Alcohol, Pregnancy, and Health Outcomes

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Abstract

Alcohol negatively impacts health outcomes at every stage of pregnancy, from conception timing to childhood development. Fetal alcohol spectrum disorder alone is estimated to cost $1.2-10 billion annually in the U.S. Despite this, relatively few public policies can affect alcohol consumption by women of reproductive age. This study aims to examine state-level alcohol excise taxes and signs warning of the dangers of drinking during pregnancy posted at the point-of-sale. I survey more than thirty years of data across six sources describing the full scope of potential health outcomes. Employing contemporary difference-in-differences methods and a novel approach to alcohol excise taxes, I find that neither policy leads to significant changes in drinking behavior or fetal health outcomes, contrary to earlier research.

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†The most recent version of this document can be found at: `https://rbhebert.github.io/files/hebert_jmp.pdf`

1 Introduction

Alcohol consumption negatively impacts a broad set of pregnancy-related health outcomes. First, impaired judgement can lead to unintended pregnancy, which may impact abortion rates and related abortion access concerns (Naimi et al., 2003). Second, women may experience a higher rate of spontaneous abortion early in the pregnancy (typically prior to the 20th week) (Kline et al., 1980; Andersen et al., 2012). Third, alcohol use can increase the rate of stillbirth, defined as occurring past the 20th week. Fourth, alcohol use leads to fetal alcohol spectrum disorder (FASD) and associated conditions, which can impact child development in terms of behavior and cognition later in life (von Hinke Kessler Scholder et al., 2014; Mamluk et al., 2017; May et al., 2021). Critically, all of these outcomes are irreversible, and so the consequences are permanent for the women and children involved.

Alcohol use among reproductive aged women in the United States has changed significantly over the last 30 years. Rates of alcohol use and binge drinking in men and women have been converging as women increase alcohol consumption, with the highest levels of drinking found among women 21-25 years of age who already have a high incidence of unintended pregnancy (White et al., 2015; Slater and Haughwout, 2017). While drinking at any stage of pregnancy has potential negative effects on fetal development; one of the most critical periods is during the first trimester, 6-8 weeks of which will pass while the women in question do not even know they are pregnant (Gosdin et al., 2022). With costs from FASD estimated to be between \$1.2-10 billion in the U.S. annually, rising alcohol consumption among women of reproductive age should be of great concern to policymakers (Greenmyer et al., 2020).

However, there are few policies which can impact drinking rates among women of reproductive age. Alcohol taxes are one possibility; Wagenaar et al.

(2009) provides a meta-analysis of studies on alcohol excise taxes, prices, and consumption, finding a robust inverse relationship between excise taxes and alcohol consumption.[1] Zhang (2010) has examined responses to alcohol taxation among pregnant women, finding significant reduction in binge drinking rates as well as a decreased incidence of low birth weight.[2]

The other major policy at the state level is signs warning of the dangers of alcohol use during pregnancy, typically posted at the point of sale (i.e. "warning signs"). About half of U.S. states now have such policies, the most recent adopter being Arkansas in 2019. From these policies, Cil (2017) finds a 35% decrease in any alcohol use and a 75% decrease in binge drinking by pregnant women, as well as 3.8% decrease in very low birth weight incidence.

This study aims to determine how these two policies, alcohol taxes and warning signs, impact the full range of potential welfare effects in the context of pregnancy. To do this, I consider outcomes across more than thirty years of data from six sources, and employ difference-in-difference methodologies that are designed to account for staggered adoption, potential dynamic effects, and continuous treatment (in the case of alcohol taxes). Further, I employ a novel approach to excise taxes as a source of policy variation by creating a composite alcohol tax measure. My results indicate that neither policy leads to effective reduction of alcohol use among women of reproductive age or improvement in health outcomes concerning pregnancy, contrary to prior literature.

[1] A more recent meta-analysis of studies on alcohol taxation and control policies found that, broadly, alcohol taxes and minimum unit price policies do reduce alcohol consumption substantially (Kilian et al., 2023).

[2] Specifically, Zhang (2010) finds a 1 cent increase in beer tax (about 0.1 cents per standard drink) leads to a decrease in low birth weight incidence by 1-2%, while binge drinking among pregnant women decreases by 2.5% with a 1% increase in beer or wine taxes, and by 9–10% with liquor taxes.

2 Background

Alcohol use during pregnancy, including binge drinking, is common across the world, in both developed and developing nations (Lange et al., 2017). Through the twentieth century, this was rarely considered an issue for fetal development; it was not until 1977 that the U.S. Department of Health, Education, and Welfare (later Department of Health and Human Services) issued a health advisory indicating that pregnant women should limit themselves to two drinks per day (Warren, 2015). In the years following, medical research conclusively demonstrated the risks of fetal alcohol spectrum disorders (FASD) and pushed for labeling changes to warn women of the dangers of drinking during pregnancy (Sokol et al., 2003). The warning label requirement was passed in 1988.[3] It was not until 2005, though, that the U.S. Surgeon General officially warned Americans that any alcohol use by women pregnant or seeking to become pregnant was dangerous, and that therefore abstinence from alcohol was the optimal choice for fetal health (Carmona, 2005). Contemporary research supports the conclusion that even small amounts of prenatal alcohol use can potentially have negative impacts on health, and that prenatal alcohol use is the leading preventable cause of birth defects in the U.S. (Williams et al., 2015; Mamluk et al., 2017, 2021).

Although abstention from alcohol prior to and during pregnancy was not officially recommended by the medical establishment in the U.S. until later in the twentieth century, it falls into a tradition of increasing expectations on mothers following advances in the understanding of disease and infant mortality. As awareness rose concerning hygiene and preventable childhood disease, cultural attitudes may have led to a shifting of blame for poor child health and mortality from amorphous factors beyond the control of families to the direct actions (or

[3] For an extended review of the history of attitudes concerning alcohol use during pregnancy, see Warren (2015).

inaction) of parents, and mothers most particularly.[4] While abstention clearly leads to optimal health outcomes based on the medical literature, it is important that we contextualize this additional restriction on maternal behavior as one in a long series of potentially guilt-inducing decisions related to motherhood. Decisions about pregnancy already involve conception timing and labor market consequences, health insurance coverage, relationship stability and family/peer support networks, worries over uncontrollable genetic factors related to infant health, and of course financial planning matters. Abstaining from alcohol use, though it is conceptually a simple binary decision informed by clear policy, is ultimately one more marginal stress factor for women who are already in a highly stressful position.

2.1 Alcohol Use

Figures 3, 4, 5, 6, and 7 document a substantial change in drinking behavior among young women over the past thirty years. First, the total per-capita ethanol consumption across all beverage types has increased by approximately 15% since 1995 and continues to rise.[5] Second, we see a convergence in drinking behavior between younger cohorts of men and women, as noted in White et al. (2015). Third, the women showing the highest levels of drinking are 21-25 years of age, which is also documented using National Survey on Drug Use and Health (NSDUH) data in Slater and Haughwout (2017). Fourth, among women who are drinking, the incidence of binge drinking is increasing over time.

[4] For a review of the increasing burden on mothers, see Ladd-Taylor and Umansky (1998).

[5] Using estimates around 2010 from Nielsen consumer panel data in Saffer et al. (2022), the "heavy drinker" 90th percentile of households in terms of alcohol consumption (excluding those which purchased no alcohol in the prior 12 months) purchased greater than or equal to 38.87 ounces of ethanol per month (per adult). "Moderate drinkers" were defined as being in the 50th to 90th percentile, with the lower value cutoff being 5.47 ounces of ethanol per month. Per Saffer et al. (2022) this aligns with 2010 NSDUH data showing 66% of households are drinkers and 7% are heavy drinkers. It is worth noting that this translates into $5.47/0.6 = 9.12$ standard drinks per month at the 50th percentile and $38.87/0.6 = 64.78$ standard drinks per month at the 90th percentile. This works out to about two standard drinks per week at the 50th percentile and fifteen standard drinks per week at the 90th percentile.

We also see changes in drinking during pregnancy, as indicated below in figure 8. Both drinking and binge drinking incidence are increasing in the data. Just as concerning, we see an increase in reported drinking in the three months before pregnancy in the CDC's Pregnancy Risk Assessment Monitoring System (PRAMS) data (Centers for Disease Control and Prevention, 2024). Most women will not be aware they are pregnant for between 6-8 weeks, meaning they are highly likely to continue drinking at the three months prior rate during at least that portion of the first trimester, when risks to fetal development are very high.

Figure 10 suggests an increase in drinking prior to pregnancy along the intensive margin on average,[6] which aligns with the estimates shown in the CDC's Behavioral Risk Factor Surveillance System (BRFSS) data[7]. In addition, the overall increase in reported drinking before pregnancy is driven by women who are over twenty-one years of age, as illustrated in figure 11. About 10% of the PRAMS sample reports drinking more than 3 drinks per week in the three months prior to pregnancy, and 32% reports at least one drink per week. If we use the estimates from Saffer et al. (2022), drinkers at the 50th percentile are consuming about 2 standard drinks per week, while drinkers at the 90th percentile are consuming about 15 per week. Considering that the PRAMS question is not asking about standard drinks in particular, drinking may be more intense than we might expect if we think only in terms of standard drinks, which may have less alcohol than what someone considers a single drink. In particular, that estimate of 32% having at least one drink per week may match up with the 50th percentile of drinkers in terms of standard drinks.

[6]Figure 9 shows a similar trend for the extensive margin.

[7]U.S. Department of Health and Human Services and Centers for Disease Control and Prevention (2024)

2.2 Pregnancy

Figure 12 documents the increasing age at first birth among women in the U.S. Looking at this, we might be tempted to conclude that the incidence of unintended pregnancy[8] is decreasing significantly over time, but there is substantial heterogeneity in the data (Mosher et al., 2012). For example, PRAMS data indicates a 35% rate for white women, a 65% rate for black women, a 50% rate for women with a high school degree or less, and a 23% rate for women with a college degree.

Examining differences between 1995 and 2020 in the rate of unintended pregnancy in figure 13, we see an enormous gap between the first two age groups and the rest of the sample, but also limited change in the rate of unintended pregnancy over time.

