who do not report being depressed or bullied is 4.5 percentage points, statistically significant at the 10 percent level, while the effect of ENDS taxes for LGBQ youths who report being depressed or bullied is 1.1 percentage points, but does not rise to the level of statistical significance. The difference between the estimated effects on the two LGBQ subsamples is statistically significant at the five percent level.

When we stratify the LGBQ sample based on reporting having considered suicide (panel IV, columns 1 and 2), we again find that ENDS tax effects are larger, and statistically different, for LGBQ teens who are in better as compared to worse mental health. The estimate is essentially zero for those who have considered suicide in the past 12 months, compared to 3.6 percentage points (17.4 percent) among those who have not. The difference in effects is statistically significant at the 10 percent level. Together, the findings in columns (1) and (2) are consistent with the adverse psychological consequences of “minority stress” leading to ENDS use as a potential coping strategy (Saffer and Dave 2005) among queer teens. A potential policy implication from this finding is that

adopting policies that improve the psychological health of LGBQ youths and/or reduce their likelihood of being bullied may result in greater ENDS tax responsiveness.

In columns (3) and (4), we explore whether psychological problems or bullying victimization also attenuate the effects of ENDS taxes on heterosexual youths. Intriguingly, they do not. Coefficient estimates among those in better and worse mental health or among those who are and are not victims of bullying are generally similar in magnitude. This result is consistent with several hypotheses, including (but not limited to): (1) psychological stressors facing LGBQ youths (“minority stress”) being uniquely traumatic (i.e., being in the closet); (2) lack of effective, LGBQ-inclusive psychological services and outreach; and (3) difficulty reaching out for help if LGBQ youths are not open about their sexual identity (perhaps due to homophobia, family pressure, religious rejection, and unsupportive peers).

5.5 Intersectionality by Sexual Identity and Demographic Characteristics

In Figure 5, we explore heterogeneity in the effects of ENDS taxes, focusing on the intersection of sexual identity with both gender and race/ethnicity.³² Panel (a) shows little evidence of differential effects of ENDS taxes across gender and race among heterosexual teens. For LGBQ teens, the most notable finding is that the estimated effect is much larger among males (around a 7 percentage-point reduction) than females (around a one percentage point reduction). Although the magnitude for males is quite large, the coefficient estimate is not quite statistically significant at the five percent level due to a wide confidence interval. In panels (b) and (c), which contains results for the more intensive vaping outcomes, we see that heterosexual males respond more strongly to ENDS taxes than heterosexual females and heterosexual White teens respond more strongly than heterosexual Hispanic or Non-White teens. In contrast, there is no evidence that ENDS taxes influence any subgroup of LGBQ teens, with most of the point estimates actually being positive.

Appendix Table 9 shows results for subsample splits by drinking status, household income, parental education, health insurance status, and presence of other children in the home. We find no statistically significant evidence that ENDS taxes affect the probability of any current ENDS use among any of these subgroups. These null results help to rule out some other potential explanations for the differential impacts of ENDS taxes on LGBQ versus heterosexual youths, such as differences in disposable income, knowledge-seeking, and health care access.

³² Appendix Figures 11 and 12 conduct similar analyses for cigarette smoking and cigarette or cigar smoking, respectively.

5.6 Do Other Recent Tobacco Policies Affect LGBQ Youth?

The findings above suggest that sexual minority youth are relatively insensitive to changes in ENDS taxes in terms of vaping. Could other policies be more effective? In Figure 7, we compare the effectiveness of ENDS taxes against other recent prominent tobacco control policies explored in the literature, including: flavored ENDS restrictions (Cotti et al. 2024; Saffer et al. 2024), T-21 laws (Hansen et al. 2023; Cotti et al. 2024b), ENDS MLPA laws (Dave et al. 2019; Pesko 2023), e-cigarette licensure laws (Courtemanche et al. 2024), and cigarette taxes (Anderson et al. 2020; Hansen et al. 2017; Carpenter and Sansone 2021). While we find no evidence that any of the policies reduce the likelihood of any current vaping among LGBQ teens, some evidence suggests that two key restrictions on ENDS access help curb habitual vaping.

The first is restrictions on the sales of flavored ENDS, which reduces the probability of frequent ENDS use by about 2.5 percentage points and the probability of everyday ENDS use by about 3 percentage points among LGBQ youths. This is consistent with Cotti et al. (2024) and Saffer et al.'s (2024) findings for youths in general, as well as evidence that 89 percent of youth ENDS users consume flavored ENDS (Birdsey et al. 2023). However, the confidence intervals are relatively wide, and only the effect on everyday use is statistically significant at the five percent level. Moreover, results shown in Appendix Figures 13 and 14 show that ENDS flavor bans increase cigarette smoking among LGBQ youths by an amount that is similar to the magnitude of the reduction in vaping. These results are robust to controlling for the menthol cigarette restrictions that sometimes accompany ENDS flavor bans. Therefore, even if ENDS flavor bans do reduce vaping among LGBQ teens, it is not clear that such a policy strategy should be pursued if the public health goal is to improve tobacco-related health more generally.

A second policy that may have reduced vaping among LGBQ teens is the adoption of T-21 laws, which typically raise the MLPA for all tobacco products from 18 to 21. As Hansen et al. (2023) discuss, there were important spillovers of these laws to teens, as 18-19-year-olds attending high schools can serve as younger teens' social sources for e-cigarettes. While imprecisely estimated and not quite statistically significant, we find that T-21 laws lead to sizeable declines in frequent and everyday ENDS use among LGBQ youth of around 3 percentage points. Perhaps because these laws covered all tobacco products, there is no evidence of corresponding substitution to cigarettes (see Appendix Figure 15).

Together, these results for flavor bans and T-21 laws suggest that stronger policies like broad access or sales bans may be more effective in curbing ENDS use among LGBQ youth than taxes. With that said, given the number of policies and outcomes studied, we cannot rule out spurious results due to multiple hypothesis testing. These results should therefore be seen as preliminary.

5.7 Auxiliary Analysis of Adults in BRFSS

Finally, we explore whether the effects of ENDS taxes on sexual identity-based disparities differs for adults as compared to teens. Given that reasons for use of e-cigarettes may differ between adults and youths (e.g., smoking cessation tool vs. first nicotine product), patterns of differential tax responsiveness could also differ.

Table 8 reports the results, obtained using the 2016-2021 BRFSS.³³ Following Carpenter and Sansone (2021), we use sampling weights and cluster our standard errors at the state level. We separately analyze younger and older adults given the literature suggesting that younger adults are more tax sensitive (Dave et al. 2022; Dave et al. 2024; Friedman and Pesko 2022). For young adults, the overall pattern of results is similar to that observed for teens, with clearer effects emerging for heterosexual than LGBQ young adults.³⁴ Among heterosexual-identifying young adults aged 18-30 (panel I, columns 1-3), we find that a one-dollar increase in ENDS taxes is associated with a 1.34 to 1.42 percentage-point reduction in current ENDS use, corresponding to a 13.9 to 14.6 percent reduction. Thus, the coefficient estimate remains virtually identical across the three specifications, although only the first two are statistically significant due to a substantial increase in the standard error after controlling for other ENDS, substance, and alcohol policies in the third model. Among LGBQ young adults (panel II), we find no evidence that ENDS taxes reduce prior month vaping, and the coefficient estimates statistically differ from those for heterosexual teens in the first two specifications. Event-study results for current ENDS use, shown in Figure 8, are consistent with the common trends assumption for both the heterosexual and LGBQ samples. For everyday ENDS use, the estimated effect of ENDS taxes is again more strongly negative for heterosexual than queer young adults, but the pattern is less pronounced, and most estimates are not statistically significant.

³³ To identify ENDS use in the BRFSS, we use the survey question: "Do you now use e-cigarettes or other electronic vaping products every day, some days, or not at all," coding those who respond with "every day" or "some days" as current ENDS users.

³⁴ To define sexual orientation, we use the question: "Which of the following best represents how you think of yourself" to code LGBQ individuals as those who respond with "gay," "bisexual," "something else," or "I don't know the answer." Heterosexual individuals are then defined as those who respond "straight, that is, not gay,"

Panels III and IV of Table 8 report the results for adults over 30 years old. There is little evidence that ENDS taxes affect vaping for either heterosexual or LGBQ adults. The pattern of signs is mixed, coefficient estimates are generally small, and there are no statistically significant reductions in vaping observed in any of the twelve regressions.

6. Conclusions

Despite dramatic social progress and greater social acceptance over the last two decades (Gallup 2024b), LGBQ youth and young adults continue to face many societal, familial, and schooling challenges that may increase stressors and adversely affect their mental health. There is strong evidence that “minority stress” as well as barriers to effective psychological treatment and support services for LGBQ youth may cause a turn to risky addictive behaviors as a means to escape or cope with psychological trauma, as well as to socialize and build queer community. Tobacco use is one such addictive behavior.

The prevalence of ENDS (cigarette) use is 32 (118) percent higher among LGBQ-identifying teens relative to their heterosexual-identifying counterparts. This study provides, to our knowledge, the first empirical investigation of the impact of ENDS taxes on sexual identity-based disparities in youth ENDS use. Using data from the State YRBS over the period 2015-2021, our findings show that a one-dollar increase in ENDS taxes is associated with around a four percentage-point decline in current ENDS use among heterosexual-identifying youths, but a smaller and statistically significant reduction among LGBQ-identifying teens. We also find that ENDS taxes increase disparities in LGBQ versus heterosexual teens’ frequent and everyday vaping by around two percentage points. Our results are qualitatively similar for young adults ages 18-30, although the effect sizes are smaller.

Together, our findings suggest a relatively more inelastic demand for ENDS among LGBQ youth and young adults. Supporting evidence points to a potentially important mechanisms: minority stress-induced coping strategies, perhaps in response to barriers to psychological services or unique trauma, such as from bullying. To the extent that “minority stress” is an important channel, improving mental health of LGBQ youth or reducing bullying may increase tax sensitivity.

An evaluation of other public policies provides some preliminary evidence that while licensure laws and cigarette taxes have limited effects on LGBQ youth’s ENDS use, laws that restrict sales – specifically, bans on flavored ENDS products and Tobacco-21 laws – may be more effective. However, flavor restrictions on ENDS appear to induce large substitution effects to

cigarettes for queer teens, implying that their net effect on tobacco-related health could be small or even negative. Together, our results underscore the substantial challenges policymakers face in curbing nicotine vaping among LGBQ youth as well as in reducing queer-straight disparities in youth ENDS use. Targeted information campaigns to the queer community on the (relative) risks of ENDS and combustible tobacco products, practical instruction on healthy tools to manage the consequences of “minority stress,” and effective outreach for and provision of LGBQ-inclusive psychological services may be among the more fruitful approaches to encourage tobacco harm reduction (including abstinence) among queer teens as well as to narrow disparities in vaping with their heterosexual peers.

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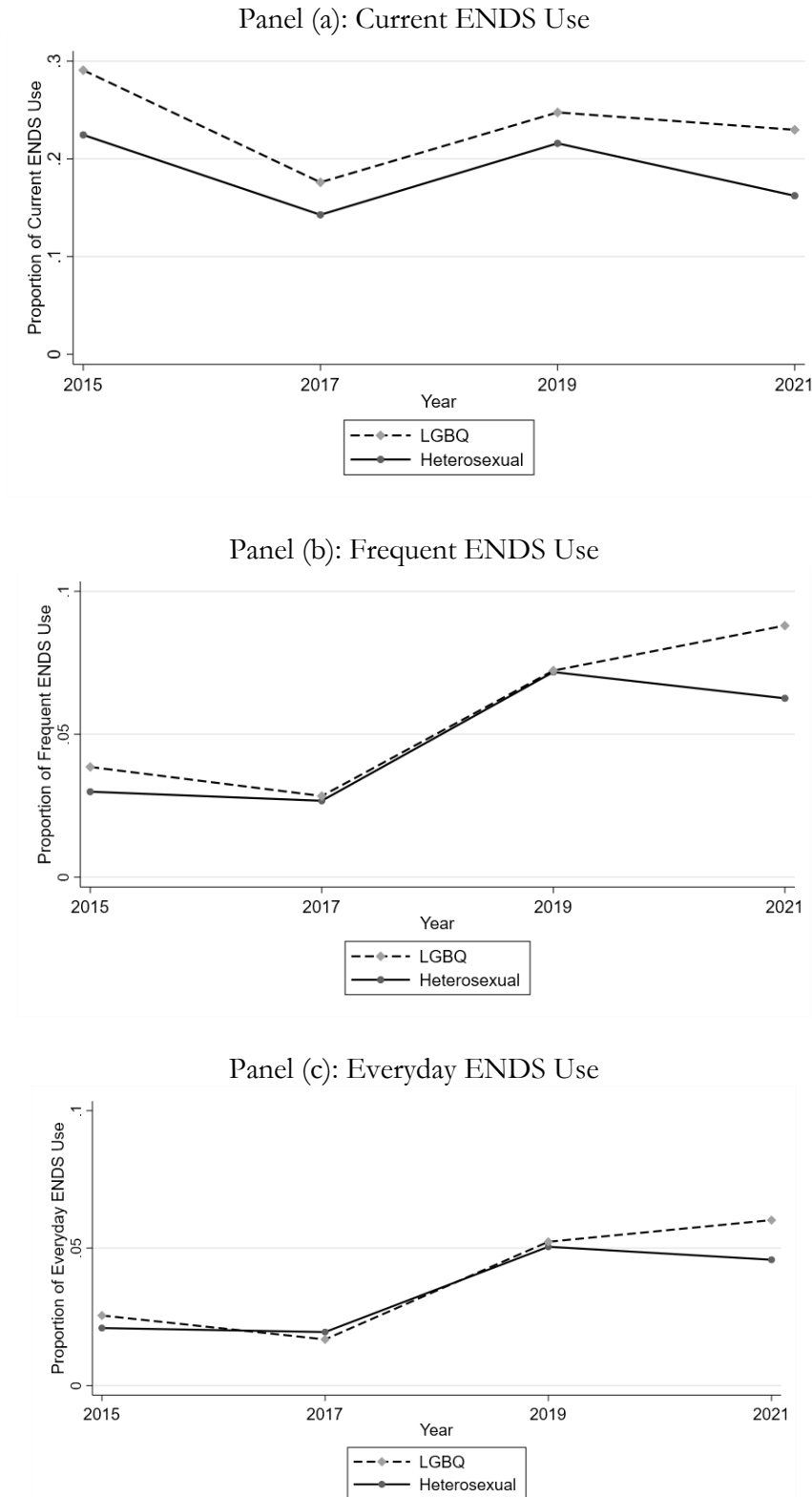
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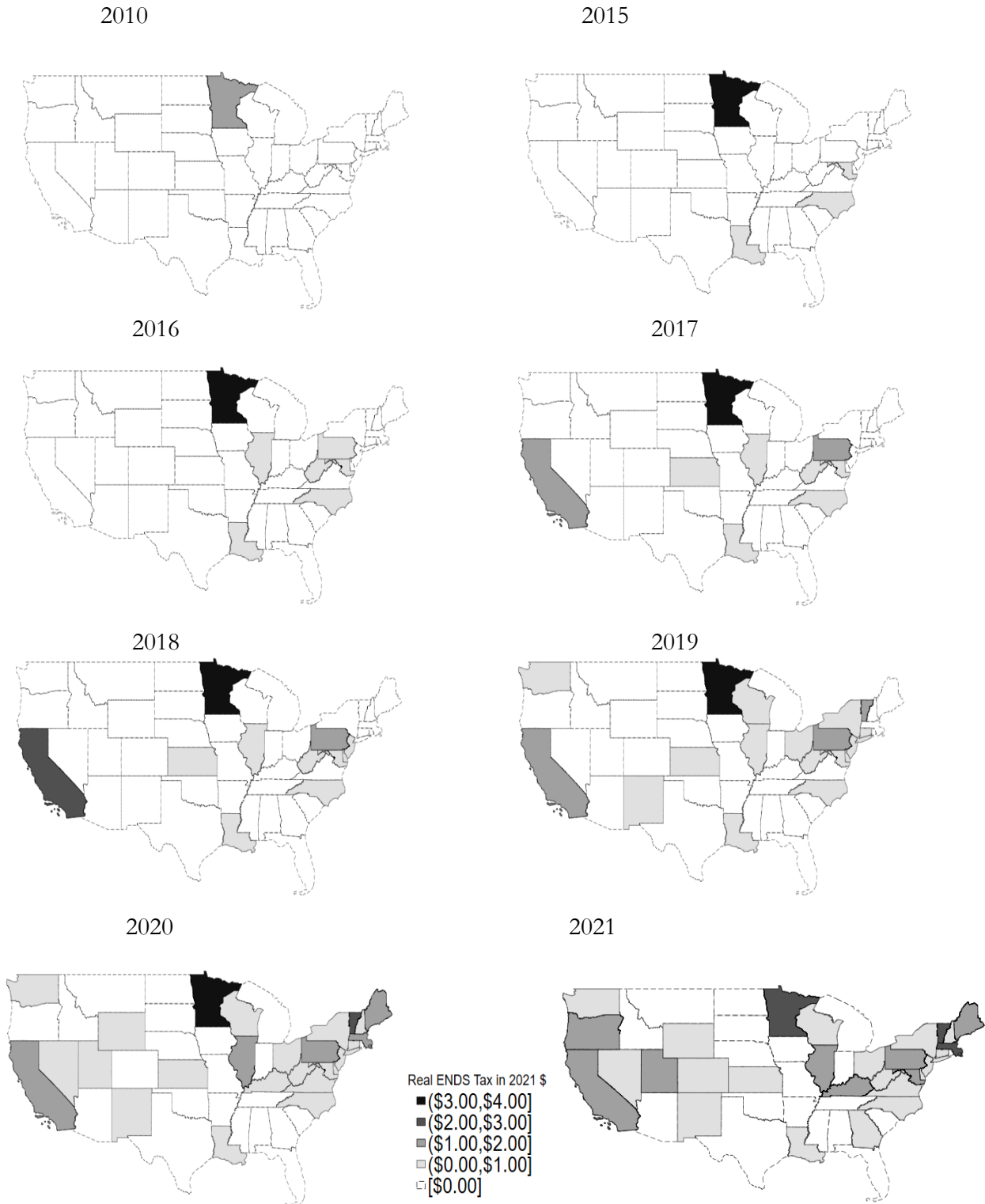
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Figure 1. Trends in Prior-Month Youth ENDS Use, 2015-2021, by Sexual Identity



Notes: These data are weighted and drawn from the State Youth Risk Behavior Surveys over the 2015-2021 period.