2.3 Health Consequences

There are four major health risks concerning pregnancy as a consequence of alcohol use: unintended pregnancy, fetal death prior to 20 weeks (i.e. spontaneous abortion), fetal death post-20 weeks (i.e. stillbirth), and FASD. Increasing rates of alcohol use and binge drinking among reproductive aged women may be translating into higher risk for each of these. However, all four outcomes have considerable measurement difficulties, making exact analysis of these effects challenging.

Unintended pregnancy tends to result in negative health outcomes for the child and negative economic outcomes for both the mother and the child (Mosher et al., 2012). While alcohol use is itself correlated with other risky behavior, the

[8] Unintended pregnancy is defined using responses to the question: "Thinking back to just before you got pregnant, how did you feel about becoming pregnant?" If the response is "sooner" or "wanted to be pregnant then", then the pregnancy is considered to be intended. Otherwise it is coded as unintended, with the response being "later," "not sure," or "did not want."

use of alcohol can lead to risky sexual behavior and thus unintended pregnancy (Naimi et al., 2003). The incidence of unintended pregnancy is not homogeneous in the population, but is heavily biased toward younger women, a group which seems to demonstrate increasing binge drinking.

One potential outcome of unintended pregnancy is abortion. Most abortions take place very early in pregnancy, 80.9% at ≤ 9 weeks and 93.1% at ≤ 13 weeks in 2020 (Kortsmit, 2022). The recent overturning of Roe v. Wade at the federal level and continuing restrictions on abortion, especially for younger women, are leading to greater obstacles to abortion access (Myers, 2024; Jones and Pineda-Torres, 2024). Alcohol-related policies may play a role in reducing unintended pregnancy and its downstream welfare impacts in a post-Roe abortion environment.

Spontaneous abortion is estimated to occur in between 10-20% of pregnancies, but of course this is not perfectly documented. The literature on alcohol's effect on this outcome has been mixed over time, but more recent evidence from large-scale studies supports the conclusion that alcohol use increases the incidence of spontaneous abortion, particularly in the first trimester (Kline et al., 1980; Andersen et al., 2012). In particular, Andersen et al. (2012), studying a Danish national birth cohort of over ninety thousand women, report a spontaneous abortion hazard ratio (relative to the non-drinking group) of 1.66 for moderate drinkers (2-3 drinks per week) and 2.82 for heavy drinkers (4+ drinks per week) in the first trimester. If we assume a baseline rate of only 5% among nondrinkers, then that implies a rate of 8.3% for moderate and 14.1% for heavy drinkers, with corresponding decreases in risk if alcohol use is reduced.

Fetal alcohol spectrum disorder (FASD) is an umbrella term that includes several conditions. These include fetal alcohol syndrome (FAS), the most severe condition, pFAS, or partial fetal alcohol syndrome, alcohol-related neurodevelopmental disorder (ARND), and alcohol-related birth defects (ARBD) (May and Gossage, 2001). All of these conditions can be difficult to detect in many cases, and each of them is usually observed at different stages of development. Some FASD indicators can be observed at birth, but many others relate to behavioral outcomes which will not be apparent until years later (Hur et al., 2022). As a result, the precise prevalence and incidence of FASD is highly uncertain, although researchers do document consistently higher rates of FASD in higher-risk (i.e. higher alcohol use) communities (Roozen et al., 2016). Despite heterogeneity in terms of observed prevalence, it is clear from the literature that increasing alcohol use results in increasing incidence of FASD; Sokol et al. (2003) estimated an overall FASD prevalence to be 9.1 per 1000, with higher rates among lower-educated and minority groups, while more recent studies indicate 65 per 1000 (6.5%) when examining children[9] (May et al., 2021).

2.3.1 Empirical Testing

To investigate the correlation between first trimester alcohol use and birth outcomes, I use the rate of drinking three months prior to pregnancy. The PRAMS also has a categorical intensive margin variable for drinking three months prior to pregnancy, with levels of drinks per week: 0, less than 1, 1-3, 4-6, 7-13, more than 14. I regress these outcomes on the drinking status indicators using PRAMS analytic weights and state and year fixed effects. I also include the

[9] Studies which cover whole communities of children are referred to as "active case ascertainment" studies, and they typically provide better insight than passive surveillance studies in general. In the U.S., those studies examining children show the following rates per 1000 (Results documented from the survey in Roozen et al. (2016)):

- FAS 2.4 (May et al. 1983),
- FAS 5.92 (Burd et al. 1999),
- FAS 4.91/5.21 (Clarren et al. 2001),
- FAS 4.34 (Poitra et al. 2003),
- FAS 0.23 (Weiss et al. 2004),
- FAS 8.37; pFAS 16.05; ARND 9.07; FASD 33.50 (May et al. 2014).

following control variables: marital status, education, age, and race. About 10% of the sample reports drinking more than 3 drinks per week in the three months prior to pregnancy. Per the PRAMS, the average alcohol consumption in this group is about 7 drinks per week, or 365 drinks per year. From the NIAAA data above, if we assume 500 standard drinks per person and two-thirds of households drinking at all, then about 750 standard drinks per person would be the average consumption. The 365 reported drinks may be an underestimate, as one drink is likely to be more than a single standard drink. It is certain that there is considerable heterogeneity among women in this group.

Tables 15 and 16 show outcomes for the simple binary drank/did not drink three months prior to pregnancy. We show significant but small effects, some of which are counterintuitive. For example, gestational age is slightly higher, low birth weight incidence is slightly lower, and premature birth incidence is slightly lower for the group which reports drinking. These are small effects, but it is important to keep in mind that these only reflect live births and not miscarriages. If drinking does increase the incidence of spontaneous abortion, those women who are drinking in the first trimester would be less likely to be represented in the data. When we control for demographic factors, we see an increase in the rate of unintended pregnancy of 11.2% from the non-drinking group.

When we examine women who report drinking more than three drinks per week in the three months before pregnancy in tables 17 and 18, we find a much stronger difference from the non-drinkers. Unintended pregnancy shows a 19.2% increase, considerably higher than even the 11.2% in the any drinking sample. Interestingly, infants are 14.9% less likely to be large for gestational age and 10% more likely to be small for gestational age for the mothers who report this drinking intensity. So despite showing longer gestation, lower incidence of low birth weight, and lower incidence of preterm birth, these infants demonstrate significant markers for developmental issues related to alcohol use.

2.4 Alcohol Policies

Policy responses to alcohol use in general and alcohol use during pregnancy in particular come in a few forms: 1) education and physician guidance, 2) minimum legal drinking age laws (MLDA), 3) vertical ID laws, 4) federal warning labels on alcohol containers, 5) state point-of-sale (and physician's office) warning signs[10], 6) federal excise taxes, and 7) state excise taxes[11]. Federal warning labels were mandated for alcohol containers in 1988 (Warren, 2015). In 2005, the surgeon general announced that there was no safe level of alcohol use during pregnancy (Carmona, 2005). From earlier research, we know that MLDAs have a substantial effect on underage drinking, particularly among men, but do not reduce binge drinking among young women (Carpenter et al., 2016). Vertical ID laws do not seem to be effective in reducing underage drinking and smoking, based recent work (Mtenga and Pesko, 2024). Federal excise taxes seem to have reduced traffic fatalities and injury related to alcohol use, but have been unchanged since 1991 (Cook and Durrance, 2013).

Two of these policies may have a significant effect on women over the minimum legal drinking age. State-mandated warning signs seem to have a meaningful effect in reducing alcohol consumption by pregnant women and reducing very low birth weight incidence, but the single study in question, Cil (2017), has limitations. It uses birth certificate data where alcohol use is substantially underreported (Northam and Knapp, 2006), and a relatively small number of years from the BRFSS. Moreover, recent advances in the difference-in-differences literature indicate potential issues with the methodology. State excise taxes are

[10]See figure 2 for warning sign laws visualization.
[11]See figure 1 for state-level tax visualization.

also not well-studied in this context, with only Zhang (2010) examining birth outcomes and excise taxes, but again using limited BRFSS data and birth certificate data. Neither of these studies examines the broader range of potential health impacts from alcohol use on pregnancy.

2.5 Contribution

This study makes novel contributions to the literature in the areas of women's health and pregnancy, alcohol policy, and particularly alcohol taxes. I examine the broadest set of pregnancy-related health outcomes to determine potential welfare impacts of alcohol policies; to do so, I use more than 30 years of data across six data sets, most of which have not been used in this context. This is only the second study to examine warning sign laws. It is the first study to examine alcohol excise taxes using the dynamic method of De Chaisemartin and d'Haultfoeuille (2024). Moreover, I use a novel method to examine the multiple types of excise taxes on alcohol, taking into account the presence of liquor and wine monopoly states.

3 Data

3.1 PRAMS

For thorough information on pregnancy and health, I use the restricted-access Pregnancy Risk Assessment Monitoring Survey (PRAMS) data (Centers for Disease Control and Prevention, 2024).[12] This survey began in 1987 and runs annually in the U.S. in participating states, with a larger number of states participating over time. As of 2020, 40 states and the District of Columbia met

[12]See table 7.

the required response rate criteria for inclusion in the data set.[13] The PRAMS survey typically has between 1000 and 3000 observations per state per year. Any state whose survey response rate falls below 50%[14] for the year in question is not included in the data set.

The survey questionnaire is updated every few years by the CDC, most recently in 2016 with the introduction of PRAMS Phase 8, and individual states also offer state-specific survey addenda. Questions in the PRAMS cover details about a variety of topics including prenatal care and health behaviors, prior pregnancy, family history, and infant care.[15]

The alcohol-related outcomes in PRAMS include: drank in the three months before pregnancy, drank in the last three months of pregnancy, and drank in the last two years (prior to the survey). For the first two, the data includes binary variables as well as a categorical number of drinks per week. I use this latter variable to construct an expected number of drinks per week variable for each outcome, so that I can measure changes along the extensive margin. It is important to note that these are self-reported outcomes that cannot be verified with any biomarker for substance use. Moreover, the variables for drinking during pregnancy are omitted from approximately half of participating states' questionnaires post-2015.

Concerning demographics, the data includes categories for Asian, Native American, and Native Hawaiian. Mother's age is a continuous variable (with some imputation needed for certain states). Marital status is either married or unmarried. Maternal education is coded in five categories: less than 8th grade, 9-12th grade without diploma, high school graduate, some college without degree, and bachelor's degree or higher. I use a four category race variable

[13]At present, Connecticut, Florida, North Carolina, Oklahoma, and Texas are not participating in the restricted data disclosure portal via CDC. I am reaching out to these states individually for potential data access.

[14]This threshold was higher prior to 2018.

[15]For further details on PRAMS methodology and design, refer to Shulman et al. (2018).

(white, black, other, and Hispanic), plus three levels of mother's education: high school or less, some college, and BA or higher. Observations missing these demographic details are omitted from the analysis.

Both Alaska and Vermont omit the birth month from PRAMS reporting. Consequently, I label births from these states as taking place in the middle of the year of birth. As with the NVSS data, I code gestation timing using the same approach as Currie and Rossin-Slater (2013).

3.2 BRFSS

Alcohol use and binge drinking incidence among the general population and self-reported pregnant women comes from CDC BRFSS, 1984-2022 (U.S. Department of Health and Human Services and Centers for Disease Control and Prevention, 2024).[16] I use the same race and education categories as those for PRAMS, but the age bins in BRFSS mean that 18-25 year old individuals are in a single group. I use a standard drinks measure as well, but due to changes over time in its reporting and number of unreliable observations, it is not part of the main specification. I drop observations missing demographic covariates from the analysis.

3.3 Abortion Data

Data on abortion rates and policies are sourced from the Guttmacher Institute data center.[17] In particular, abortion rate data are taken from Maddow-Zimet and Kost (2021, 2022). These range from 1988-2020, with 1-3 year gaps in the early years of the data. In these cases I linearly interpolate the abortion rate by state. County abortion provider data is taken from Frost et al. (2016). Concerning policies, minimum waiting period laws come from Myers (2021), parental

[16]See table 4.
[17]See table 9.

involvement laws from Myers and Ladd (2020), and targeted restrictions on abortion providers (TRAP laws) from Jones and Pineda-Torres (2024).

3.4 NVSS Natality

Data on state-level births comes from the restricted-access Natality Detail Files via the Centers for Disease Control (CDC), the National Vital Statistics Service (NVSS), and the National Center for Health Statistics (NCHS) from 1995-2022 (NCHS, 2024).[18] These data come from U.S. birth certificate records, and provide a full record of all births recorded on birth certificates in the U.S. in that time period.

These data contain a host of useful information at the individual level. In 2003, birth certificate coding was revised by NVSS, and these revisions were adopted by individual states from 2004 to 2015. For the purposes of this study, relevant information is coded with sufficient consistency across the original and revised birth certificates.

In particular, data on alcohol use listed on birth certificates is known to be unreliable and substantially underreported (Northam and Knapp, 2006). Consequently, although the data has excellent demographic detail and health data concerning natality, it does not have information on alcohol consumption to act as a proper first stage.

In this data, I code race with four categories: non-Hispanic white, non-Hispanic black, Hispanic, and missing/other. I code marital status as either married, unmarried, or other. Mother's age can be continuous, but I also employ categorical breakdowns in my compositional analysis below. I also include birth order (first or second plus) to stratify the data. Regarding gestation timing, I rely on the method used in Currie and Rossin-Slater (2013). Observations missing demographics covariates are dropped from the analysis.

[18]See table 5.

3.5 NVSS Fetal Death

Data on fetal deaths from 2005-2022 is taken from CDC WONDER (U.S. Department of Health and Human Services et al., 2024).[19] I use the same four-category race variable as in the natality data, along with age bins and marital status. The outcomes are presented in fetal deaths per 1,000 births.

3.6 National Survey of Children's Health

Childhood outcome data that may be related to FASD is taken from the National Survey of Children's Health, 2016-2022 (U.S. Department of Health and Human Services et al., 2024).[20] The survey covers children up to age 17, so this provides a substantial range of imputed birth years for analysis from 1999 to 2021. Using the detail surveys, I use a four-category race variable as well as mother's education.

The outcomes listed are those which may be impacted by FASD. In particular, they are: behavioral problems, developmental delay, intellectual disability, speech disorder, learning disability, ADD/ADHD diagnosis, and in the final survey year both FASD diagnosis and evaluation for FASD recommended by a health care provider.

3.7 Other Data

Data on alcohol excise taxes for distilled spirits (i.e. liquor), wine, and beer comes initially from a database compiled by the Tax Policy Center for years 1982-2023 (Tax Policy Center, 2023). Using this annual data as a starting point, I researched individual state-level excise tax changes to determine more precise dates for policy changes.[21]

[19] See table 6.
[20] See table 8.
[21] See table 1 for recent tax change dates by state.

Information on alcohol use and pregnancy state point of sale warning signs comes from the NIAAA's Alcohol Policy Information System (APIS) (National Institute on Alcohol Abuse and Alcoholism, 2023c).[22] Sunday sales law restrictions are taken from APIS (National Institute on Alcohol Abuse and Alcoholism, 2023a), and augmented using data in Stehr (2007) and Lovenheim and Steefel (2011). Blood Alcohol Content (BAC) laws are taken from APIS (National Institute on Alcohol Abuse and Alcoholism, 2023b) and from Scherer and Fell (2019). NIAAA alcohol use data are taken from Slater and Alpert (2023).[23]

4 Methodology

4.1 Composite Excise Tax Measure

It is common in the literature to proxy all alcohol taxes at the state level using beer taxes, due to the presence of state liquor and wine monopolies whose prices are not easily observable to researchers.[24] Alcohol excise taxes are levied on the categories of distilled spirits, wine, and beer; each individual tax is potentially subject to individual change or as part of a shift of all three taxes at once, depending on the state legislature's goals. Moreover, in no state are tax values harmonized with respect to ethanol content. This analysis is primarily concerned with potential health impacts from excise taxes as intermediated by beverage prices, rather than the overall excise tax level, so the primary specification will be a composite tax measure which describes the cost per unit of the drug, in this case ethanol.

To construct this measure, I begin by adjusting each category of alcohol tax using the average alcohol by volume (ABV) of that alcohol type sold using

[22] See table 2 for warning sign effective dates.
[23] See table 3.
[24] See, e.g., Ruhm (1995), Silver et al. (2019), and Nelson and Moran (2019).

estimates from Martinez et al. (2019).[25] This yields a dollars-per-gallon of pure ethanol tax for each type. Then, I weight the taxes by the national consumption shares of each type as of 1999 using NIAAA data (Slater and Alpert, 2023).[26] The national consumption shares for 1999 can be assumed to be independent of any one state's composition, and will not reflect endogeneity in state taxes as they might have had I used a share measure changing at the year level. Once we sum these shares, I have a total dollars-per-gallon of ethanol excise tax rate for the state, giving an estimate of the excise tax cost for the average gallon of ethanol sold. From here, I adjust the value to reflect the tax per standard drink in terms of ethanol, in cents, by adjusting to 0.6 fluid ounces of ethanol per standard drink (0.0046875 gallons) and multiplying by 100 cents. The computation for a single state is thus:

$$TAX_{StdDrk} = 100 \times \frac{0.6}{128} \times \sum_{i \in \{l,w,b\}} \left(SHARE1999_i \times \frac{TAX_i}{ABV_i} \right) \tag{1}$$

For states with a liquor or wine monopoly in a given year, I regress the liquor or wine tax on the beer tax in non-monopoly states and use a linear prediction for the liquor or wine tax in that state-year cell. Then I incorporate this prediction for those states in place of the zero value for the monopoly tax.

4.2 Two-Way Fixed Effects

I approach the change in taxes and warning sign passage using a difference-in-differences approach, starting with the basic two-way fixed effects (TWFE) framework, and then employing newer methods.

[25] In particular, the ABV estimate is the average of the 2003 and 2016 values for each alcohol category: liquor: 37.6%, wine: 11.95%, beer: 4.695%.

[26] These values are: liquor share: 0.2885954, wine share: 0.1426035, beer share: 0.5688011.

$$Y_{st} = \alpha + \beta_1 TAX_{st} + \beta_2 WS_{st} + \gamma X_{st} + \lambda_s + \delta_t + \varepsilon_{st} \tag{2}$$

In the above specification, Y_{st} denotes the outcome, X_{st} a vector of covariates, λ_s and δ_t state and year fixed effects, and ε_{st} the error term. TAX_{st} indicates continuous alcohol excise tax, while WS_{st} is an indicator for warning sign law effective. The covariates include demographic controls such as age, race, education, and marital status where available, as well as state controls such as BAC laws, Sunday sales laws, cigarette taxes, smoke-free laws, vertical ID laws, minimum wage, unemployment rate, and poverty rate. For the abortion regressions, I also include TRAP laws, minimum waiting period laws, and parental involvement laws. Where they are provided, I use population weights for a given data set.

4.3 De Chaisemartin and d'Haultfoeuille (2024)

The standard TWFE approach has been demonstrated to have difficulties with heterogeneous treatment effects and staggered adoption (De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2021; Borusyak et al., 2024). To account for potential heterogeneity, dynamic effects from policy changes, and staggered adoption concerns, I use the method from De Chaisemartin and d'Haultfoeuille (2024).[27] This method is particularly useful in that it can flexibly accommodate unbalanced panel data and be used with continuously distributed treatments, as in the case of excise taxes. In addition, states enter with different initial treatment values, and this is the only estimator that

[27] In particular, I use the Stata package `did_multiplegt_dyn` (de Chaisemartin et al., 2024), specifying 5 pre- and post-periods in the main analysis, using normalized event study estimators to yield an unbiased average treatment effect (De Chaisemartin and d'Haultfoeuille, 2023; De Chaisemartin and d'Haultfoeuille, 2024).

supports such an overall quasi-experimental setup.