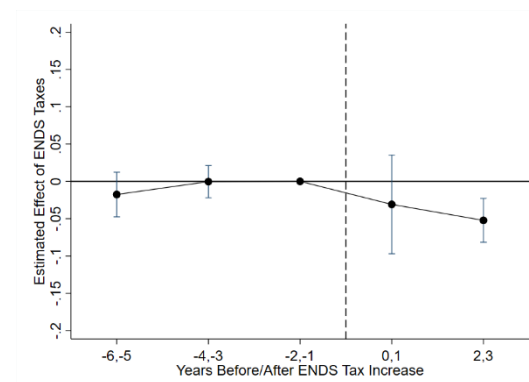
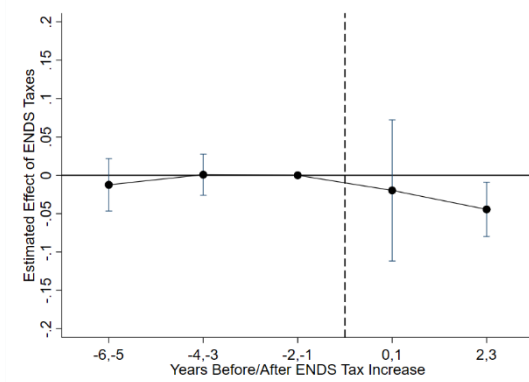
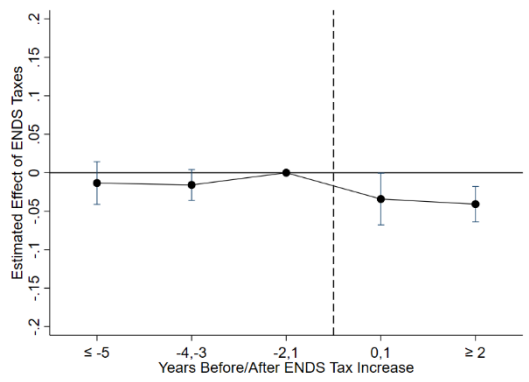
Figure 2. Geographic and Temporal Variation in ENDS Taxes



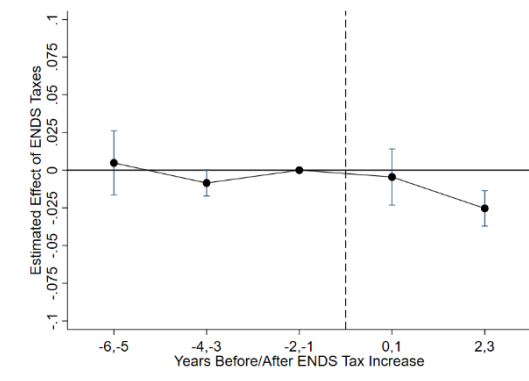
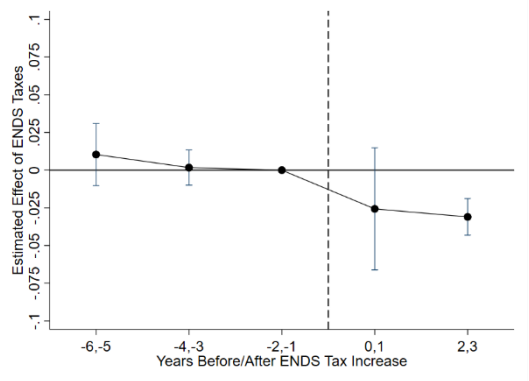
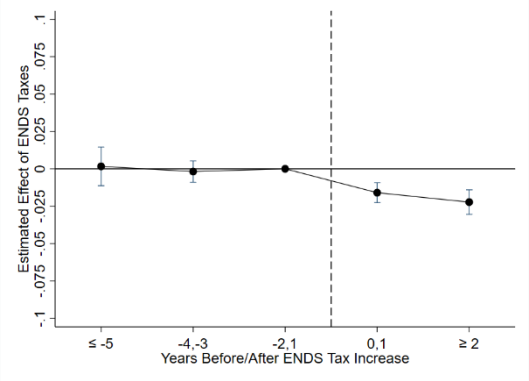
Notes: ENDS taxes are from Cotti et al. (2023). The annual average ENDS tax is calculated for each state and reported above

Figure 3. Event-Study Analyses of ENDS Taxes and ENDS Use Among Heterosexual-Identifying Teens
 Column (1): TWFE with Model 1 Column (2): Stacked DiD Column (3): Stacked DiD

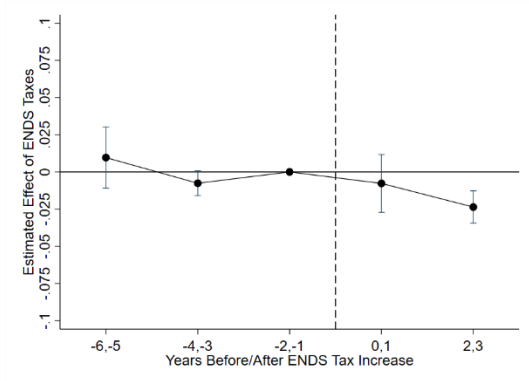
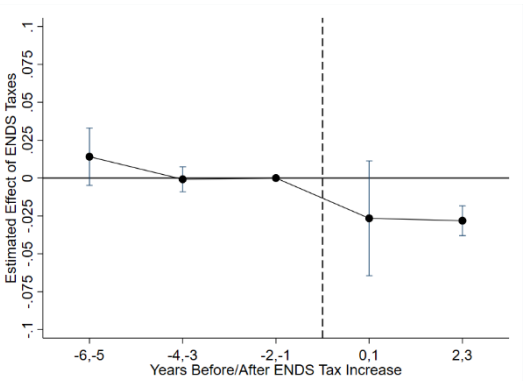
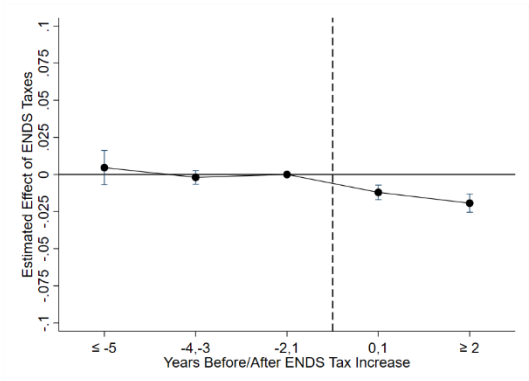
Panel (a): Current ENDS Use



Panel (b): Frequent ENDS Use



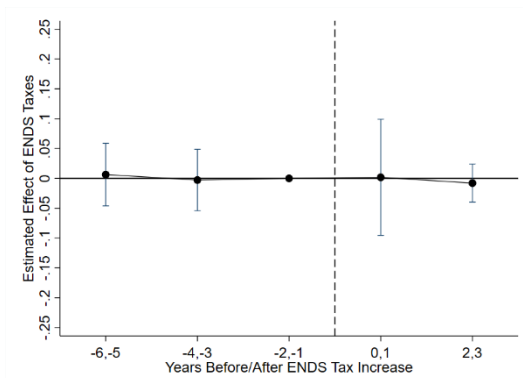
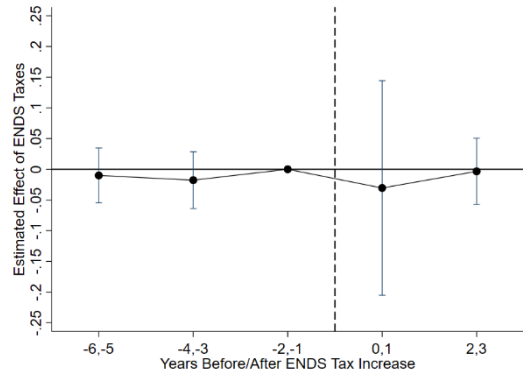
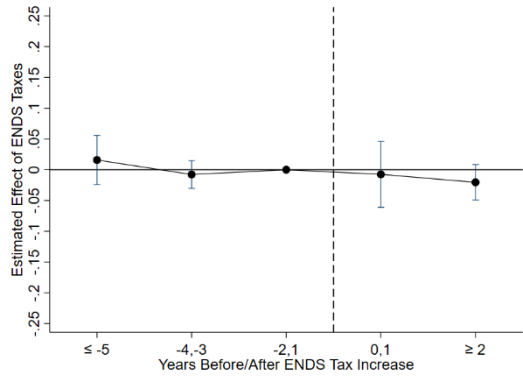
Panel (c): Everyday ENDS Use



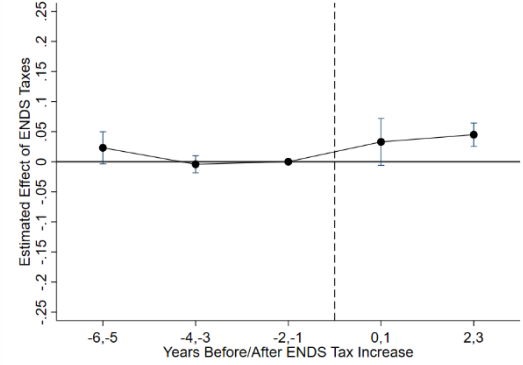
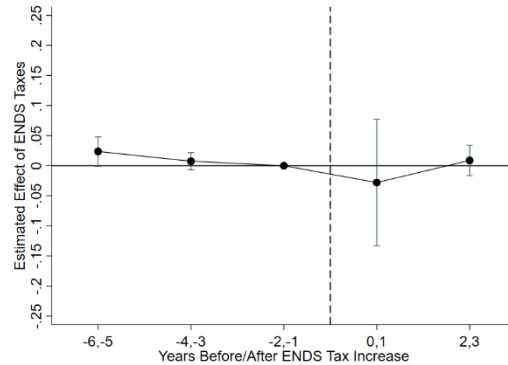
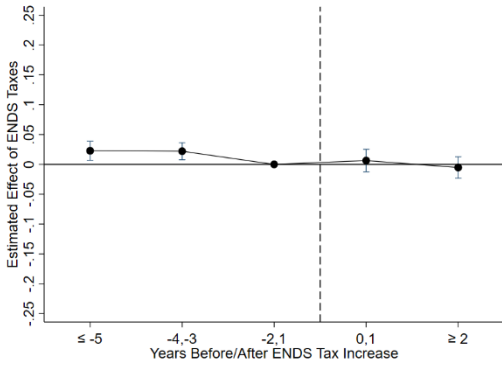
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. In column I, average marginal effects are estimated using weighted logistic regression (with 95% CIs). In columns II and III, average marginal effects are estimated using stacked difference in differences design and weighted logistic regression (with 95% CIs). Within each ENDS tax introduction year “stack,” control states are defined as who either never implement ENDS taxes or introduce ENDS taxes more than 3 years in the future. We exclude states that introduce ENDS taxes in 2021. Standard errors are clustered at the state level. Controls in columns 1 and 2 include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, and cigarette taxes (in \$2021). Controls in column 3 additionally includes other combustible tobacco and ENDS policy controls and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax increase.

Figure 4. Event-Study Analyses of ENDS Taxes and ENDS Use Among LGBQ-Identifying Teens
 Column (1): TWFE Column (2): Stacked DiD Column (3): Stacked DiD

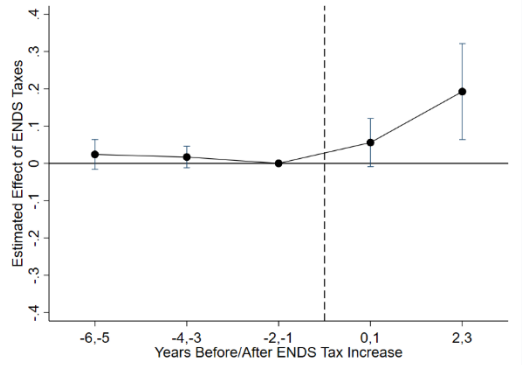
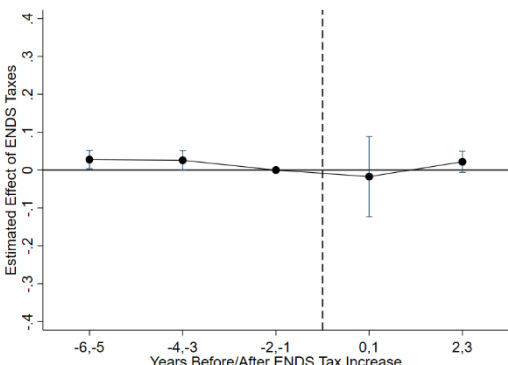
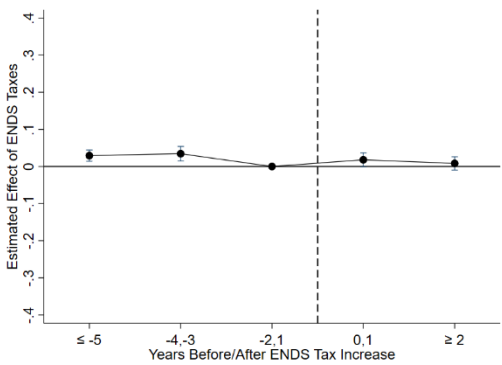
Panel (a): Current ENDS Use