I create a threshold value categorical variable for use with the De Chaisemartin and d'Haultfoeuille (2024) estimator, using 2 cent (per standard drink) bins. This binning process is the recommended method from the authors, and the thresholds provide adequate variation for examining effects from state-level changes in any of the three alcohol tax values, as they range from 0 to 12 cents over the whole data set from 1982-2023. For the warning signs laws, the treatment is binary and no other bins are required.

4.4 Stacked Difference-in-Differences

Since the warning signs laws are a binary treatment, I am also able to consider a different estimation method, stacked difference-in-differences. Originally developed in Cengiz et al. (2019), the method handles the problem of staggered treatment timing by separating each treatment timing group into its own "sub-experiment." This approach has been formalized and extended to use weights based on the sample size of the treated and control units in each sub-experiment by Wing et al. (2024).

In brief, Wing et al. (2024) addresses variation in the number of pre- and post-periods about each treatment, as well as the total number of treated and control units. The method does this by first separating each treatment timing group into its own sub-experiment, and then having the researcher pre-specify a number of pre- and post-periods that must exist for each treatment timing. Those events for which the data does not support the specified number of periods are not considered in the analysis. Then, with each sub-experiment having a balanced number of periods for consideration, the regressions are given weights based on the total sample size of treatment and control units. If all sub-experiments have the same number of units, then all weights will be equal to one, but if one has a larger number of units, it will be weighted appropriately in the regression. Moreover, these weights can be used alongside standard population weights in the regression.

5 Results

5.1 Effects on Alcohol Use

Across the estimates (see Table 10), the TWFE estimator shows higher levels of significance as well as stronger effects than those derived from DCDH and stacked DID. In the NIAAA data, which is not restricted to reproductive-age women, I observe a 3.9% decrease in standard drinks per capita from warning signs, and a 1.4% decrease from a one cent tax per standard drink increase. The DCDH estimator gives an insignificant estimate for both, with the same sign and smaller effects, while the event studies in figure 14 shows inconclusive evidence of an effect from warning signs. Overall, these indicate some evidence of a negative effect on aggregate drinking from warning signs, and a null result from tax increases.

Turning to the BRFSS data, which is restricted only to women of reproductive age, I observe no significant effects, and the event studies in figures 15 and 16 support this. The pre-pregnancy drinking outcomes from the PRAMS also show null effects when examining the event studies (figures 17 and 18).

The results from the BRFSS subsample of women currently reporting pregnancy are reported in table 11. I find similar effects on binge drinking from warning signs as Cil (2017), but estimates using DCDH and stacked DID are inconsistently signed and insignificant. Moreover, the stacked DID confidence interval is actually smaller than that for TWFE, and the sign still flips. Examining the event studies in figure 20, I conclude that this estimate is truly null rather than imprecise.

5.2 Heterogeneity in BRFSS

I stratify the BRFSS any alcohol use and binge drinking variables by age bins (figure 41), race categories (figure 42), and education levels (figure 43) to examine the possibility of any heterogeneity in response among the population of reproductive aged women. Overall estimates cluster close to zero for for warning signs across all three estimators for both outcomes, and I feel confident that these represent a null effect rather than an imprecise estimate. For taxes, the TWFE estimates seem consistently higher than DCDH in most cases, with DCDH at zero for any alcohol use and a less precise zero for binge drinking.

No group shows a notable response to warning signs, although estimates for the Hispanic population are particularly noisy. Tax estimates are of small magnitude with larger confidence bands, and the point estimates flip sign between DCDH and TWFE by race and education; none of these appear to significantly differ from a null effect overall in terms of self-reported drinking outcomes.

5.3 Effects on Unintended Pregnancy and Abortion

Next, I look at unintended pregnancy from the PRAMS data, and also overall and teen abortion rates (table 12). No effect is detectable on unintended pregnancy, but we do see suggestive evidence of a reduction in abortion (figure 23) and also teen abortion (figure 24) from taxes. The estimates are on the order of about 1.5-3% reduction in DCDH and TWFE. Warning signs show less convincing evidence, with the confidence intervals being especially wide for stacked DID. More work is needed to examine this outcome, particularly for tax increases.

5.4 Effects on Early Outcomes

The next set of results focuses on evaluating "second stage" outcomes of fetal death post-20 weeks (i.e. stillbirth) as well as outcomes at the time of delivery. The estimates in table 13 show increases in stillbirths from tax increases, but the event study (figure 25) is not indicative of a sustained effect; it is possible these results are driven by a reporting change in one of the states over the relatively limited 2005-2021 period as well.

For the outcomes drawn from NVSS data, very preterm birth shows suggestive evidence of a possible decrease from taxes (figure 31), while very low birth weight impacts are less convincing (figure 29). Warning signs do not show strong effects on any outcome, including very preterm birth where the DCDH coefficient is significant (figure 30).

5.5 Effects on Childhood Outcomes

The final set of outcomes are drawn from the NSCH, and show outcomes which may be impacted by alcohol use during pregnancy, or potentially during breastfeeding; I do not have the ability to distinguish between these two causes. The estimates in table 14 hint at some beneficial effects from warning signs, but the event studies (figures 33 to 40) do not bear out anything convincing. Some are very noisy (e.g. figure 35) while others are restricted to only one round of data collection (figures 39 and 40).[28] I find no clear indication of effects from taxes or warning signs, although the developmental delay estimates seem to be consistently negative.

[28] I am hopeful that future rounds of the NSCH will have additional data on FASD and FASD evaluation that can clarify this issue, since these questions were introduced in the 2022 questionnaire.

5.6 Robustness

To test the reliability of my results, I have examined a number of alternate specifications. Estimates without additional controls do not show uniform changes; in fact, in some cases small estimates even change sign. I attribute this particularly to the exclusion of tax effects in warning sign regressions or vice-versa, as they are the most critical policies. The BAC and Sunday sales restrictions do increase the confidence intervals in most cases, but I feel it is important to retain them as they provide a control for the overall alcohol policy environment in each state.

Next, I try a specification inflating the tax values to real 2022 dollars, and then adjusting the tax threshold values used in DCDH accordingly. In this case I do not show substantial change in the outcome, but the binning in DCDH is less reliable as it also may capture changes from one bin to another as the real tax value declines due to inflation.

Finally, I also check a logged tax value version of my regressions. Again, this does not differ significantly from the main estimates. I have also examined several of my data sources when restricting to non-liquor monopoly states only. This significantly reduces the power of the analysis, and shows no results which contradict the main estimates. Overall, multiple changes to the specification do not significantly alter the estimates or event studies.

6 Discussion

The economic impact of FASD is enormous. Amendah et al. (2011), examining Medicaid claims data in 2005, shows that healthcare expenditures for children (under 17 years of age) with FAS is 9 times greater than those without. Williams et al. (2015) documents the expense and difficulty of FASD screening in the U.S.

and Canada, and provides a lifetime care cost estimate for a child with FASD of \$2.44M. In a survey of the literature, Greenmyer et al. (2020) estimates spending (in real 2020 dollars) to be \$1.29-10.1 billion annually for FASD in the U.S., and CAD 1.9-10.5 billion in Canada. They also indicate a return from spending on programs targeting high-risk mothers of up to 62 times.

The high costs of FASD are almost certainly underestimated; many are only based on FAS rather than the FASD more broadly, and they cannot account for the welfare impacts from early-term pregnancy loss, unintended pregnancy, abortion, or the heightened risks of stillbirth. Moreover, FASD has cognitive and behavioral impacts that persist into adulthood. The impact on adult health behavior and labor market outcomes could be severe. With this in mind, how effective are the policies which may impact alcohol use and, thus FASD?

Cil (2017) documents a 35% decrease in any alcohol use and a 75% decrease in binge drinking among pregnant women; this analysis does not support that conclusion, especially when we use the Wing et al. (2024) stacked DID method to trim our estimates to 5 years around the policy change. In fact we find no substantive effect from warning signs across the full range of outcomes, from pre-pregnancy alcohol use to childhood health.

For excise taxes, the literature documents evidence of reductions in drinking and Zhang (2010) notes binge drinking decreases among pregnant women by 2.5% with 1% increase in beer or wine taxes, and by 9–10% with liquor taxes. I am not able to substantiate this conclusion using a much greater range of years as well as broader data sets, either with TWFE or DCDH. I do find suggestive evidence for abortion outcomes, which merits additional study. The very preterm birth estimates may also suggest an effect, but it is not as likely to be valid given null results for the small and large for gestational age variables.

6.1 Conclusion

When examining 30 plus years of data across six data sets representing the full scope of potential health effects related to pregnancy and alcohol use, using available empirical methods, I cannot confirm beneficial effects from either state-level alcohol excise taxes or warning signs. The results for abortion outcomes are worth of additional study. Given the high welfare cost of alcohol use with regard to pregnancy, the lack of strong effects is unfortunate. However, this result underscores the importance of unified messaging from healthcare providers and public policy researchers.[29]

[29] More work is needed to examine drinking behavior in particular, as self-reported drinking outcomes are far from ideal. I am currently working to access consumer panel data which provides better estimates of alcohol consumption by women of reproductive age.

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7 Figures

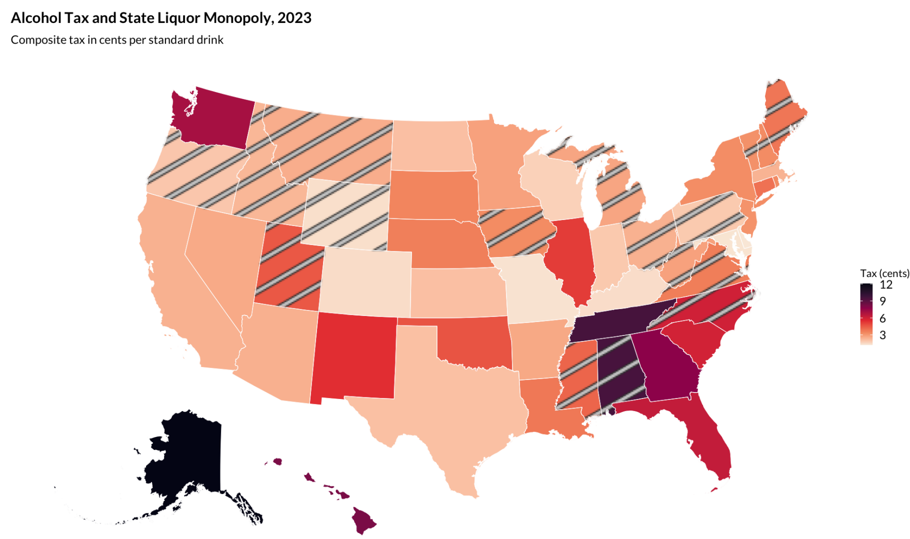

Figure 1: Composite alcohol excise tax per standard drink in cents as of 2023. States with stripe pattern have current state liquor sales monopoly. See methodology section for details of composite tax computation.

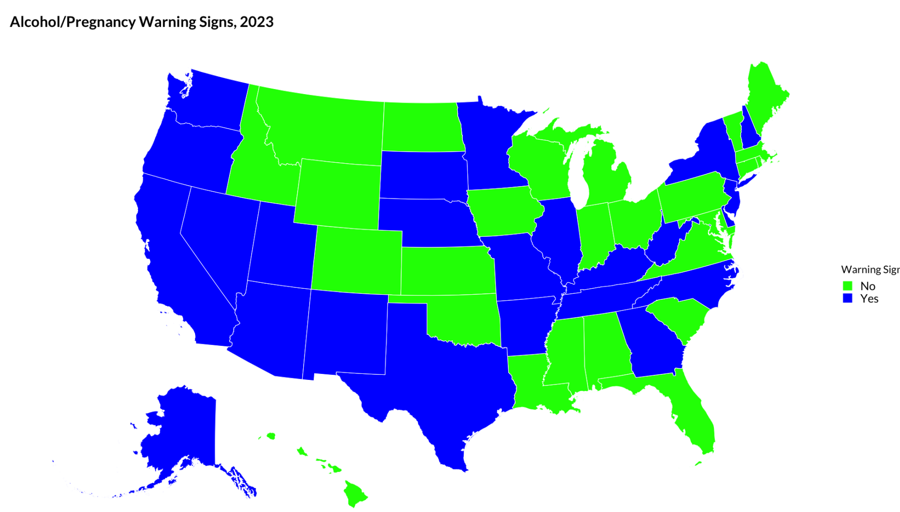

Figure 2: State pregnancy and alcohol use posted point of sale warning sign laws as of 2023. Policy data drawn from Alcohol Policy Information System (National Institute on Alcohol Abuse and Alcoholism, 2023c).

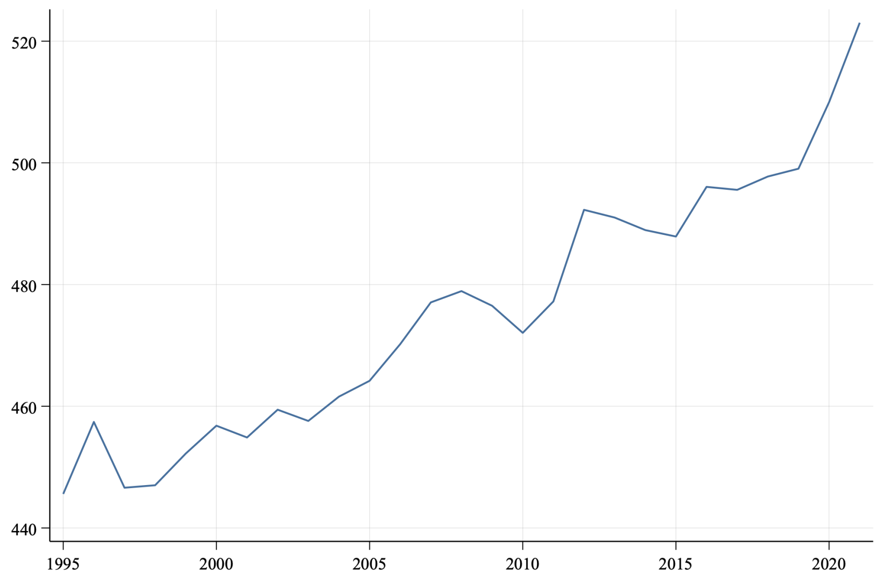

Figure 3: Total per capita alcohol consumption in terms of pure ethanol, United States, 1995-2021. Values are number of standard drinks per capita population 14 and older. One standard drink is defined to be 0.6 fluid ounces / 14 grams of ethanol, or approximately one 12 fl oz beer at 5% ABV, one 5 fl oz glass of wine at 12% ABV, or one 1.5 fl oz shot of distilled spirits at 40% ABV. Data taken from Slater and Alpert (2023).

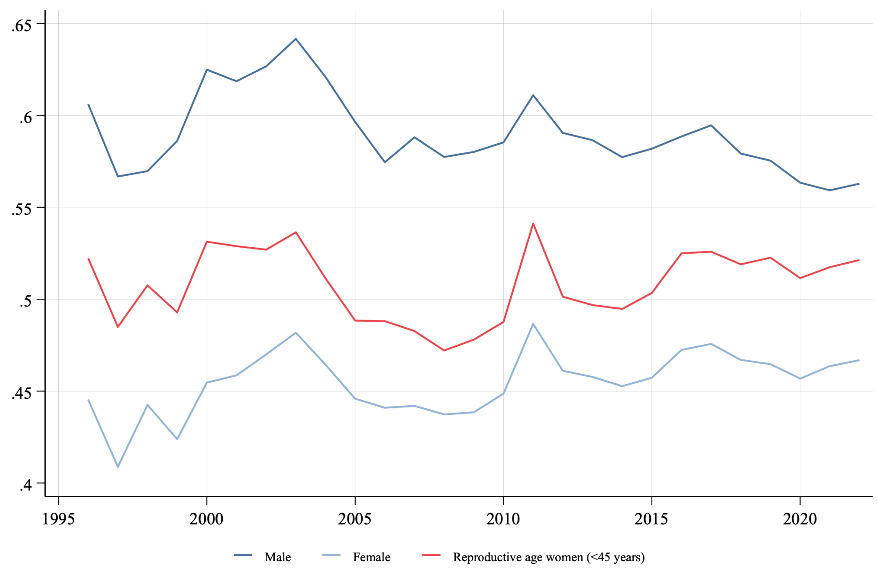

Figure 4: Any alcohol use in the last 30 days indicator, CDC BRFSS, 1995-2022. Includes all U.S. states available in BRFSS sample by year. Figure shows all male, all female, and all women of reproductive age (18-44). Estimates are weighted for national representation using BRFSS sample weights.

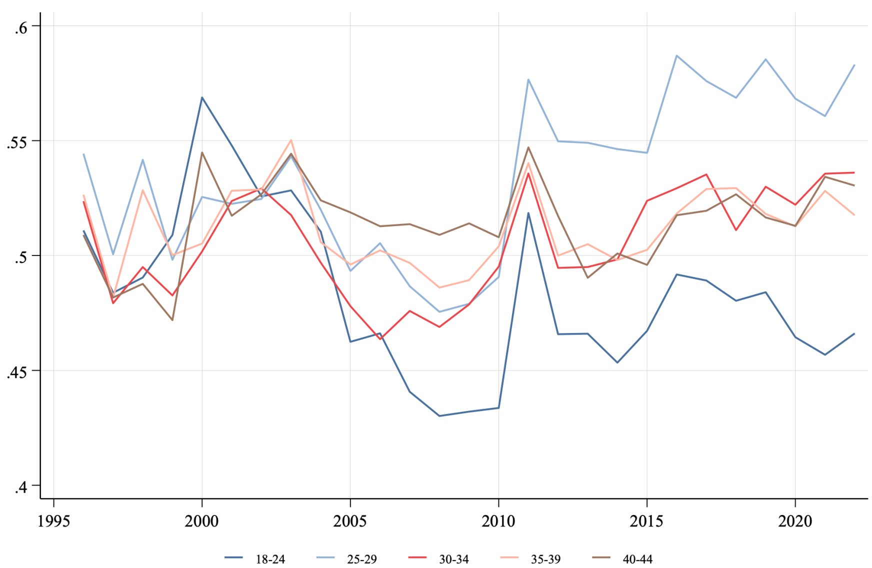

Figure 5: Any alcohol use in the last 30 days indicator, CDC BRFSS, 1995-2022. Includes all U.S. states available in BRFSS sample by year. Figure shows detail for reproductive aged women by age group. Estimates are weighted for national representation using BRFSS sample weights.

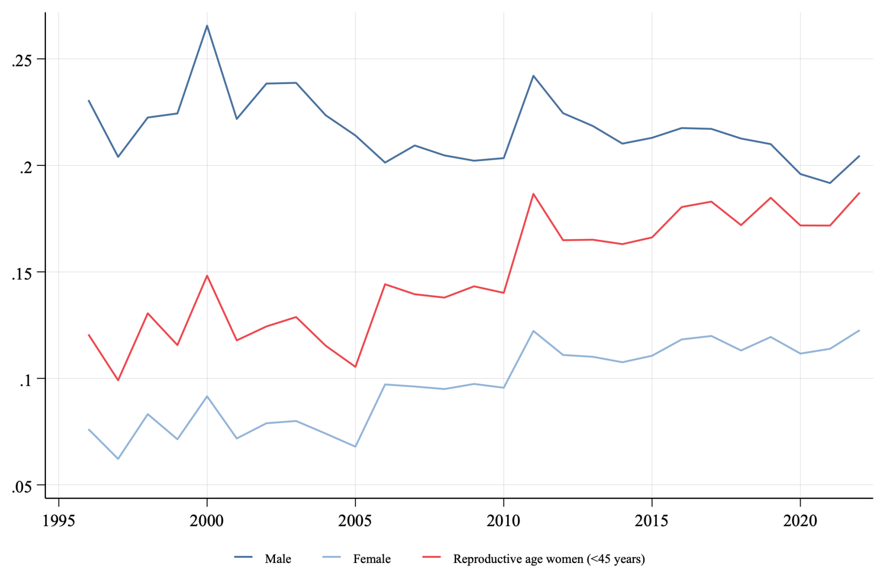

Figure 6: Binge drinking in the last 30 days indicator, CDC BRFSS, 1995-2022. Includes all U.S. states available in BRFSS sample by year. Figure shows all male, all female, and all women of reproductive age (18-44). Estimates are weighted for national representation using BRFSS sample weights.