Panel (b): Frequent ENDS Use

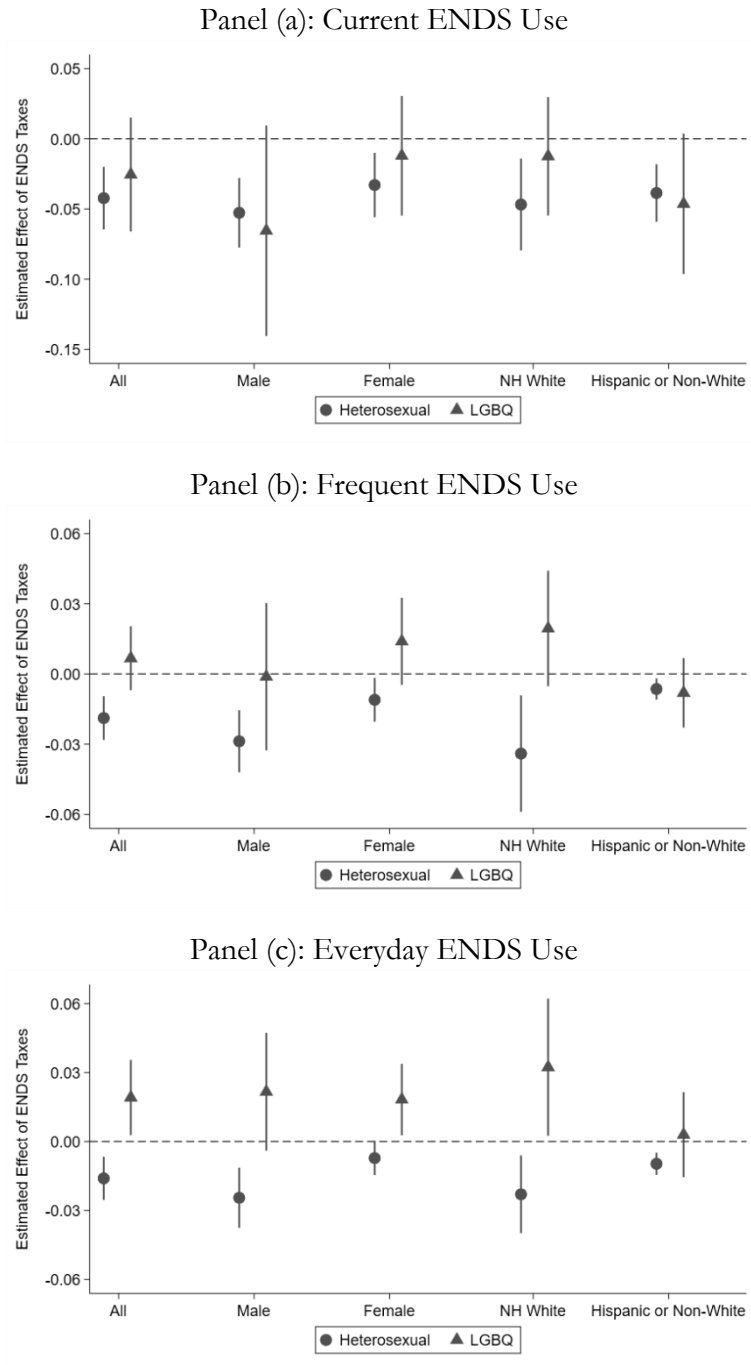


Panel (c): Everyday ENDS Use



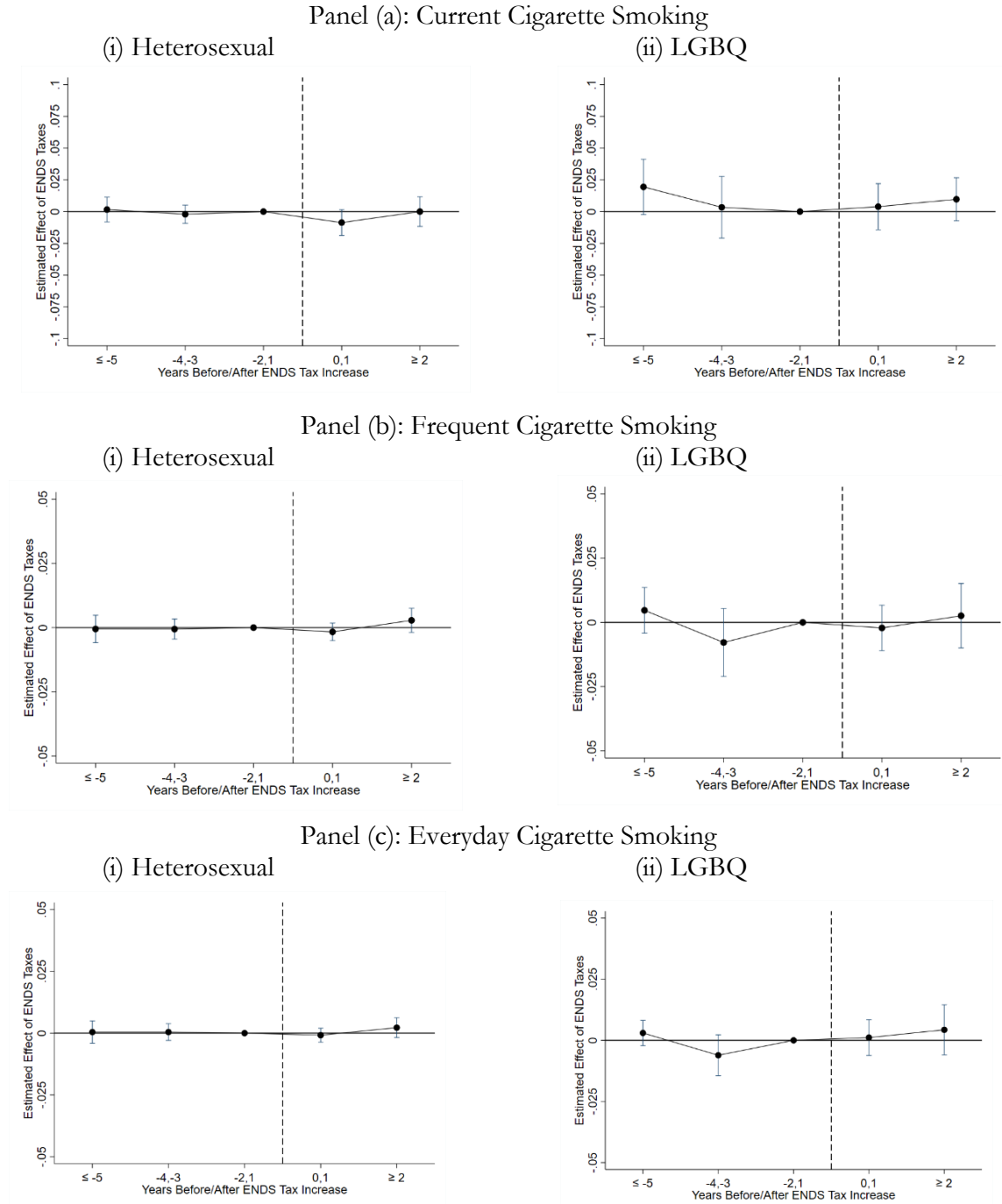
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. In column I, average marginal effects are estimated using weighted logistic regression (with 95% CIs). In columns II and III, average marginal effects are estimated using stacked difference in differences design and weighted logistic regression (with 95% CIs). Within each ENDS tax introduction year “stack,” control states are defined as who either never implement ENDS taxes or introduce ENDS taxes more than 3 years in the future. We exclude states that introduce ENDS taxes in 2021. In all specifications, standard errors are clustered at the state level. Controls in columns 1 and 2 include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, and cigarette taxes (in \$2021). Controls in column 3 additionally includes other combustible tobacco and ENDS policy controls and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax increase.

Figure 5. Exploring the Role of Intersectionality on the Estimated Treatment Effect of ENDS Taxes



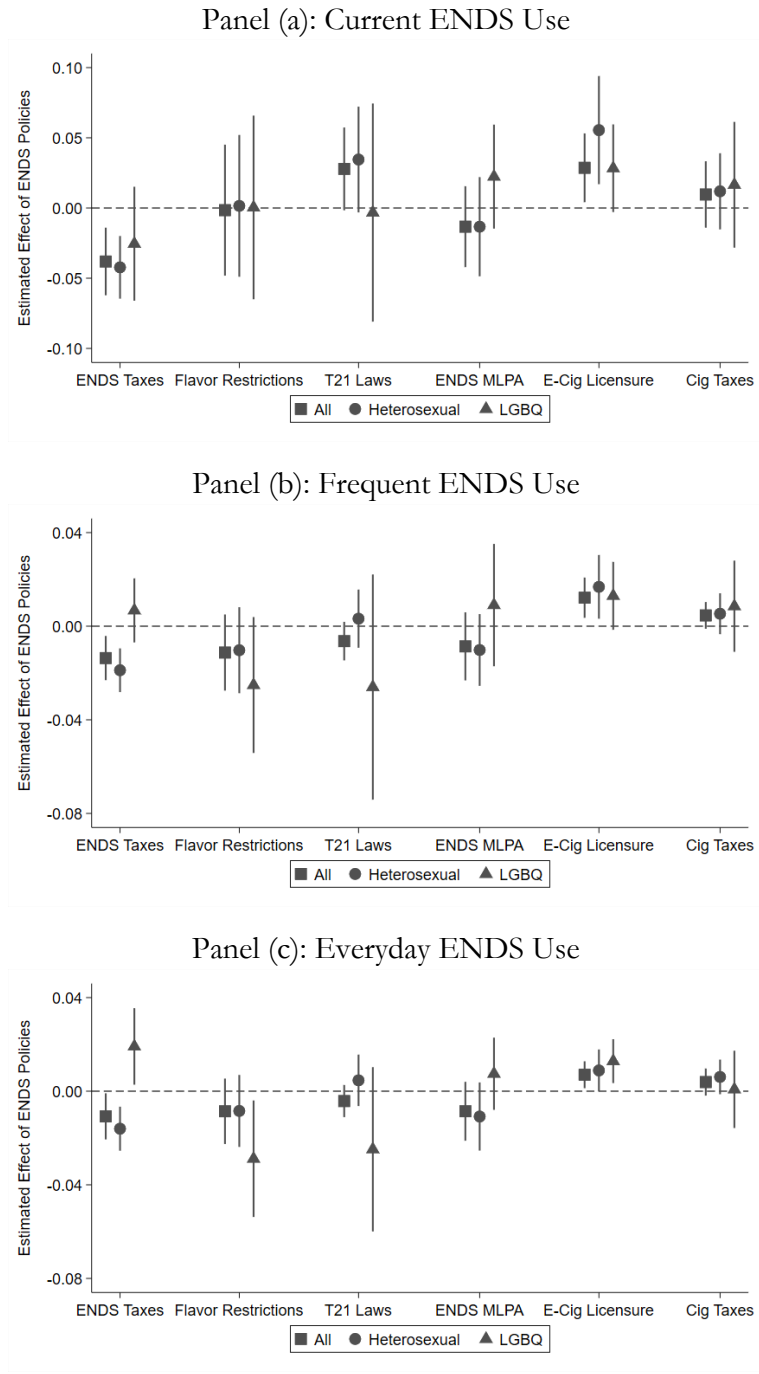
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use controls. The x-axis label “NH White” refers to Non-Hispanic White individuals.

Figure 6. Event-Study Analysis of ENDS Taxes and Cigarette Smoking, by Sexual Identity, Using TWFE Logit Estimates



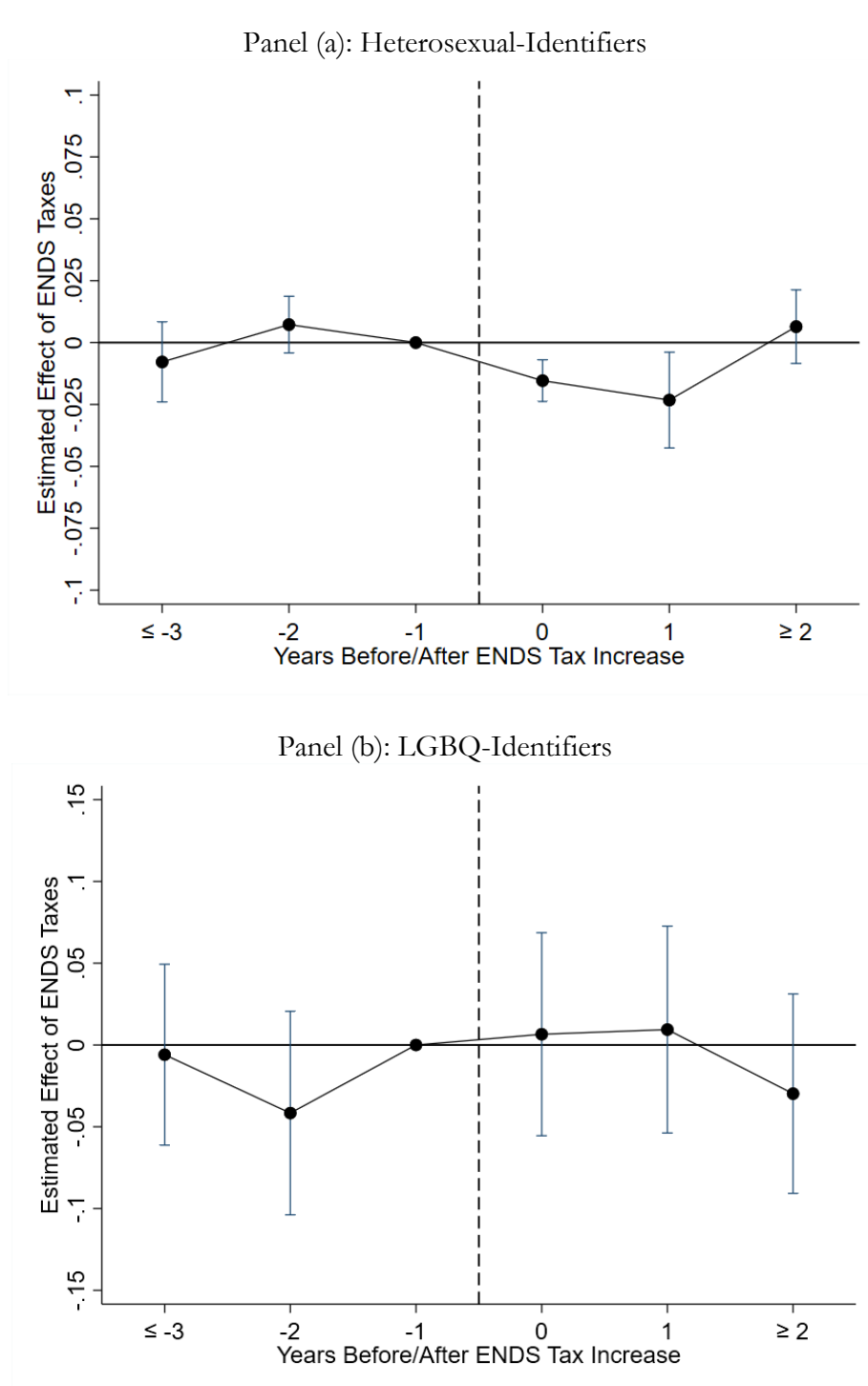
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2011-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax increase.

Figure 7. Comparing Effects of ENDS Taxes to Other ENDS and Tobacco Policies



Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use controls. The x-axis labels “Flavor Restrictions,” “T21 Laws,” and “ENDS MLPA” refer to flavored ENDS restrictions, Tobacco 21 laws, and ENDS minimum legal purchasing age laws, respectively.

Figure 8. Event-Study Analyses of ENDS Taxes and Current ENDS Use Among Young Adults Aged 18-30, by Sexual Identity (BRFSS)



Notes: These data are drawn from the Behavioral Risk Factor Surveillance Survey from 2016-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, and quarter fixed effects, demographic controls, macroeconomic and COVID-19 controls, and cigarette taxes (in \$2021). The reference period is the year prior to an ENDS tax increase.

Table 1. Descriptive Statistics

	All (2015- 2021)	All* (2015- 2021)	LGBQ (2015- 2021)	Hetero (2015- 2021)	LGBQ (2011- 2021)	Hetero (2011- 2021)
<i>Dependent Variables</i>						
Current ENDS Use	0.192	0.194	0.232	0.186	0.232	0.186
Frequent ENDS Use	0.051	0.052	0.064	0.049	0.064	0.049
Everyday ENDS Use	0.036	0.037	0.044	0.035	0.044	0.035
Current Cigarette Smoking	0.066	0.063	0.099	0.056	0.111	0.064
Frequent Cigarette Smoking	0.016	0.015	0.025	0.012	0.031	0.016
Everyday Cigarette Smoking	0.012	0.011	0.018	0.009	0.023	0.012
Current Cigarette/Cigar Use	0.116	0.114	0.167	0.102	0.187	0.118
Frequent Cigarette/Cigar Use	0.026	0.025	0.042	0.021	0.051	0.026
Everyday Cigarette/Cigar Use	0.019	0.018	0.030	0.016	0.037	0.019
<i>Independent Variables</i>						
ENDS Tax (\$2021)	0.237 (0.527)	0.279 (0.566)	0.306 (0.583)	0.273 (0.562)	0.285 (0.568)	0.239 (0.533)
Cigarette Tax (\$2021)	1.836 (1.177)	2.029 (1.159)	2.074 (1.197)	2.019 (1.151)	2.079 (1.178)	2.031 (1.124)
Unemployment Rate	4.580 (1.027)	4.647 (1.017)	4.610 (0.983)	4.655 (1.024)	4.869 (1.378)	5.119 (1.613)
Cumulative Covid Death Rate	0.058 (0.104)	0.057 (0.102)	0.083 (0.114)	0.051 (0.098)	0.078 (0.112)	0.045 (0.093)
Indoor Smoking Restriction	0.683	0.715	0.722	0.713	0.736	0.741
Cigarette Licensure Law	0.734	0.765	0.769	0.765	0.750	0.731
Vaping MLSA Law	0.925	0.912	0.932	0.908	0.876	0.809
Tobacco 21 Law	0.350	0.372	0.468	0.352	0.436	0.308
ENDS Licensure Law	0.307	0.309	0.349	0.301	0.325	0.263
Indoor Vaping Restriction	0.220	0.253	0.274	0.249	0.255	0.218
Flavored ENDS Restriction	0.041	0.048	0.071	0.044	0.066	0.038
ENDS Online Sales Ban	0.020	0.017	0.017	0.017	0.015	0.015
Recreational Marijuana Law	0.193	0.224	0.258	0.217	0.240	0.190
Medical Marijuana Law	0.603	0.679	0.693	0.676	0.665	0.627
Naloxone Access Law	0.927	0.950	0.964	0.947	0.925	0.875
Good Samaritan Alcohol Law	0.231	0.240	0.264	0.234	0.248	0.210
Beer Tax (\$2021)	0.328 (0.294)	0.264 (0.186)	0.259 (0.185)	0.265 (0.186)	0.265 (0.189)	0.274 (0.192)
Observations	694230	588050	104035	484015	117842	602308

Note: State Youth Risk Behavior Surveys data is used in each column. Weighted means are shown for dichotomous variables, while weighted means and standard deviations are shown for continuous variables. All denotes the entire sample, All* denotes the sample that includes information on sexual identity, LGBQ denotes individuals who respond as lesbian or gay, bisexual, or questioning, and Hetero denotes individuals who respond as heterosexual. The Cumulative Covid Death Rate variable is scaled up by a factor of 100 for display.