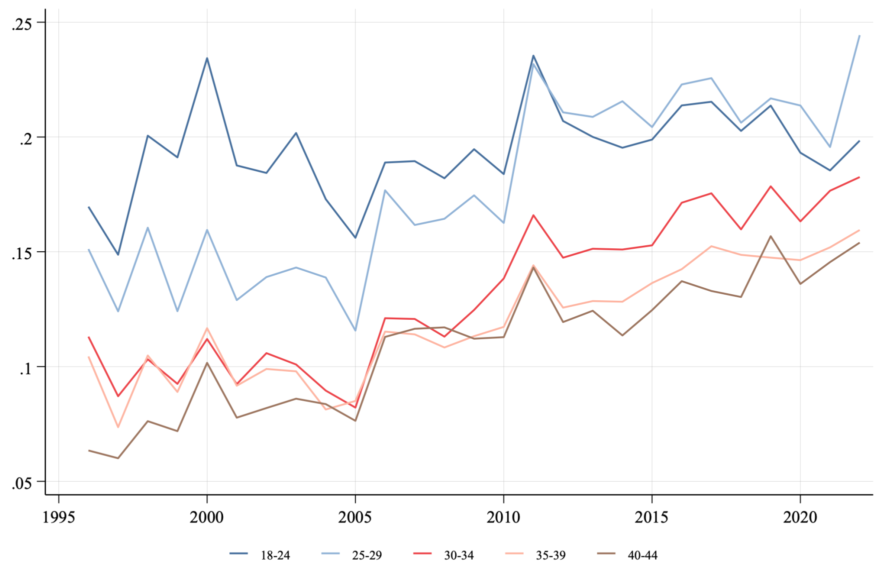

Figure 7: Binge drinking in the last 30 days indicator, CDC BRFSS, 1995-2022. Includes all U.S. states available in BRFSS sample by year. Figure shows detail for reproductive aged women by age group. Estimates are weighted for national representation using BRFSS sample weights.

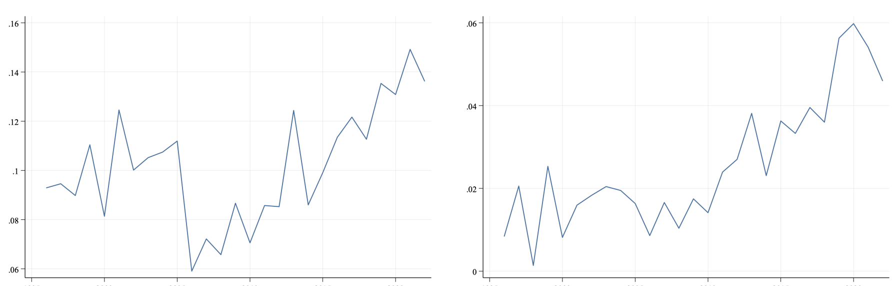

Figure 8: (Left) Any alcohol use in the last 30 days indicator, (Right) Binge drinking in the last 30 days indicator, CDC BRFSS, 1995-2022. Includes all U.S. states available in BRFSS sample by year. Figure shows women reporting they are currently pregnant. Estimates are weighted for national representation using BRFSS sample weights.

Figure 9: Drinking in the 3 months before pregnancy and drinking in the last 2 years indicators, PRAMS data, 1995-2021. Estimates are weighted using PRAMS analytic weights.

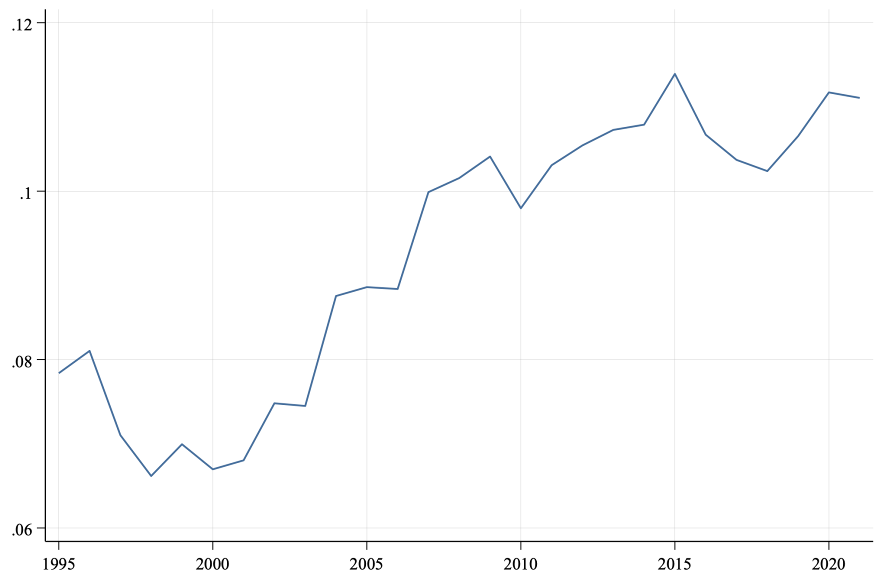

Figure 10: Drank more than 3 drinks per week in the 3 months before pregnancy indicator, PRAMS data, 1995-2021. Estimates are weighted using PRAMS analytic weights.

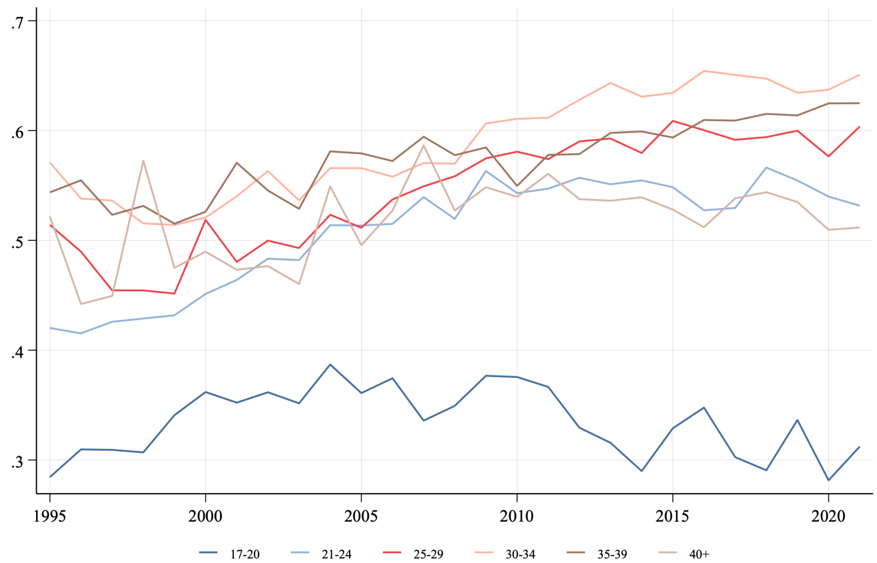

Figure 11: Drinking in the 3 months before pregnancy indicator, PRAMS data, 1995-2021. Figure shows detail for reproductive aged women by age group. Estimates are weighted using PRAMS analytic weights.

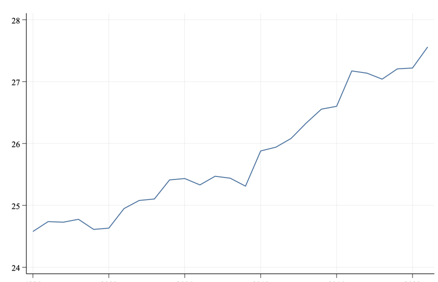

Figure 12: Age at first birth, PRAMS data, 1995-2021. Estimates are weighted using PRAMS analytic weights.

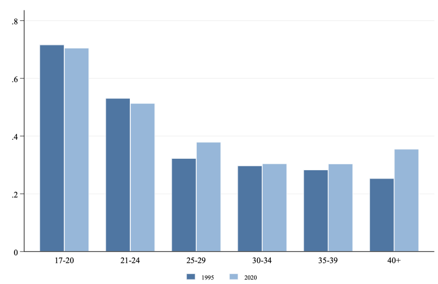

Figure 13: Rate of unintended pregnancy by age group, PRAMS data, 1995 and 2020. Estimates are weighted using PRAMS analytic weights.

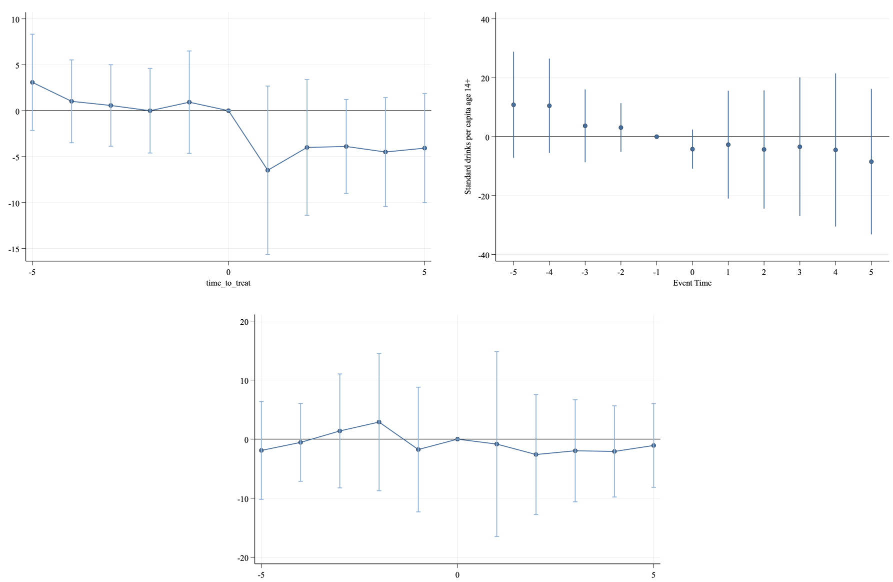

Figure 14: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on standard drinks per capita 14+, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