Table 2. Logit Estimates of Effect of ENDS Taxes on Youth Current ENDS Use

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Current ENDS Use			Frequent ENDS Use				Everyday ENDS Use				
Panel I: Sample Including Information on Sexual Identity												
ENDS Tax (\$2021)	-0.033**	-0.030**	-0.037***	-0.038***	-0.018***	-0.017***	-0.015***	-0.015***	-0.015***	-0.014***	-0.012**	-0.012**
	(0.014)	(0.012)	(0.011)	(0.012)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)
Pre-Treat Mean DV	0.212	0.212	0.212	0.212	0.042	0.042	0.042	0.042	0.029	0.029	0.029	0.029
N	526488	526488	526488	526488	526488	526488	526488	526488	526488	526488	526488	526488
Panel II: Heterosexual-Identifiers												
ENDS Tax (\$2021)	-0.039***	-0.036***	-0.042***	-0.042***	-0.021***	-0.021***	-0.020***	-0.019***	-0.019***	-0.018***	-0.017***	-0.016***
	(0.014)	(0.012)	(0.010)	(0.011)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)
Pre-Treat Mean DV	0.204	0.204	0.204	0.204	0.039	0.039	0.039	0.039	0.028	0.028	0.028	0.028
N	434665	434665	434665	434665	434665	434665	434665	434665	434665	434665	434665	434665
Panel III: LGBQ-Identifiers												
ENDS Tax (\$2021)	-0.021	-0.020	-0.022	-0.025	-0.009	-0.007	0.005	0.007	-0.001	0.001	0.015*	0.019**
	(0.016)	(0.015)	(0.020)	(0.021)	(0.009)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.009)	(0.008)
Pre-Treat Mean DV	0.261	0.261	0.261	0.261	0.055	0.055	0.055	0.055	0.036	0.036	0.036	0.036
N	91823	91823	91823	91823	91823	91823	91823	91823	91823	91823	91823	91823
p-value on $\hat{\beta}_{ENDS\ Tax}^{Hetero} = \hat{\beta}_{ENDS\ Tax}^{LGBQ}$	0.071*	0.097*	0.076*	0.139	0.068*	0.026**	0.004***	0.001***	0.016**	0.008***	0.002***	0.003***
<i>Controls:</i>												
Macro and COVID?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cigarette Taxes (\$2021)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Combustible Tob Policies?	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
ENDS Policies?	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Drug Policies?	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
Alcohol Policies?	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. Each column includes state, year, and semester fixed effects and demographic controls. Demographic controls include sex, grade, age, and race. Macroeconomic controls include the unemployment rate, and COVID controls include the cumulative COVID-19 death rate. Combustible tobacco policies include cigarette taxes (in \$2021), indoor smoking bans, and combustible tobacco licensure laws. ENDS policies include minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, and ENDS online sales bans. Drug policies include recreational marijuana laws, medical marijuana laws, and naloxone access laws, and alcohol policies include beer taxes (in \$2021) and Good Samaritan alcohol laws. Due to non-convergence of the fully-interacted logistic regression (to test differences in ENDS taxes across demographic groups allowing for each right-hand side control to have a different effect by sexual identity), we estimate a slightly modified specification to obtain the p-value in the final row of columns (11) and (12) using the model described in footnote 23.

Table 3. Sensitivity to Use of Linear Probability Model

	(1)	(2)	(3)
	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use
Panel I: Heterosexual-Identifiers			
ENDS Tax (\$2021)	-0.038*** (0.010)	-0.024*** (0.005)	-0.020*** (0.004)
Pre-Treat Mean DV	0.204	0.039	0.028
N	434665	434665	434665
Panel II: LGBTQ-Identifiers			
ENDS Tax (\$2021)	-0.030 (0.021)	-0.012 (0.011)	-0.001 (0.010)
Pre-Treat Mean DV	0.261	0.055	0.036
N	91823	91823	91823
p-value on $\hat{\beta}_1^{\text{Hetero}} = \hat{\beta}_1^{\text{LGBQ}}$	0.650	0.194	0.052*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted OLS, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws.

Table 4. Robustness of Estimates to Stacked DiD and Use of Combined YRBS

	(1)	(2)	(3)
	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use
Panel I: Stacked DiD Using State YRBS			
(a) Heterosexual-Identifiers			
ENDS Tax (\$2021)	-0.056*** (0.013)	-0.036*** (0.007)	-0.034*** (0.006)
Pre-Treat Mean DV	0.193	0.044	0.031
N	1786428	1786428	1786428
(b) LGBQ-Identifiers			
ENDS Tax (\$2021)	-0.017 (0.019)	0.032** (0.010)	0.031 (0.023)
Pre-Treat Mean DV	0.258	0.061	0.040
N	317968	317968	317717
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.0079***	0.0001***	0.0040***
Panel II: TWFE Using Combined YRBS			
(a) Heterosexual-Identifiers			
ENDS Tax (\$2021)	-0.023** (0.010)	-0.008** (0.004)	-0.009*** (0.003)
Pre-Treat Mean DV	0.231	0.044	0.030
N	478181	478181	478181
(b) LGBQ-Identifiers			
ENDS Tax (\$2021)	-0.007 (0.019)	0.001 (0.017)	0.014 (0.013)
Pre-Treat Mean DV	0.261	0.063	0.040
N	100531	100531	100531
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.341	0.494	0.093*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: In panel I, average marginal effects, using a stacked difference in differences design and weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Within each ENDS tax introduction year “stack,” control states are those that either never implement ENDS taxes or introduce ENDS taxes more than 3 years in the future. We exclude states that introduce ENDS taxes in 2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. In panel II, average marginal effect estimates, using weighted logistic regression, are generated from individual-level State and National Youth Risk Behavior Surveys collected over the period 2015-2021. In both panels, standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. Panel II additionally includes dataset (state, national) fixed effects. Due to non-convergence of the fully-interacted logistic regression (to test differences in ENDS taxes across demographic groups allowing for each right-hand side control to have a different effect by sexual identity), we estimate a slightly modified specification to obtain the p-value in the final row of panel II, column (3) using the model described in footnote 23.

Table 5. Sensitivity of ENDS Tax Effects to Census Region-by-Year Fixed Effects and Treatment State-Specific Linear Time Trends

	(1)	(2)	(3)	(4)	(5)	(6)
	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use
	<u>Census Region – Year FEs</u>			<u>Common Treated State Linear Time Trend</u>		
Panel I: Heterosexual-Identifiers						
ENDS Tax (\$2021)	-0.009 (0.012)	-0.013*** (0.004)	-0.010*** (0.003)	-0.045*** (0.012)	-0.019*** (0.005)	-0.016*** (0.005)
Pre-Treat Mean DV	0.204	0.039	0.028	0.204	0.039	0.028
N	434665	434665	434665	434665	434665	434665
Panel II: LGBQ-Identifiers						
ENDS Tax (\$2021)	0.008 (0.012)	0.007 (0.007)	0.023*** (0.007)	-0.028 (0.021)	0.007 (0.008)	0.020** (0.009)
Pre-Treat Mean DV	0.261	0.055	0.036	0.261	0.055	0.036
N	91823	91823	91823	91823	91823	91823
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.2350	0.0002***	0.0001***	0.1571	0.0011***	0.0029***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. In addition, census region by year fixed effects are included in columns (1) through (3), and a common linear time trend for the group of treated states is included in columns (4) through (6). Due to non-convergence of the fully-interacted logistic regression (to test differences in ENDS taxes across demographic groups allowing for each right-hand side control to have a different effect by sexual identity), we estimate slightly modified specifications, using the model described in footnote 23 to obtain the p-value in the final row of column (3) and excluding the differential sexual orientation term on beer taxes, ENDS licensure laws, and the treated state linear time trend to obtain the p-value in the final row of column (6).

Table 6. Logit Estimates of Effect of ENDS Taxes on Combustible Tobacco Use

	(1)	(2)	(3)	(4)	(5)	(6)
	Current Cigarette Smoking	Frequent Cigarette Smoking	Everyday Cigarette Smoking	Current Cig/Cigar Smoking	Frequent Cig/Cigar Smoking	Everyday Cig/Cigar Smoking
Panel I: State YRBS						
(a) Heterosexual-Identifiers						
ENDS Tax (\$2021)	-0.0051 (0.0054)	0.0003 (0.0019)	0.0001 (0.0015)	-0.0035 (0.0148)	0.0037 (0.0072)	0.0026 (0.0057)
Pre-Treat Mean DV	0.083	0.024	0.017	0.137	0.033	0.023
N	577318	577318	577318	497399	492126	491807
(b) LGBTQ-Identifiers						
ENDS Tax (\$2021)	0.0005 (0.0085)	0.0002 (0.0060)	0.0029 (0.0046)	0.0023 (0.0247)	0.0050 (0.0101)	0.0010 (0.0081)
Pre-Treat Mean DV	0.157	0.048	0.035	0.236	0.070	0.051
N	108500	108500	108500	95419	92888	92715
Panel II: Combined YRBS						
(a) Heterosexual-Identifiers						
ENDS Tax (\$2021)	0.0122** (0.0051)	0.0117** (0.0046)	0.0096** (0.0038)	0.0163 (0.0155)	0.0185** (0.0073)	0.0148** (0.0061)
Pre-Treat Mean DV	0.084	0.027	0.020	0.137	0.036	0.027
N	622003	622003	621554	543027	535702	534792
(b) LGBTQ-Identifiers						
ENDS Tax (\$2021)	0.0122 (0.0118)	-0.0079 (0.0077)	-0.0036 (0.0054)	0.0121 (0.0246)	0.0101 (0.0148)	0.0082 (0.0125)
Pre-Treat Mean DV	0.152	0.050	0.037	0.222	0.071	0.053
N	117437	117311	117311	104973	101701	101459
Panel III: Combined YRBS, Using OLS						
(a) Heterosexual-Identifiers						
ENDS Tax (\$2021)	0.0130* (0.0066)	0.0081 (0.0051)	0.0081* (0.0045)	0.0173 (0.0184)	0.0162 (0.0098)	0.0141 (0.0084)
Pre-Treat Mean DV	0.084	0.027	0.020	0.137	0.036	0.027
N	622003	622003	622003	543027	535702	535240
(b) LGBTQ-Identifiers						
ENDS Tax (\$2021)	0.0168 (0.0112)	-0.0018 (0.0061)	0.0002 (0.0048)	0.0125 (0.0247)	0.0108 (0.0168)	0.0114 (0.0148)
Pre-Treat Mean DV	0.152	0.050	0.037	0.222	0.071	0.053
N	117437	117437	117437	104973	101701	101459
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} =$ $\hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.764	0.046**	0.083*	0.785	0.661	0.803

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression in Panels I and II and weighted OLS in Panel III, are generated from individual-level State and National Youth Risk Behavior Surveys collected over the period 2011-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, semester, and dataset (state, national) fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. The outcomes in columns (4) through (6) with “Cig/Cigar” refer to prior-month cigarette *or* cigar smoking.

Table 7. Effects of ENDS Taxes on Current ENDS Use by Mental Health and Sexual Identity

	(1)	(2)	(3)	(4)
Panel I: Heterogeneity by Persistent Sadness				
	Depression=1	Depression=0	Depression=1	Depression=0
	LGBQ		Heterosexual	
ENDS Tax (\$2021)	-0.022 (0.021)	-0.046 (0.029)	-0.048** (0.014)	-0.046*** (0.013)
Pre-Treat Vape Mean	0.311	0.185	0.309	0.167
N	51231	38705	114714	315681
p-value on $\hat{\beta}_{ENDS\ Tax}^{Depress=1} = \hat{\beta}_{ENDS\ Tax}^{Depress=0}$	0.1071		0.1257	
Panel II: Heterogeneity by Bullying Victimization				
	Bullied=1	Bullied=0	Bullied=1	Bullied=0
	LGBQ		Heterosexual	
ENDS Tax (\$2021)	0.007 (0.042)	-0.028 (0.019)	-0.098** (0.016)	-0.038** (0.013)
Pre-Treat Vape Mean	0.354	0.213	0.274	0.189
N	21766	55199	60412	309299
p-value on $\hat{\beta}_{ENDS\ Tax}^{Bullied=1} = \hat{\beta}_{ENDS\ Tax}^{Bullied=0}$	0.0418**		0.0002***	
Panel III: Heterogeneity by Depression or Bullying				
	Sad or Bullied=1	Sad & Bullied =0	Sad or Bullied =1	Sad & Bullied =0
	LGBQ		Heterosexual	
ENDS Tax (\$2021)	-0.011 (0.021)	-0.045* (0.027)	-0.050*** (0.014)	-0.045*** (0.015)
Pre-Treat Vape Mean	0.305	0.171	0.280	0.163
N	56957	26608	144870	236324
p-value on $\hat{\beta}_{ENDS\ Tax}^{Sad Bully=1} = \hat{\beta}_{ENDS\ Tax}^{Sad Bully=0}$	0.0495**		0.2664	
Panel IV: Heterogeneity by Suicidal Ideation				
	Suicide Ideation=1	Suicide Ideation=0	Suicide Ideation=1	Suicide Ideation=0
	LGBQ		Heterosexual	
ENDS Tax (\$2021)	-0.004 (0.020)	-0.036 (0.027)	-0.054** (0.021)	-0.046*** (0.012)
Pre-Treat Vape Mean	0.333	0.207	0.339	0.184
N	30429	47296	49160	324743
p-value on $\hat{\beta}_{ENDS\ Tax}^{Ideation=1} = \hat{\beta}_{ENDS\ Tax}^{Ideation=0}$	0.0825*		0.4620	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws.

Table 8. TWFE Estimates of Effects of ENDS Tax on ENDS Use Among Adults, by Sexual Identity

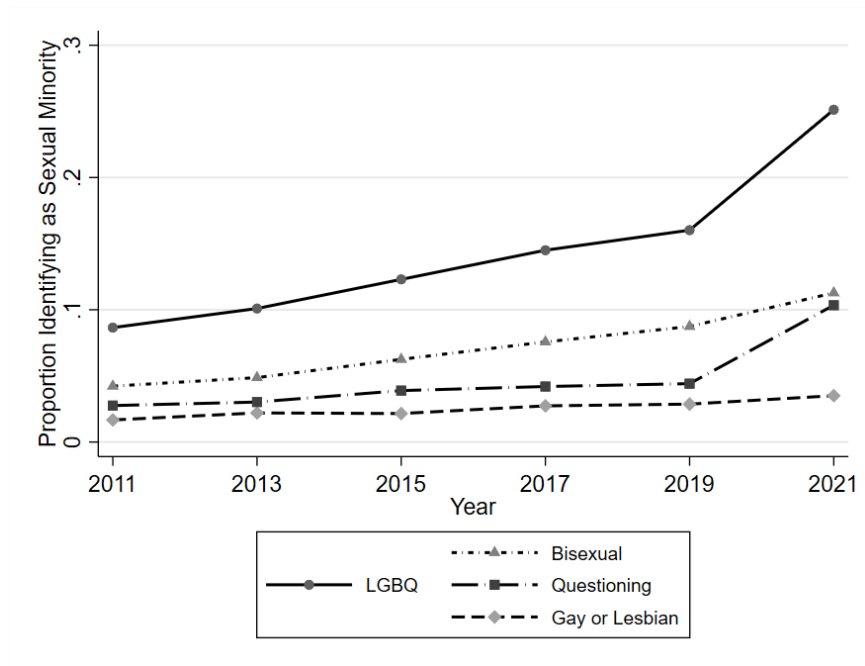
	(1)	(2)	(3)	(4)	(5)	(6)
	Current ENDS Use			Everyday ENDS Use		
Panel I: Heterosexual-Identifiers, Aged 18-30 Years						
ENDS Tax (\$2021)	-0.0142 ^{***}	-0.0136 ^{***}	-0.0135	-0.0032	-0.0032 [*]	-0.0001
	(0.0044)	(0.0044)	(0.0102)	(0.0020)	(0.0019)	(0.0037)
Pre-Treat Mean DV	0.097	0.097	0.097	0.030	0.030	0.030
N	78424	78424	78424	78424	78424	78424
Panel II: LGBQ-Identifiers, Aged 18-30 Years						
ENDS Tax (\$2021)	0.0143	0.0139	-0.0053	-0.0006	-0.0012	0.0065
	(0.0149)	(0.0146)	(0.0304)	(0.0110)	(0.0110)	(0.0228)
Pre-Treat Mean DV	0.125	0.125	0.125	0.034	0.034	0.034
N	12343	12343	12343	12343	12343	12343
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.0413 ^{**}	0.0455 ^{**}	0.6971	0.6782	0.7196	0.7767
Panel III: Heterosexual-Identifiers, Aged > 30 Years						
ENDS Tax (\$2021)	-0.0010	-0.0009	0.0011	-0.0013	-0.0012	-0.0013
	(0.0017)	(0.0016)	(0.0023)	(0.0009)	(0.0009)	(0.0019)
Pre-Treat Mean DV	0.032	0.032	0.032	0.011	0.011	0.011
N	661757	661757	661757	661756	661756	661756
Panel IV: LGBQ Identifiers, Aged > 30 Years						
ENDS Tax (\$2021)	0.0003	0.0004	0.0251 ^{**}	-0.0034	-0.0033	0.0134
	(0.0065)	(0.0064)	(0.0110)	(0.0042)	(0.0041)	(0.0099)
Pre-Treat Mean DV	0.049	0.049	0.049	0.016	0.016	0.016
N	33083	33083	33083	32718	32718	32718
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.7092	0.7067	0.0302 ^{**}	0.7705	0.7492	0.0969 [*]
<i>Controls:</i>						
Macro, COVID, and Cigarette Taxes?	Yes	Yes	Yes	Yes	Yes	Yes
Cigarette Taxes (\$2021)?	Yes	Yes	Yes	Yes	Yes	Yes
Other Combustible Tobacco Policies?	No	Yes	Yes	No	Yes	Yes
ENDS, Substance, and Alcohol Policies?	No	No	Yes	No	No	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from the Behavioral Risk Factor Surveillance System collected over the period 2016-2021. Standard errors are in parentheses and clustered at the state level (and at the state and year level for columns 4 and 8). We include the following controls: state, year, and quarter fixed effects, demographics (sex, race, age, education, marital status), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. Observations surveyed in January and February of 2022 for the 2021 survey wave are assigned December 2021 control values.

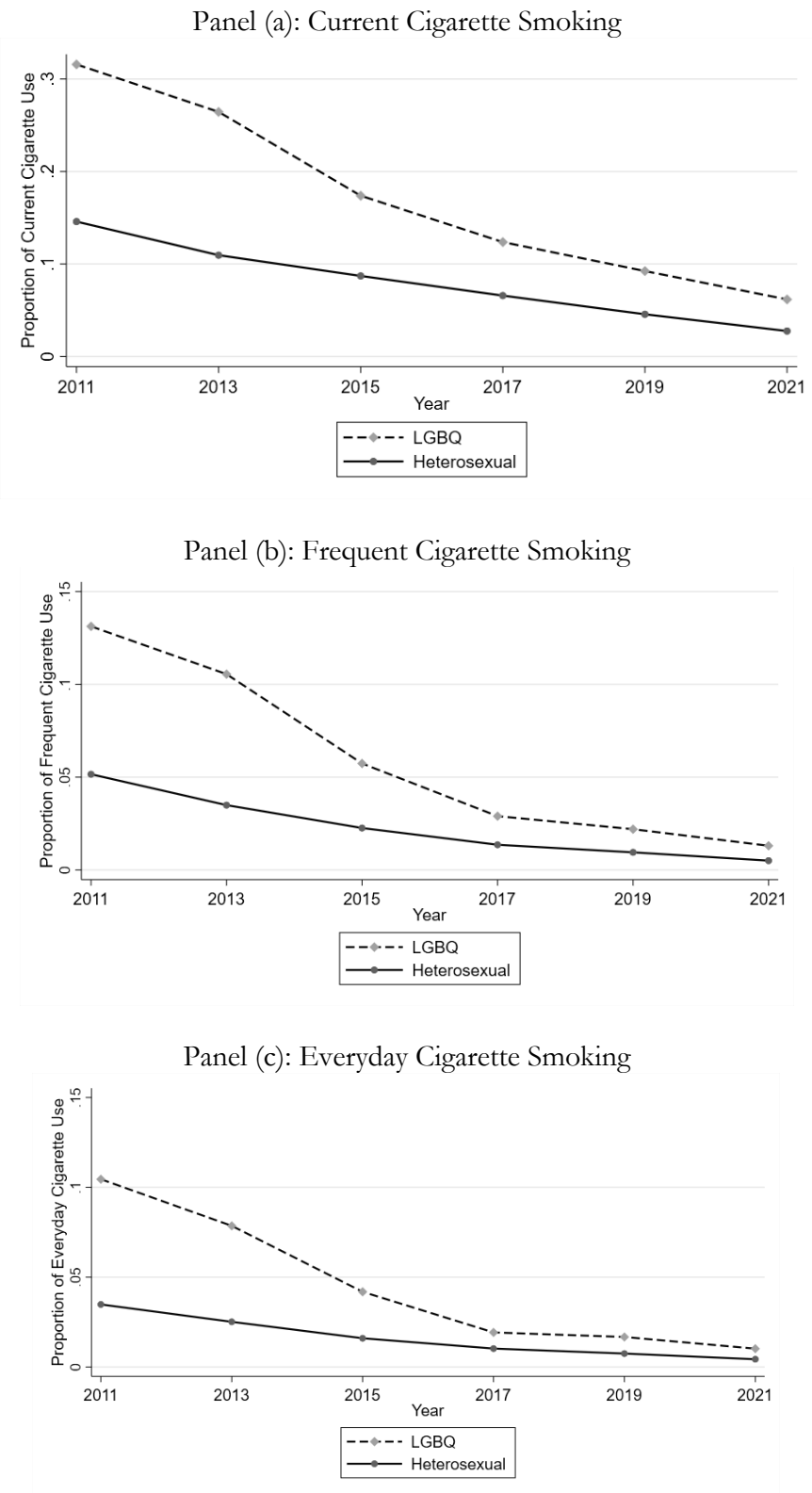
Online Appendix

Appendix Figure 1. Trends in Identifying as Sexual Minority



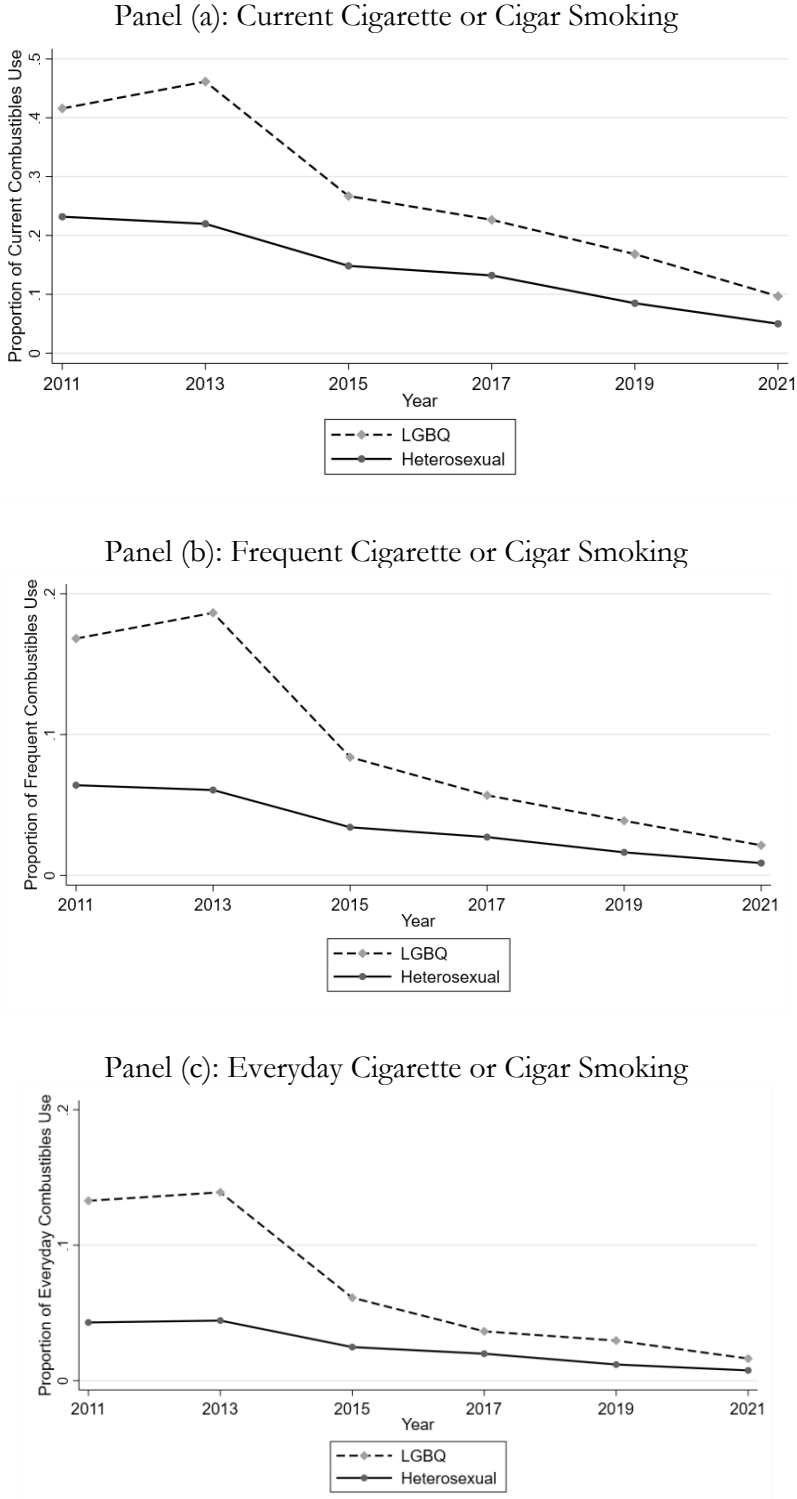
Notes: These data are weighted and drawn from the State Youth Risk Behavior Surveys over the 2011-2021 period.

Appendix Figure 2. Trends in Prior-Month Youth Cigarette Smoking, by Sexual Identity



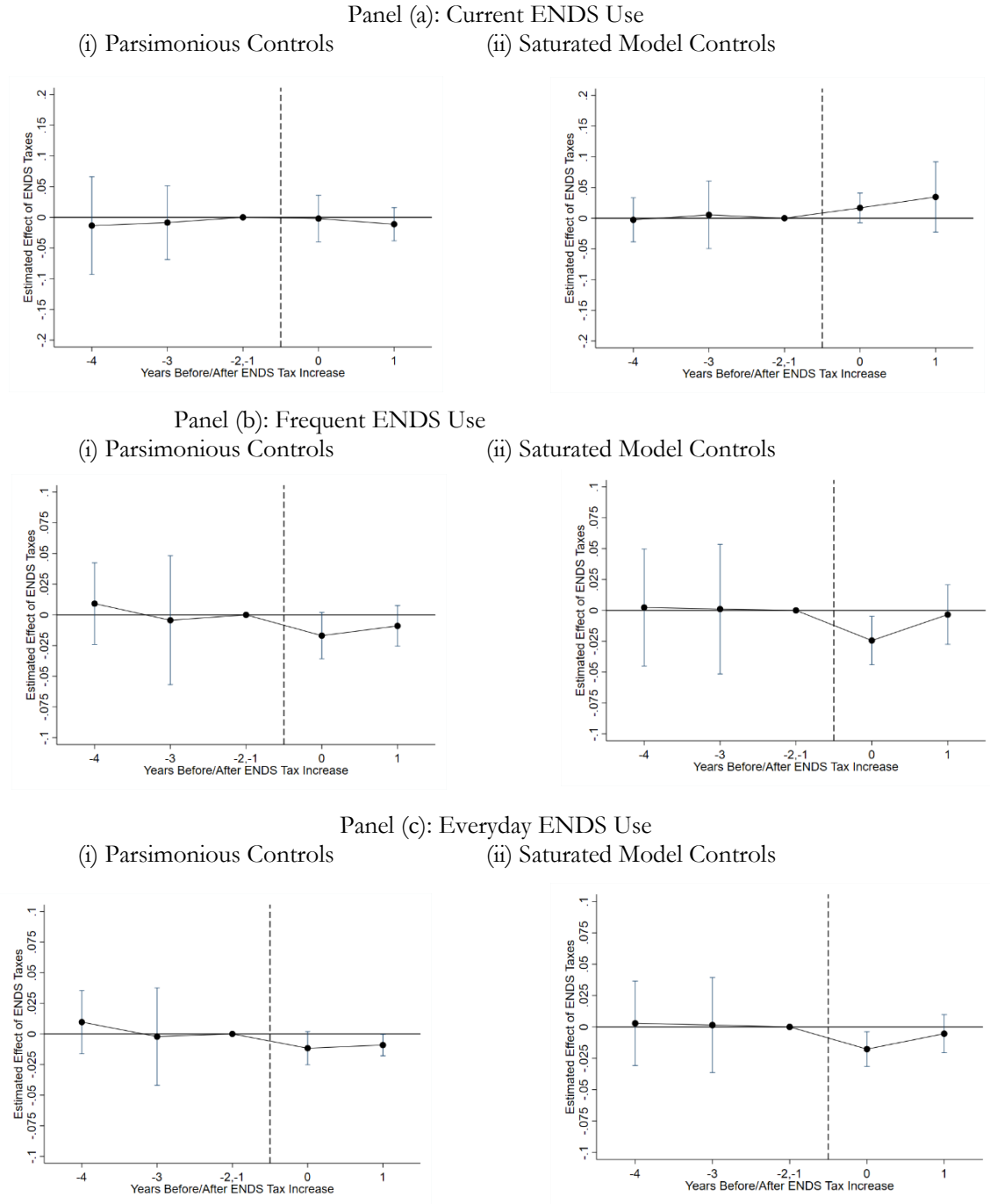
Notes: These data are weighted and drawn from the State Youth Risk Behavior Surveys over the 2011-2021 period.

Appendix Figure 3. Trends in Prior-Month Youth Cigarette or Cigar Smoking, by Sexual Identity



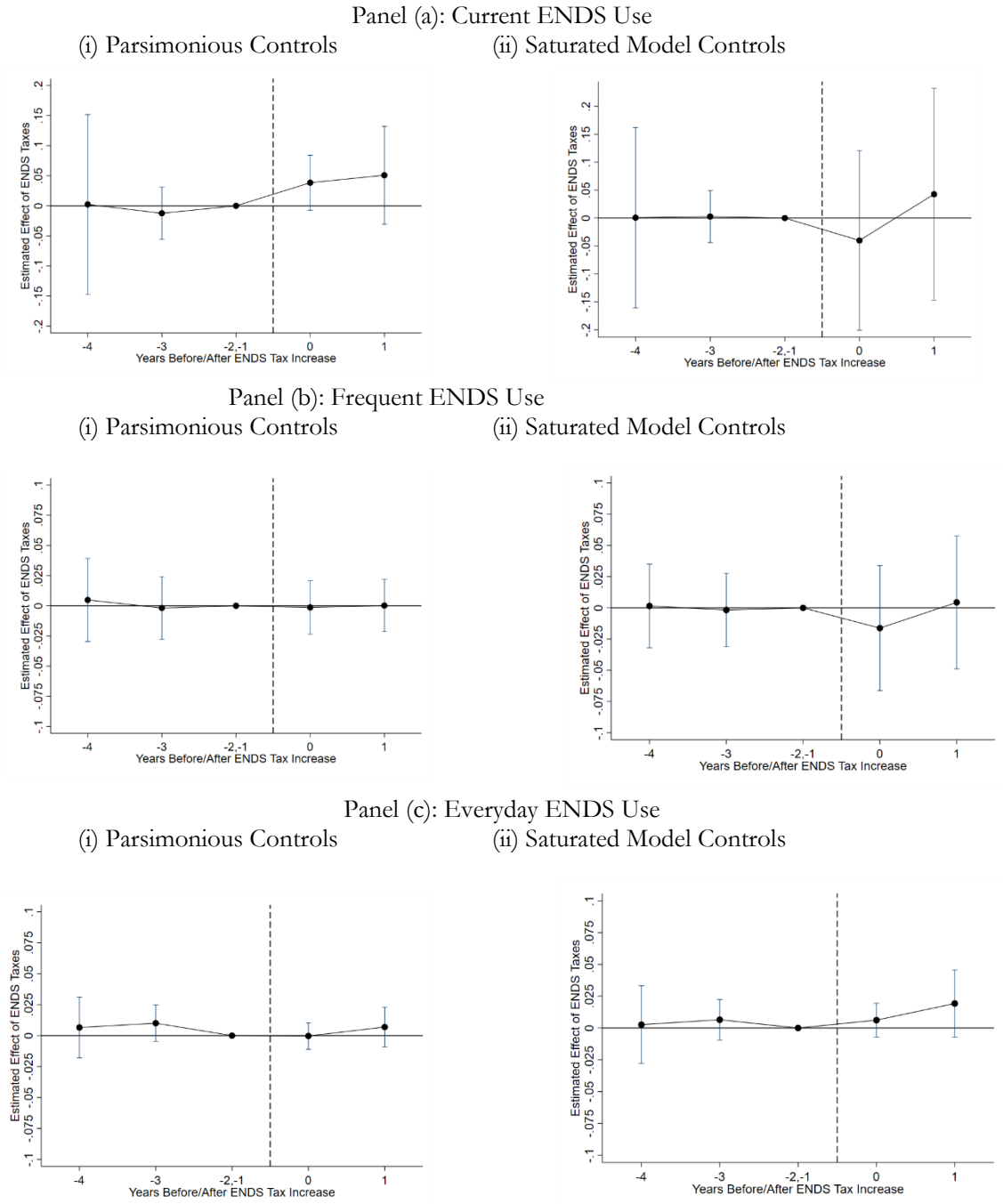
Notes: These data are weighted drawn from the State Youth Risk Behavior Surveys over the 2011-2021 period.