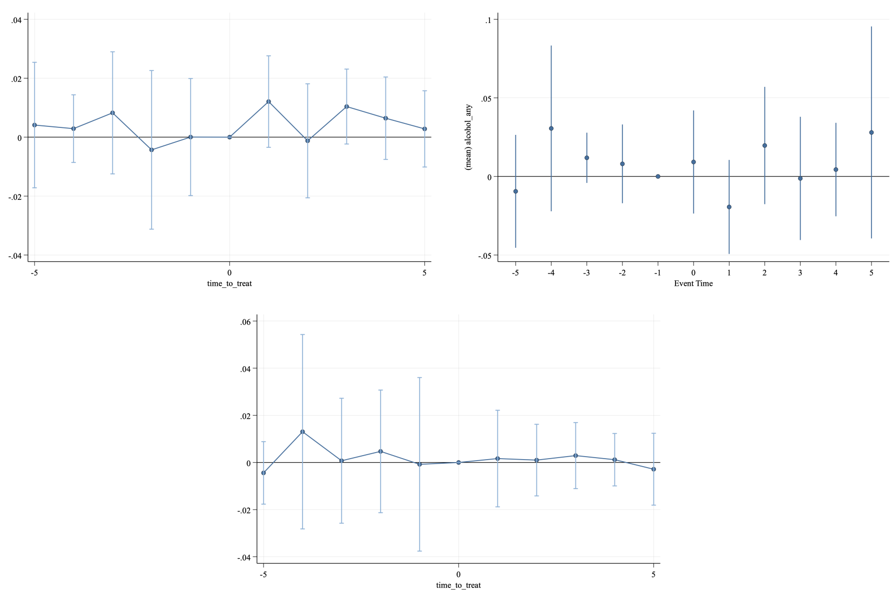

Figure 15: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on any alcohol use in BRFSS sample of women of reproductive age, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

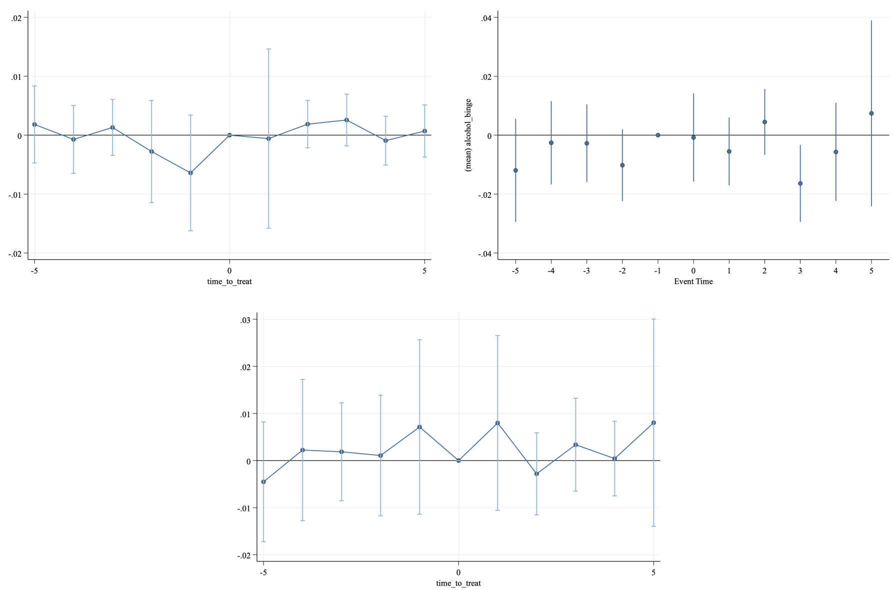

Figure 16: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on binge drinking in BRFSS sample of women of reproductive age, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

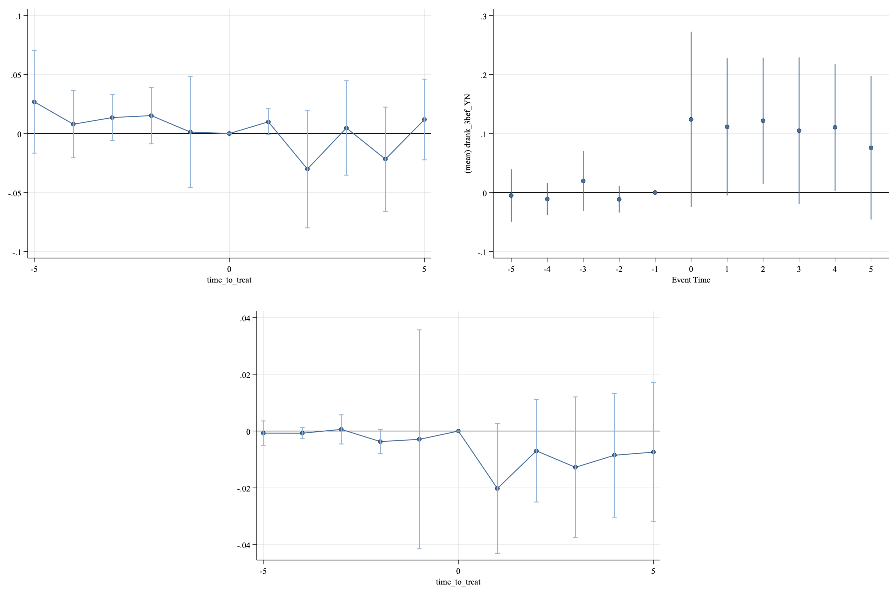

Figure 17: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on drinking in the 3 months prior to pregnancy, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

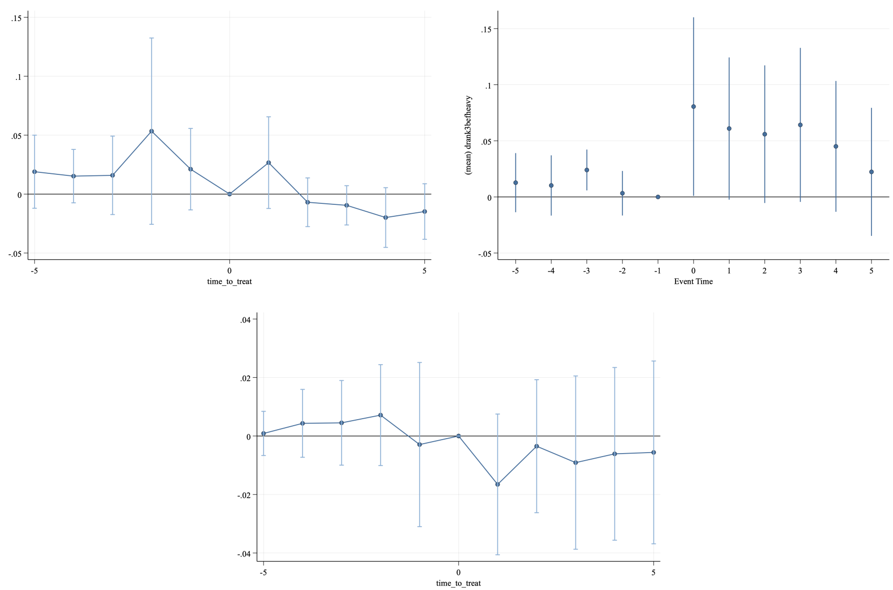

Figure 18: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on drinking more than 3 drinks per week in the 3 months prior to pregnancy, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

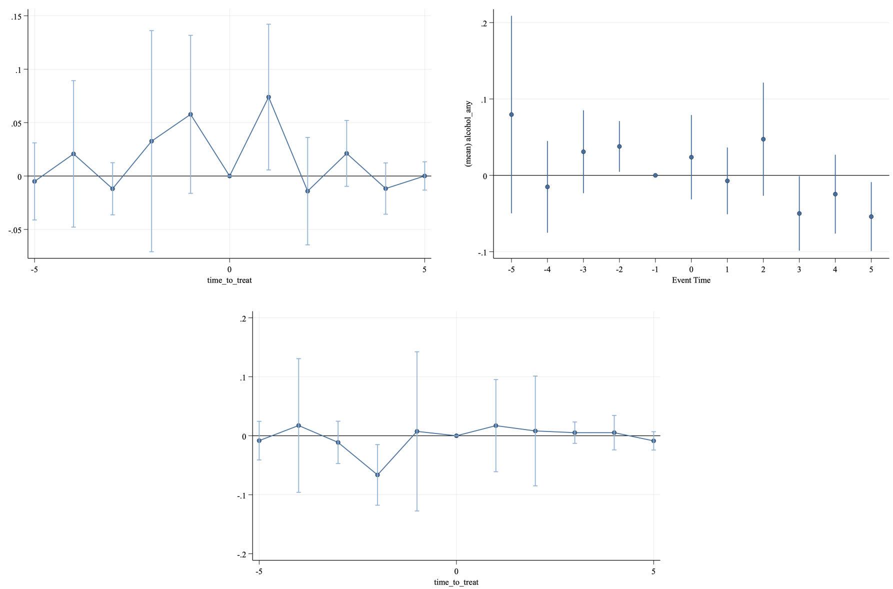

Figure 19: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on any alcohol use in BRFSS pregnant subsample, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