Appendix Figure 4. Event-Study Analyses of ENDS Taxes and ENDS Use Among Heterosexuals, Using dCDH Estimates



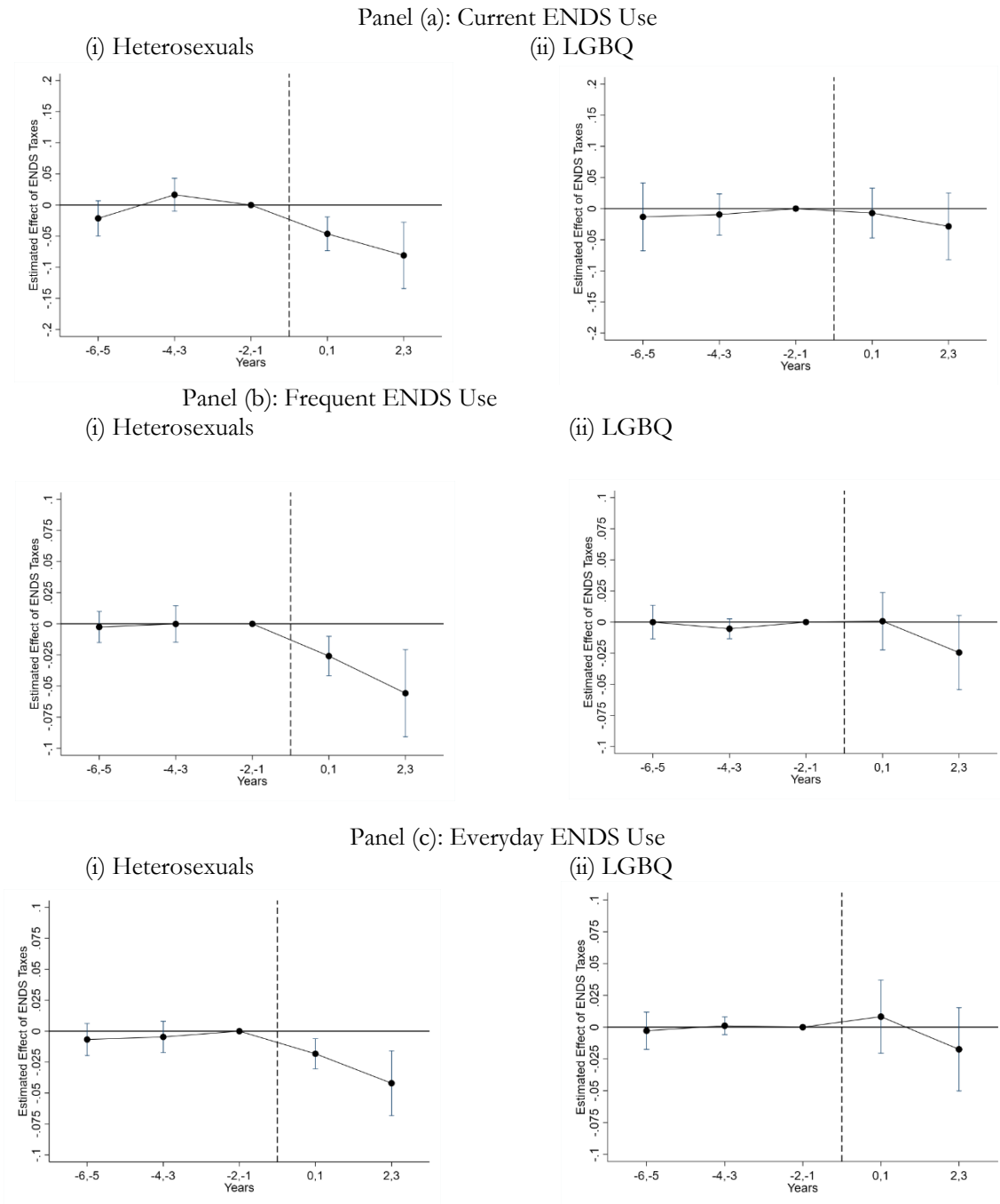
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. Yearly ENDS tax (in \$2021) is binned into four, right-continuous categories: no tax, \$0 to \$1, \$1 to \$2, and \$2 or more. Estimates are obtained using DID event-study estimators introduced in de Chaisemartin and D'Haultfœuille (2020) with Stata command 'did_multiplegt_dyn' (with 95% CIs), and standard errors are clustered at the state level. Parsimonious controls include state and year fixed effects, demographic controls, macroeconomic and COVID-19 controls, and cigarette taxes (in \$2021). Saturated model controls additionally include other combustible tobacco and ENDS policy controls and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax category change.

Appendix Figure 5. Event-Study Analyses of ENDS Taxes and ENDS Use Among LGBQ Individuals, Using dCDH Estimates



Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. Yearly ENDS tax (in \$2021) is binned into four, right-continuous categories: no tax, \$0 to \$1, \$1 to \$2, and \$2 or more. Estimates are obtained using DID event-study estimators introduced in de Chaisemartin and D'Haultfœuille (2020) with Stata command 'did_multipligt_dyn' (with 95% CIs), and standard errors are clustered at the state level. Parsimonious controls include state and year fixed effects, demographic controls, macroeconomic and COVID-19 controls, and cigarette taxes (in \$2021). Saturated model controls additionally include other combustible tobacco and ENDS policy controls and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax category change.

Appendix Figure 6. Event-Study Analyses of Prominent Increases in ENDS Taxes (\$0.25) and ENDS Use by Sexual Orientation, Using Stacked DiD Estimates

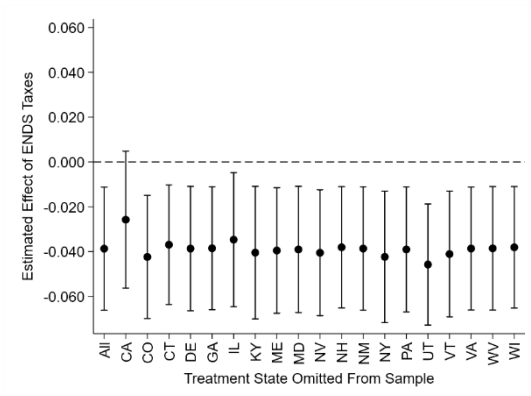


Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using a stacked difference in differences design and weighted OLS (with 95% CIs). Within each \$0.25 (in nominal terms) ENDS tax increase “stack,” control states are defined as who either never implement ENDS taxes or introduce ENDS taxes more than 3 years in the future. Standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, cigarette taxes (in 2021, other combustible tobacco and ENDS policy controls, and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax increase.

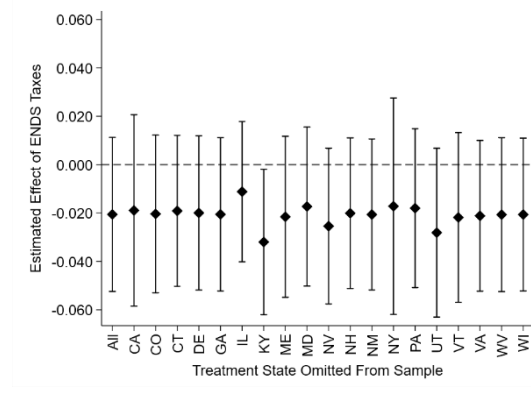
Appendix Figure 7. Robustness to Leaving Out One Treatment State at a Time By Sexual Orientation

Panel (a): Current ENDS Use

(i) Heterosexual

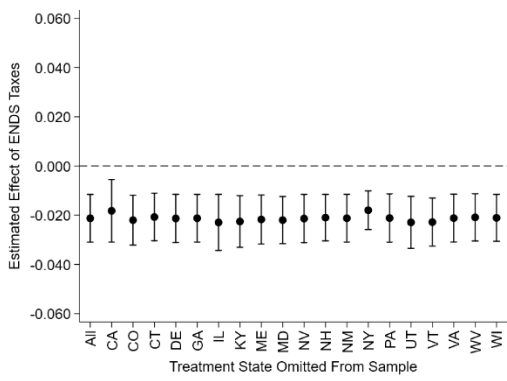


(ii) LGBQ

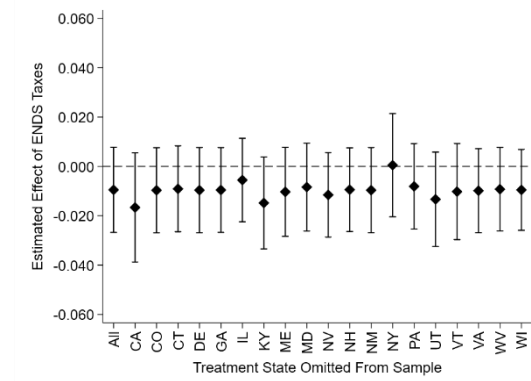


Panel (b): Frequent ENDS Use

(i) Heterosexual

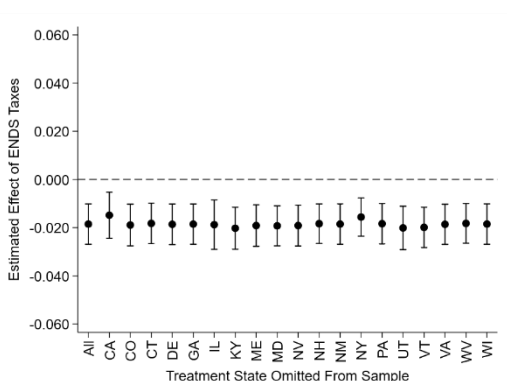


(ii) LGBQ

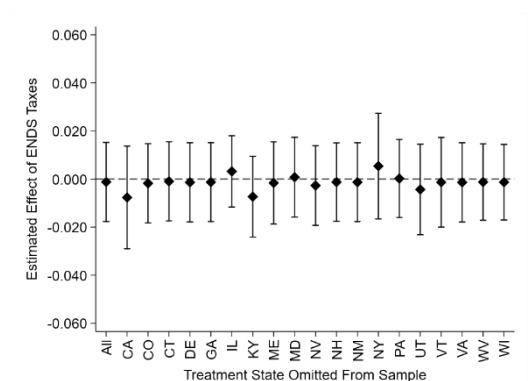


Panel (c): Everyday ENDS Use

(i) Heterosexual

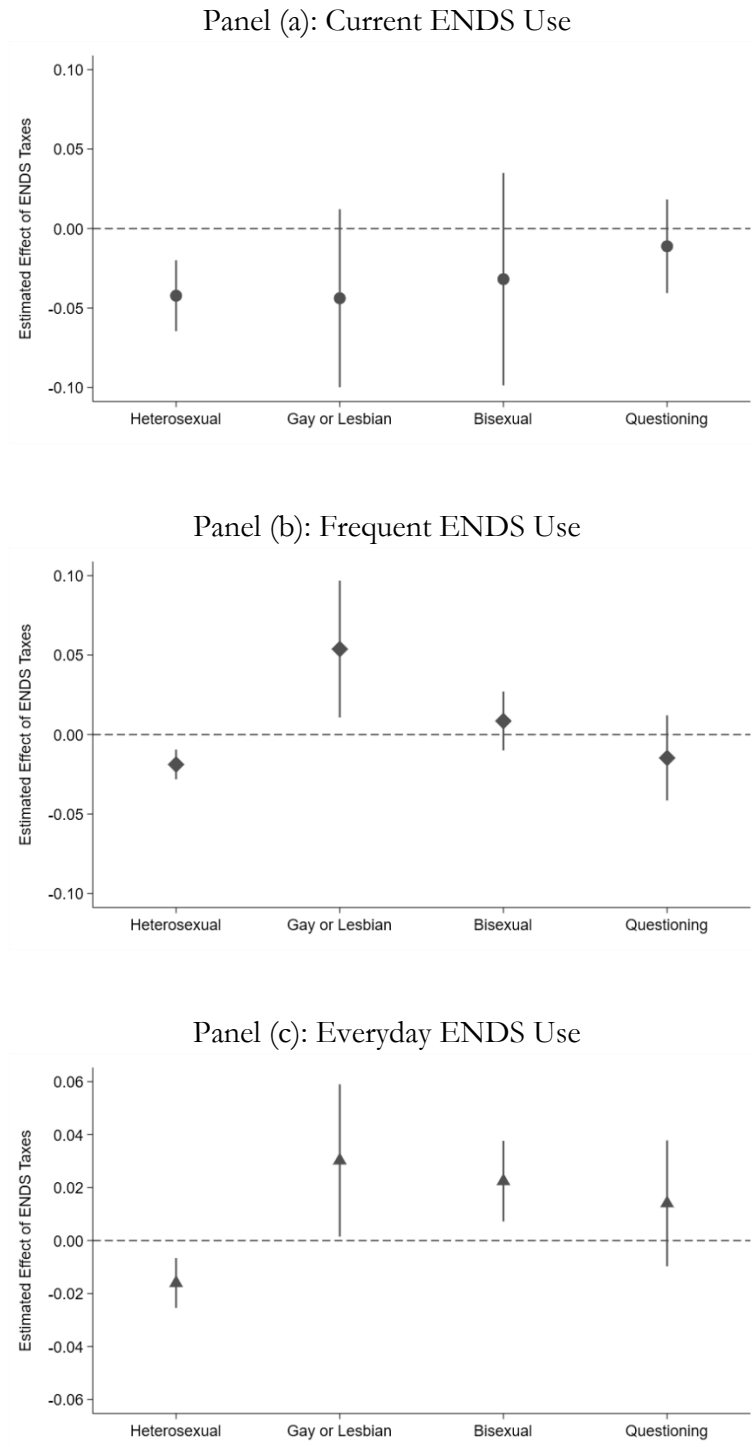


(ii) LGBQ



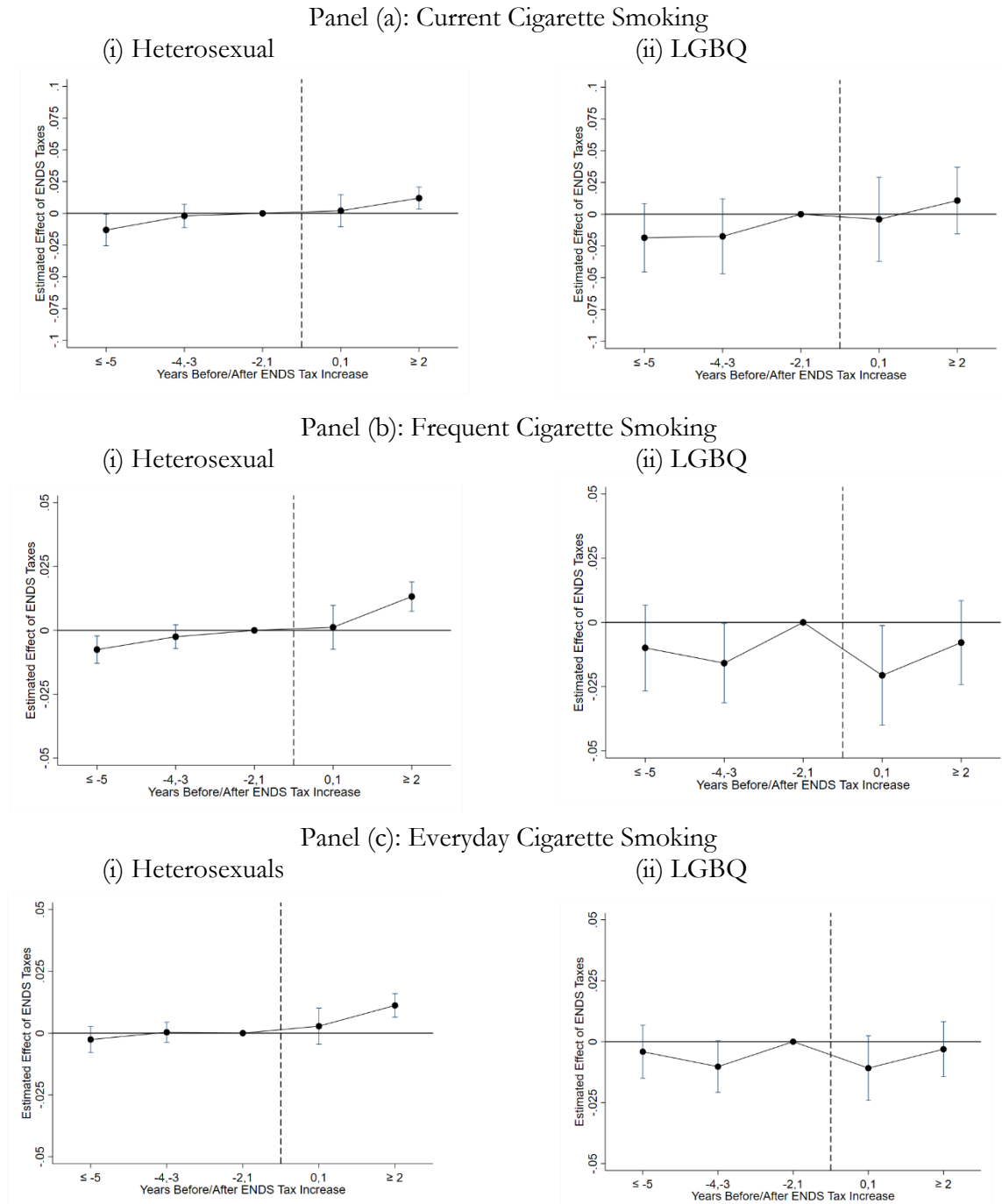
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographics, macroeconomic and COVID-19 controls, and cigarette taxes (in \$2021).

Appendix Figure 8. Exploring Heterogeneity in Estimated Treatment Effect on ENDS Use Among Sexual Minority Youth



Notes: These data are drawn from the State Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use policy controls.

Appendix Figure 9. Event-Study Analysis of ENDS Taxes and Cigarette Smoking, Combined YRBS



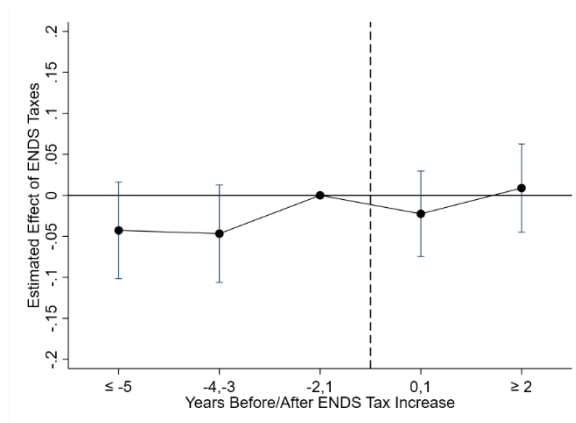
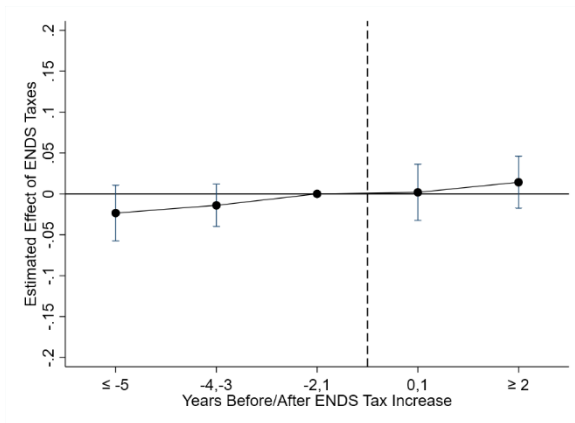
Notes: These data are drawn from the State and National Youth Risk Behavior Survey from 2011-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, semester, and dataset (state, national) fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax increase.

Appendix Figure 10. Event-Study Analyses of ENDS Taxes and Cigarette or Cigar Smoking, by Sexual Identity

Panel (a): Combined YRBS

(i) Heterosexual

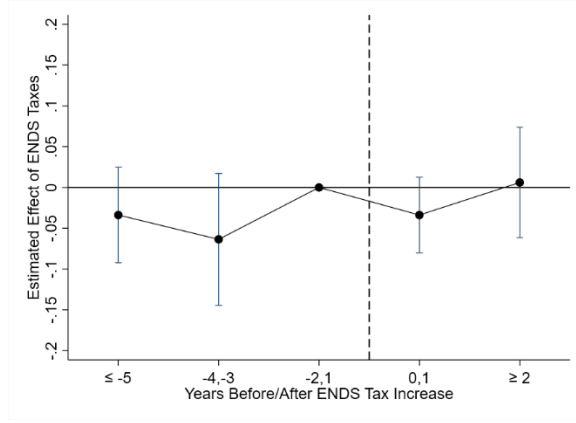
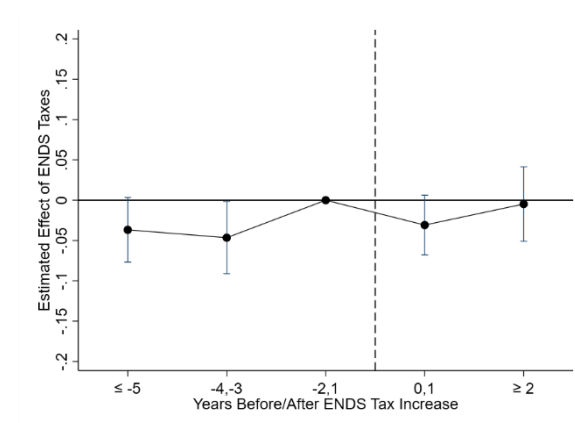
(ii) LGBQ



Panel (b): State YRBS

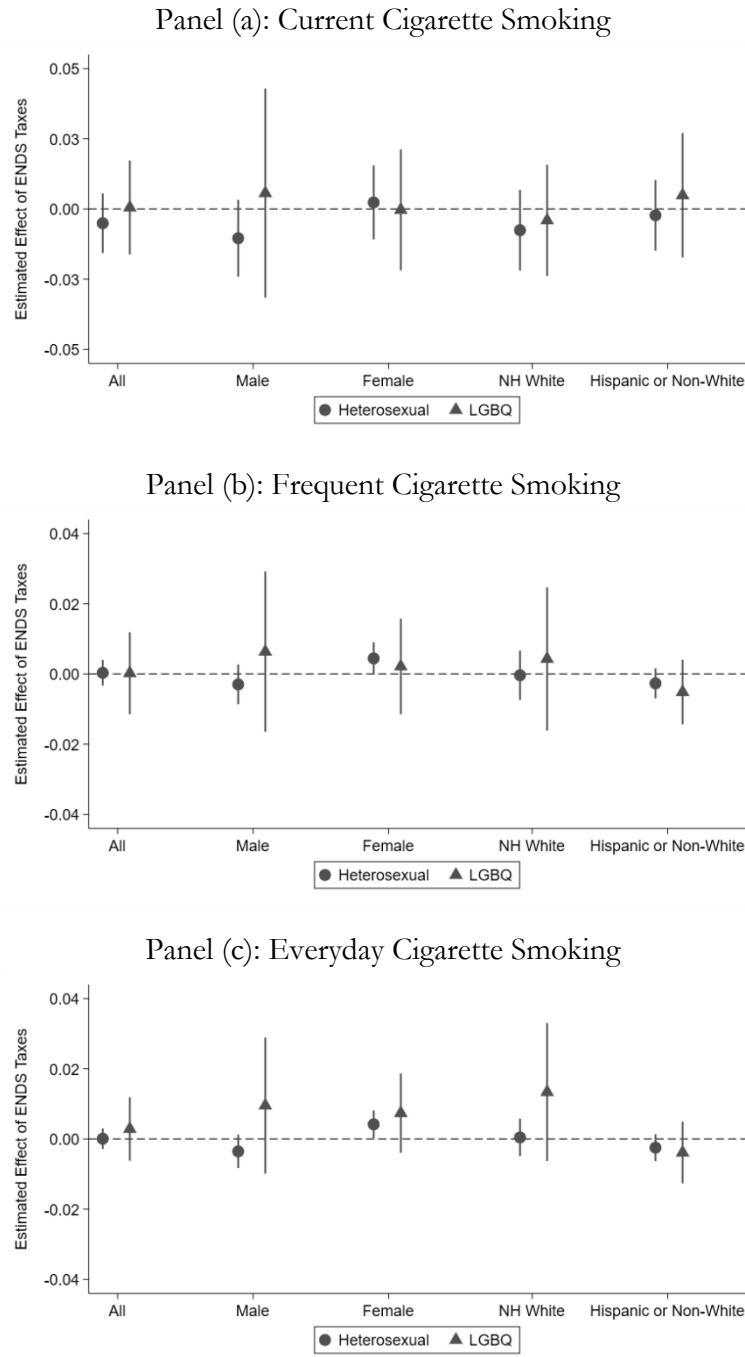
(i) Heterosexuals

(ii) LGBQ



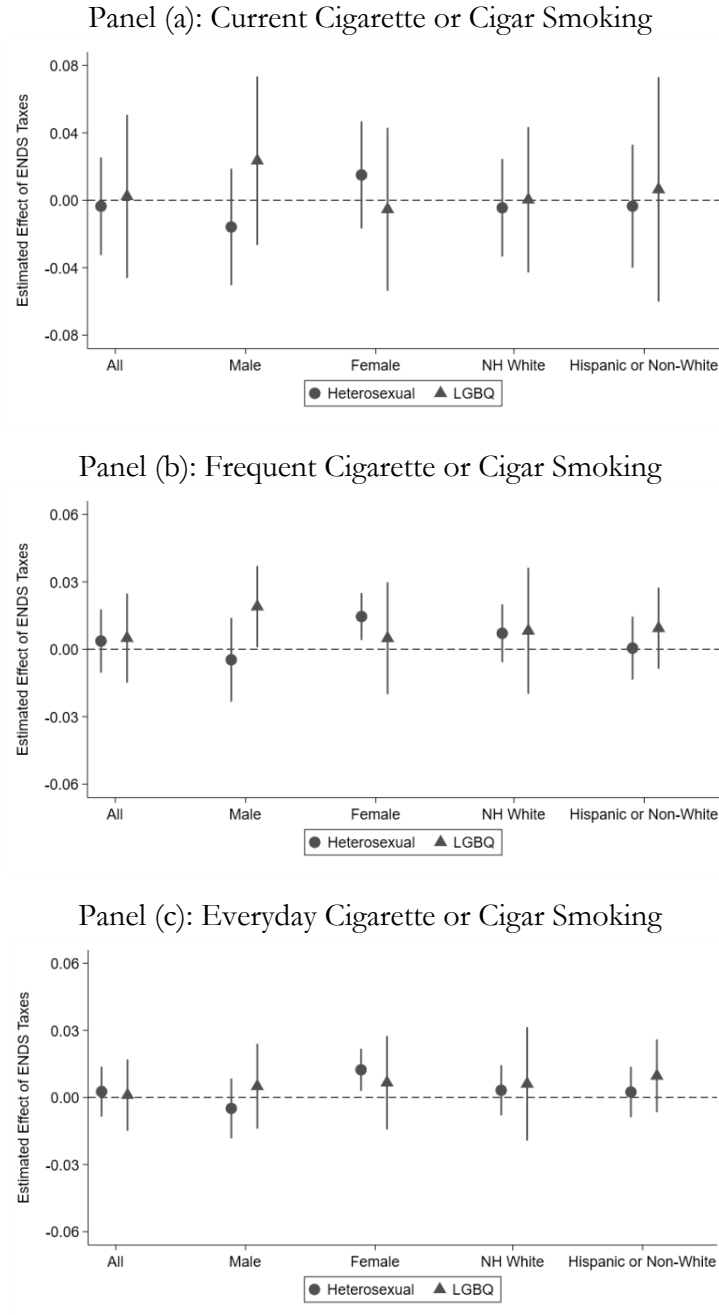
Notes: These data are drawn from the State and National Youth Risk Behavior Survey from 2011-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, semester, and dataset (state, national) fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use policy controls. The reference period is the 1-2 years prior to an ENDS tax increase.

Appendix Figure 11. Further Exploring the Role of Intersectionality on Spillovers to Cigarette Smoking



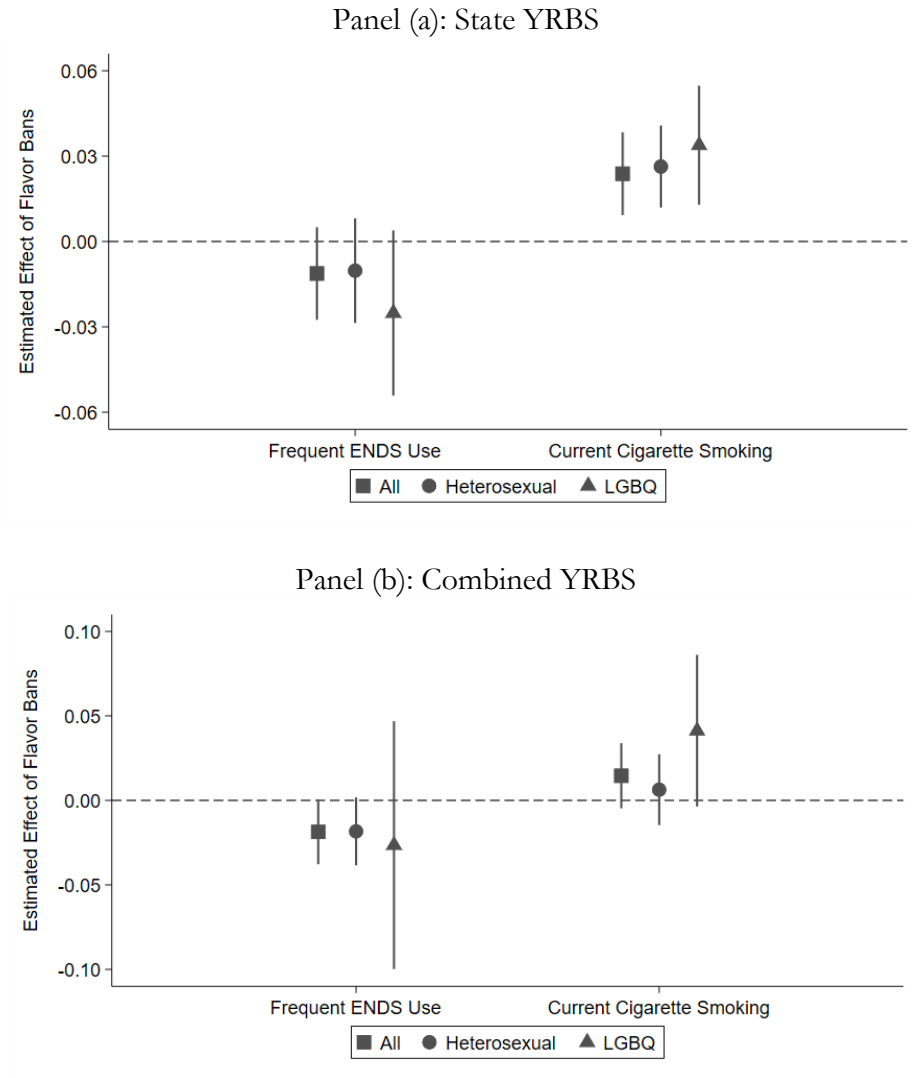
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2011-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use policy controls. The x-axis label “NH White” refers to Non-Hispanic White individuals. Due to non-convergence, logistic estimates are replaced by OLS in panel (b) for Non-Hispanic White, Heterosexual and Non-Hispanic White, LGBQ subgroups, and in panel (c) for the Non-Hispanic White, Heterosexual subgroup.

Appendix Figure 12. Further Exploring the Role of Intersectionality on Spillovers to Cigarette or Cigar Smoking



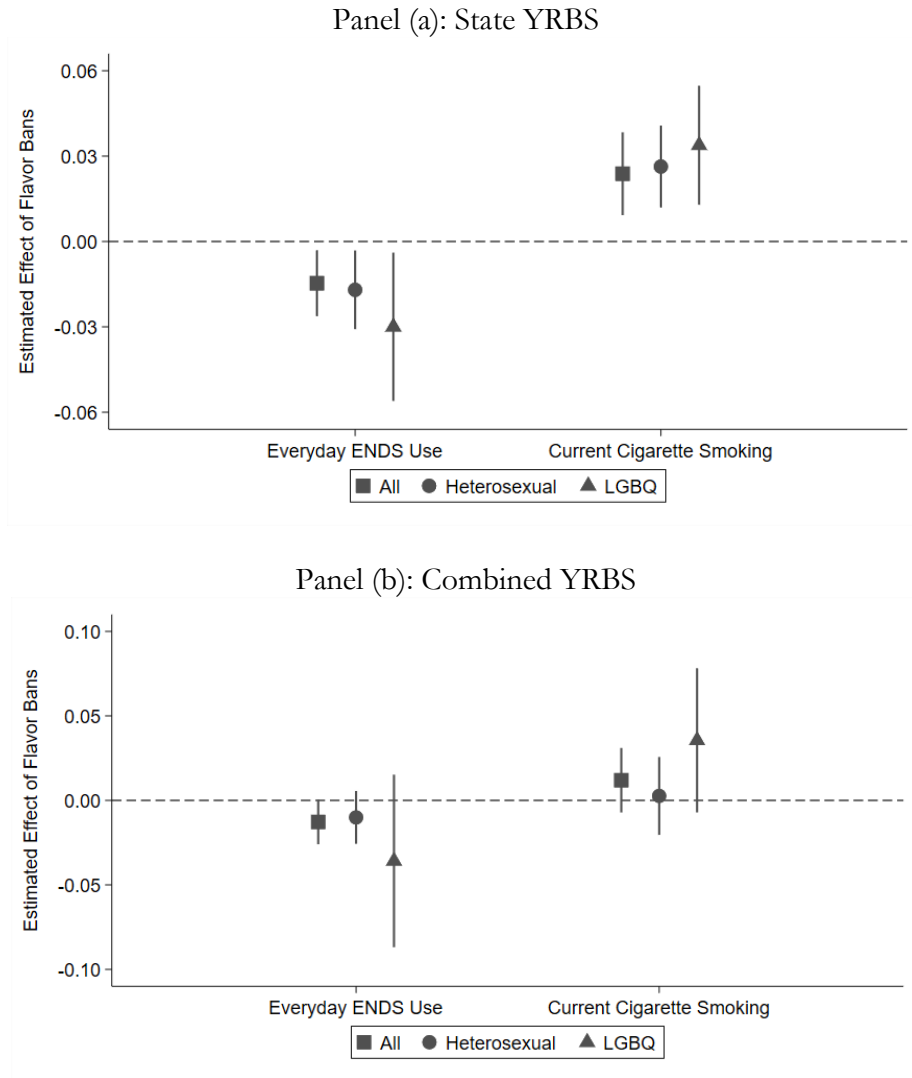
Notes: These data are drawn from the State Youth Risk Behavior Survey from 2011-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs) from our fully specified model, and standard errors are clustered at the state level. Controls include state, year, and semester fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use policy controls. The x-axis label “NH White” refers to Non-Hispanic White individuals. Due to non-convergence, logistic estimates are replaced by OLS in panel (c) for the Non-Hispanic White, Heterosexual subgroup.

Appendix Figure 13. Effects of ENDS Flavor Restrictions on ENDS Use and Combustible Cigarette Smoking, by Sexual Identity



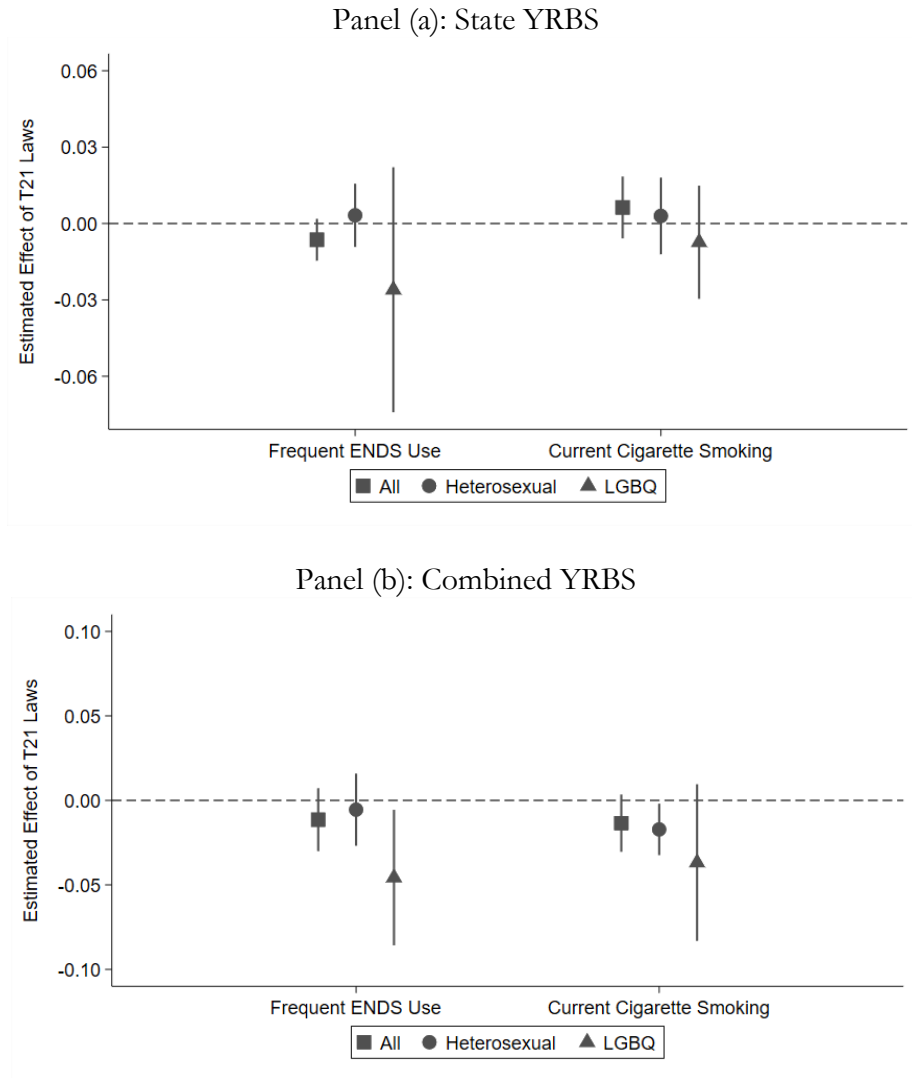
Notes: These data are drawn from the State and National Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, semester, and dataset (state, national) fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use controls.

Appendix Figure 14. Effects of ENDS Flavor Restrictions on ENDS Use and Combustible Cigarette Smoking, by Sexual Identity, with Controls for Menthol Cigarette Restrictions



Notes: These data are drawn from the State and National Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using weighted logistic regression (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, semester, and dataset (state, national) fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use controls. Given the focus on ENDS flavor bans, these specifications also include controls for menthol cigarette flavor bans.

Appendix Figure 15. First-Stage and Spillover Effects of Tobacco 21 Laws



Notes: These data are drawn from the State and National Youth Risk Behavior Survey from 2015-2021. Average marginal effects are estimated using weighted logistic regression and weighted least squares (with 95% CIs), and standard errors are clustered at the state level. Controls include state, year, semester, and dataset (state, national) fixed effects, demographic controls, macroeconomic and COVID-19 controls, combustible tobacco and ENDS policy controls, and other substance use controls.

Appendix Table 1. Test of Sample Selection Bias with Sexual Orientation as an Outcome Variable

	(1)	(2)	(3)	(4)	(5)
ENDS Tax (\$2021)	-0.004 (0.008)	-0.004 (0.008)	0.009 (0.007)	0.008 (0.007)	0.008 (0.007)
Pre-Treat Mean DV	0.133	0.133	0.133	0.133	0.133
N	720150	720150	720150	720150	720150
<i>Controls:</i>					
Macro and COVID?	Yes	Yes	Yes	Yes	Yes
Cigarette Taxes (\$2021)?	Yes	Yes	Yes	Yes	Yes
Other Combustible Tobacco Policies?	No	Yes	Yes	Yes	Yes
ENDS Policies?	No	No	Yes	Yes	Yes
Drug Policies?	No	No	No	Yes	Yes
Alcohol Policies?	No	No	No	No	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2011-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws.

Appendix Table 2. Effect of Cigarette Taxes on Current ENDS Use

	(1)	(2)	(3)	(4)	(5)
Panel I: Full Sample					
Cigarette Tax (\$2021)	0.015 (0.013)	0.004 (0.010)	0.007 (0.011)	0.009 (0.012)	0.010 (0.012)
Pre-Treat Mean DV	0.205	0.205	0.205	0.205	0.205
N	622122	622122	622122	622122	622122
Panel II: Sample Including Information on Sexual Identity					
Cigarette Tax (\$2021)	0.014 (0.013)	0.005 (0.011)	0.009 (0.012)	0.011 (0.013)	0.010 (0.013)
Pre-Treat Mean DV	0.212	0.212	0.212	0.212	0.212
N	526488	526488	526488	526488	526488
Panel III: Heterosexual-Identifiers					
Cigarette Tax (\$2021)	0.020 (0.013)	0.008 (0.011)	0.012 (0.012)	0.014 (0.013)	0.012 (0.014)
Pre-Treat Mean DV	0.204	0.204	0.204	0.204	0.204
N	434665	434665	434665	434665	434665
Panel IV: LGBTQ-Identifiers					
Cigarette Tax (\$2021)	0.005 (0.016)	0.003 (0.017)	0.008 (0.021)	0.015 (0.023)	0.017 (0.023)
Pre-Treat Mean DV	0.261	0.261	0.261	0.261	0.261
N	91823	91823	91823	91823	91823
p-value on $\hat{\beta}_{\text{Cig Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{Cig Tax}}^{\text{LGBQ}}$	0.177	0.609	0.689	0.955	0.894
<i>Controls:</i>					
Macro and COVID?	Yes	Yes	Yes	Yes	Yes
ENDS Taxes (\$2021)?	Yes	Yes	Yes	Yes	Yes
Other Combustible Tobacco Policies?	No	Yes	Yes	Yes	Yes
ENDS Policies?	No	No	Yes	Yes	Yes
Drug Policies?	No	No	No	Yes	Yes
Alcohol Policies?	No	No	No	No	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws.

Appendix Table 3. Effects of Cigarette Taxes on Frequent and Everyday ENDS Use

	(1)	(2)	(3)	(4)	(5)	(6)
	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use
	<u>Logit (Marginal Effects)</u>			<u>OLS</u>		
Panel I: Full Sample						
Cigarette Tax (\$2021)	0.010 (0.012)	0.005 (0.003)	0.004 (0.003)	0.009 (0.011)	0.004 (0.003)	0.004 (0.003)
Pre-Treat Mean DV	0.205	0.041	0.029	0.205	0.041	0.029
N	622122	622122	622122	622122	622122	622122
Panel II: Sample Including Information on Sexual Identity						
Cigarette Tax (\$2021)	0.010 (0.013)	0.004 (0.004)	0.003 (0.004)	0.008 (0.013)	0.003 (0.005)	0.003 (0.004)
Pre-Treat Mean DV	0.212	0.042	0.029	0.212	0.042	0.029
N	526488	526488	526488	526488	526488	526488
Panel III: Heterosexual-Identifiers						
Cigarette Tax (\$2021)	0.012 (0.014)	0.005 (0.004)	0.006 (0.004)	0.008 (0.014)	0.003 (0.006)	0.005 (0.004)
Pre-Treat Mean DV	0.204	0.039	0.028	0.204	0.039	0.028
N	434665	434665	434665	434665	434665	434665
Panel IV: LGBQ-Identifiers						
Cigarette Tax (\$2021)	0.017 (0.023)	0.009 (0.010)	0.001 (0.008)	0.020 (0.024)	0.006 (0.011)	-0.005 (0.010)
Pre-Treat Mean DV	0.261	0.055	0.036	0.261	0.055	0.036
N	91823	91823	91823	91823	91823	91823

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws.

Appendix Table 4. Sensitivity of Estimates to Use of Covariates that Impede Logit Convergence of “DDD” Models for Everyday ENDS Use

	(1)	(2)	(3)	(4)	(5)	(6)
	Fully Specified	Adjusted Covariates	Fully Specified	Adjusted Covariates	Fully Specified	Adjusted Covariates
	State YRBS		State YRBS with Region-Year FE		Combined YRBS	
Panel I: Full Sample						
ENDS Tax (\$2021)	-0.011** (0.005)	-0.011** (0.005)	-0.006** (0.003)	-0.006** (0.003)	-0.007*** (0.003)	-0.005* (0.003)
<i>N</i>	622122	622122	622122	622122	676563	676563
Panel II: Sample Including Information on Sexual Identity						
ENDS Tax (\$2021)	-0.012** (0.005)	-0.011** (0.005)	-0.007** (0.003)	-0.006* (0.003)	-0.006** (0.003)	-0.004 (0.004)
<i>N</i>	526488	526488	526488	526488	578712	578712
Panel III: Heterosexual-Identifiers						
ENDS Tax (\$2021)	-0.016*** (0.005)	-0.015*** (0.005)	-0.010*** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)	-0.007 (0.004)
<i>N</i>	434665	434665	434665	434665	478181	478181
Panel IV: LGBTQ-Identifiers						
ENDS Tax (\$2021)	0.019** (0.008)	0.016* (0.008)	0.023*** (0.007)	0.022*** (0.007)	0.014 (0.013)	0.016 (0.013)
<i>N</i>	91823	91823	91823	91823	100531	100531

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State and National Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. Fully specified columns include the following controls: state, year, semester, and dataset (state, national) fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. Adjusted covariate columns exclude ENDS licensure laws and beer taxes (in \$2021), and columns (3) and (4) include census region by year fixed effects.

Appendix Table 5. Robustness of Estimates to Use of “Prominent” Increase Stacked DiD

	(1)	(2)	(3)
	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use
(a) Heterosexual-Identifiers			
ENDS Tax Increase (\$0.25 in nominal terms)	-0.0458*** (0.0136)	-0.0269*** (0.0077)	-0.0188*** (0.0061)
Pre-Treat Mean DV	0.199	0.035	0.025
N	111955	111955	111955
(b) LGBQ-Identifiers			
ENDS Tax Increase (\$0.25 in nominal terms)	-0.0063 (0.0204)	0.0002 (0.0116)	0.0076 (0.0137)
Pre-Treat Mean DV	0.238	0.042	0.027
N	79477	79477	79477
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.0454**	0.0491**	0.0815*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using a stacked difference in differences design and weighted OLS, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Within each \$0.25 (in nominal terms) ENDS tax increase “stack,” control states are defined as who either never implement ENDS taxes or introduce ENDS taxes more than 3 years in the future. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws.

Appendix Table 6. Sensitivity of ENDS Tax Effects to Census Region-by-Year Fixed Effects and Treatment State-Specific Linear Time Trends, OLS Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use
	<u>Census Region – Year FEs</u>			<u>Treated State Linear Time Trend</u>		
Panel I: Heterosexual-Identifiers						
ENDS Tax (\$2021)	-0.005 (0.014)	-0.016*** (0.004)	-0.012*** (0.004)	-0.041*** (0.010)	-0.025*** (0.005)	-0.021*** (0.004)
Pre-Treat Mean DV	0.204	0.039	0.028	0.204	0.039	0.028
N	434665	434665	434665	434665	434665	434665
Panel II: LGBQ-Identifiers						
ENDS Tax (\$2021)	0.007 (0.014)	-0.008 (0.010)	0.007 (0.010)	-0.033 (0.021)	-0.014 (0.011)	-0.002 (0.010)
Pre-Treat Mean DV	0.261	0.055	0.036	0.261	0.055	0.036
N	91823	91823	91823	91823	91823	91823
p-value on $\hat{\beta}_{\text{ENDS Tax}}^{\text{Hetero}} = \hat{\beta}_{\text{ENDS Tax}}^{\text{LGBQ}}$	0.569	0.479	0.094*	0.673	0.255	0.056*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Estimates, using weighted least squares, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. In addition, census region by year fixed effects are included in columns (1) through (3), and a common linear time trend for the group of treated states is included in columns (4) through (6).

Appendix Table 7. Sensitivity of Main Results to Further Controls for COVID-19 Pandemic

	(1)	(2)	(3)
	Current ENDS Use	Frequent ENDS Use	Everyday ENDS Use
Panel I: Heterosexual-Identifiers			
ENDS Tax (\$2021)	-0.040 ^{***} (0.011)	-0.018 ^{***} (0.005)	-0.016 ^{***} (0.005)
Pre-Treat Mean DV	0.204	0.039	0.028
N	434665	434665	434665
Panel II: LGBTQ-Identifiers			
ENDS Tax (\$2021)	-0.025 (0.021)	0.007 (0.007)	0.019 ^{**} (0.009)
Pre-Treat Mean DV	0.261	0.055	0.036
N	91823	91823	91823

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State Youth Risk Behavior Surveys collected over the period 2015-2021. Sample weights are generated using the individual State YRBS-provided weights and the Surveillance, Epidemiology, and End Results Program (SEER) data. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and semester fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. Additionally, we include an index for overall government response to the Covid-19 pandemic and the percentage of fully vaccinated individuals within the state, both from Hale et al. (2021).

Appendix Table 8. Logit Estimates of Effects of ENDS Taxes on Combustible Tobacco Use, 2015-2021

	(1)	(2)	(3)	(4)	(5)	(6)
	Current Cigarette Smoking	Frequent Cigarette Smoking	Everyday Cigarette Smoking	Current Cig/Cigar Smoking	Frequent Cig/Cigar Smoking	Everyday Cig/Cigar Smoking
Panel I: State YRBS						
(a) Heterosexual-Identifiers						
ENDS Tax (\$2021)	-0.0105* (0.0054)	-0.0022 (0.0018)	-0.0016 (0.0015)	-0.0141 (0.0093)	-0.0045 (0.0037)	-0.0028 (0.0026)
Pre-Treat Mean DV	0.067	0.017	0.012	0.110	0.024	0.017
N	463875	463875	463875	395623	392959	392830
(b) LGBTQ-Identifiers						
ENDS Tax (\$2021)	0.0009 (0.0077)	-0.0004 (0.0053)	-0.0000 (0.0043)	-0.0008 (0.0262)	-0.0021 (0.0098)	-0.0050 (0.0080)
Pre-Treat Mean DV	0.129	0.036	0.025	0.197	0.053	0.038
N	96115	96115	96115	83532	81973	81876
Panel II: Combined YRBS						
(a) Heterosexual-Identifiers						
ENDS Tax (\$2021)	0.0074 (0.0053)	0.0078* (0.0042)	0.0058* (0.0034)	-0.0044 (0.0128)	0.0095 (0.0066)	0.0073 (0.0053)
Pre-Treat Mean DV	0.074	0.024	0.017	0.121	0.031	0.023
N	508560	508560	508111	440657	436353	435683
(b) LGBTQ-Identifiers						
ENDS Tax (\$2021)	0.0124 (0.0119)	-0.0055 (0.0072)	-0.0013 (0.0049)	-0.0040 (0.0229)	0.0069 (0.0157)	0.0051 (0.0132)
Pre-Treat Mean DV	0.133	0.041	0.030	0.196	0.060	0.044
N	105052	104926	104926	92908	90714	90566

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from individual-level State and National Youth Risk Behavior Surveys collected over the period 2015-2021. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, semester, and dataset (state, national) fixed effects, demographics (sex, grade, age, race), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. The outcomes in columns (4) through (6) with “Cig/Cigar” refer to prior-month cigarette *or* cigar smoking.

Appendix Table 9. Effects of ENDS Taxes on Current ENDS Use by Various Demographic Characteristics Among Young Adults

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Non-Drinker	Drinker	HH Inc <25k	HH Inc 25-50k	HH Inc >50k	High School	Some College	College	No Health Insure	Health Insure	No Child	Child
Panel I: Heterosexual-Identifiers												
ENDS Tax (\$2021)	-0.0095 (0.011)	-0.0196 (0.012)	0.0162 (0.019)	-0.0260 (0.027)	-0.0069 (0.012)	-0.0084 (0.014)	-0.0056 (0.026)	-0.0342* (0.020)	-0.0003 (0.020)	-0.0168* (0.010)	-0.0120 (0.011)	-0.0100 (0.014)
Pre-Treat Mean DV	0.067	0.120	0.102	0.090	0.098	0.119	0.095	0.054	0.113	0.094	0.100	0.094
N	30927	45195	16310	18562	28835	25490	24772	23075	11015	64971	47267	30790
Panel II: LGBQ-Identifiers												
ENDS Tax (\$2021)	0.0139 (0.045)	0.0245 (0.058)	-0.0214 (0.040)	-0.0279 (0.059)	0.0815* (0.048)	0.0042 (0.049)	-0.0126 (0.032)	-0.0029 (0.042)	-0.0659 (0.076)	-0.0061 (0.026)	-0.0041 (0.038)	-0.0110 (0.034)
Pre-Treat Mean DV	0.095	0.144	0.123	0.112	0.119	0.150	0.115	0.089	0.131	0.123	0.122	0.130
N	4642	7320	3120	3035	3344	3934	4115	3126	1901	9986	8401	3888

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Average marginal effect estimates, using weighted logistic regression, are generated from 18-30 year olds in the Behavioral Risk Factor Surveillance System collected over the period 2016-2021. Standard errors are in parentheses and clustered at the state level. We include the following controls: state, year, and quarter fixed effects, demographics (sex, race, age, education, marital status), unemployment rates, cumulative COVID-19 death rates, cigarette taxes (in \$2021), indoor smoking bans, combustible tobacco licensure laws, minimum legal sales age (MLSA) laws, tobacco 21 laws, indoor vaping bans, ENDS licensure laws, flavored ENDS restrictions, ENDS online sales bans, recreational marijuana laws, medical marijuana laws, naloxone access laws, beer taxes (in \$2021), and Good Samaritan alcohol laws. Observations surveyed in January and February of 2022 for the 2021 survey wave are assigned December 2021 control values. The column labels “HH Inc” and “Health Insure” refer to household income and health insurance status, respectively.