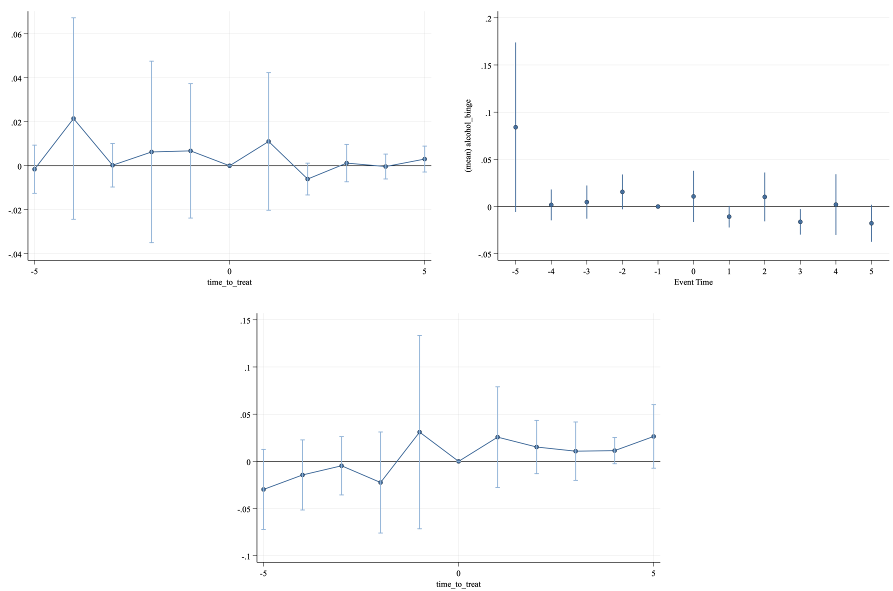

Figure 20: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on binge drinking in BRFSS pregnant subsample, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

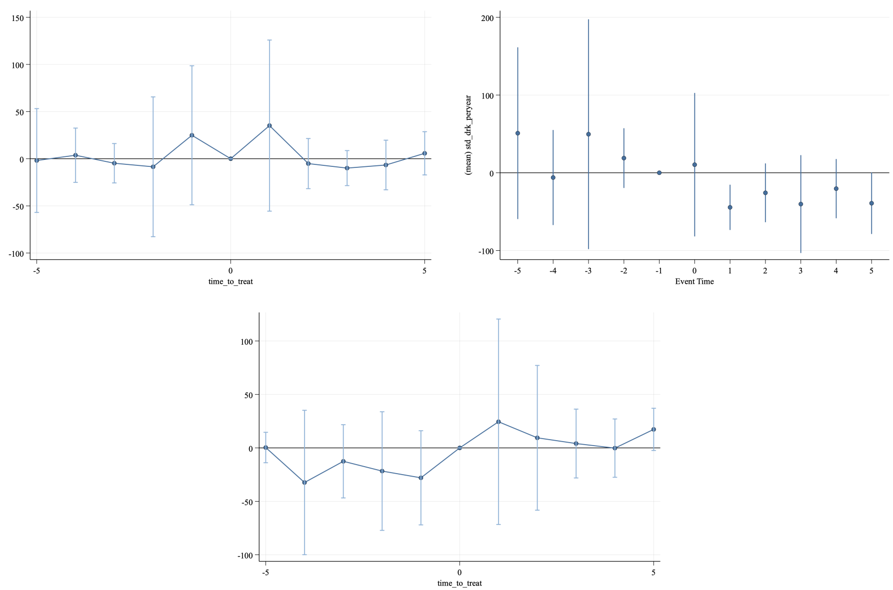

Figure 21: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on standard drinks per year in BRFSS pregnant subsample, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

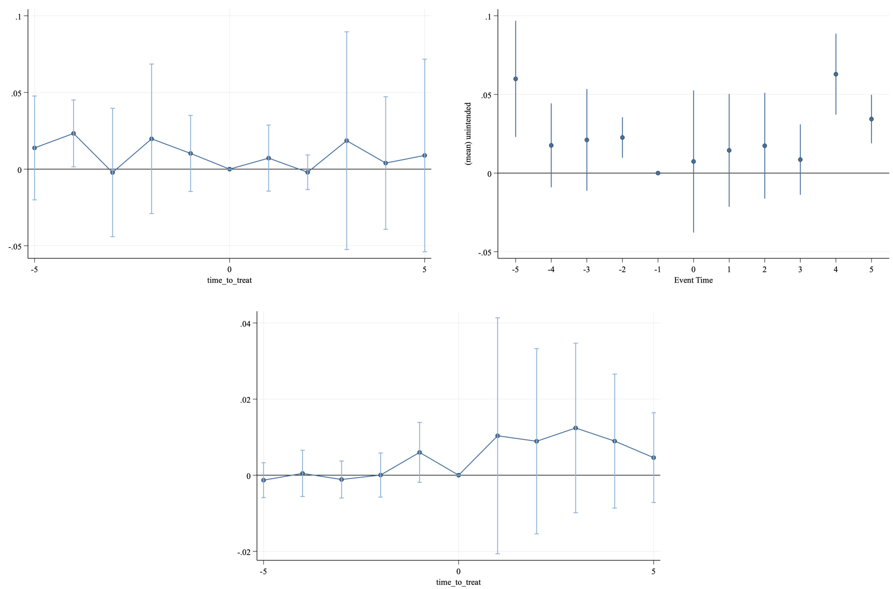

Figure 22: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on unintended pregnancy in PRAMS, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

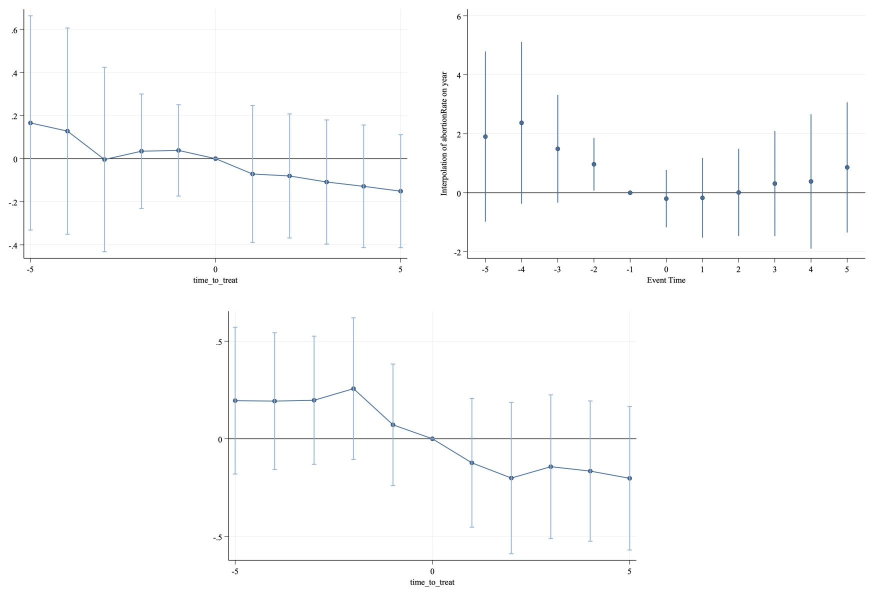

Figure 23: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on abortion rate, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

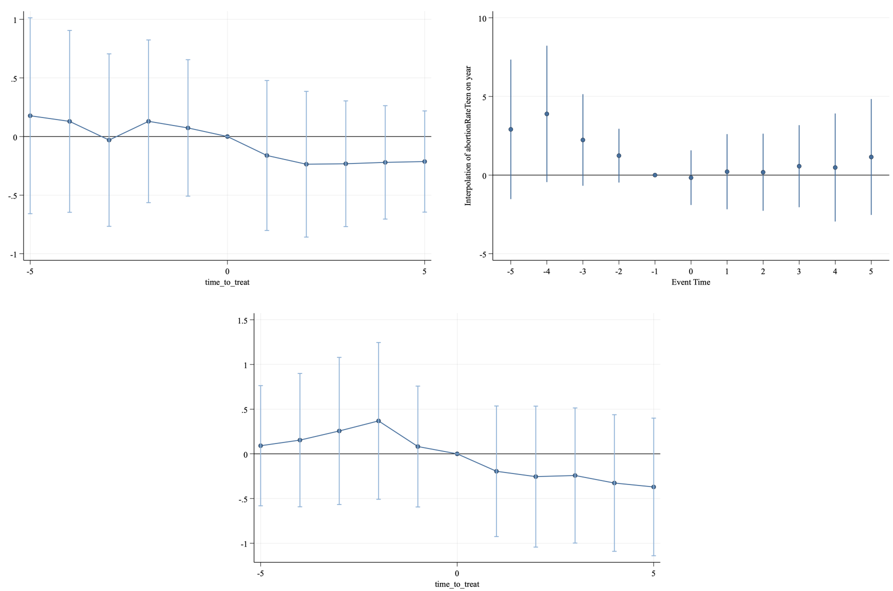

Figure 24: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on teen (15-19) abortion rate, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

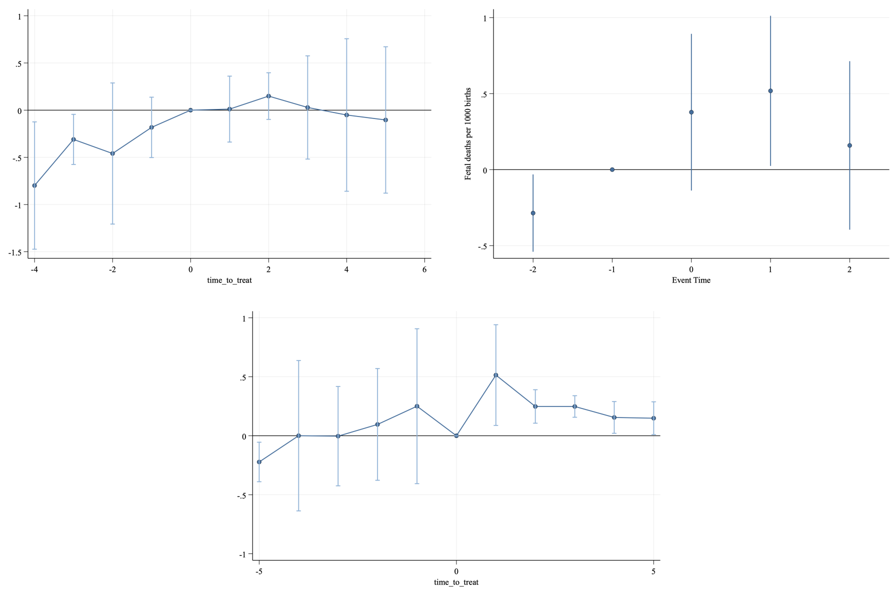

Figure 25: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on fetal deaths per 1,000 births, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

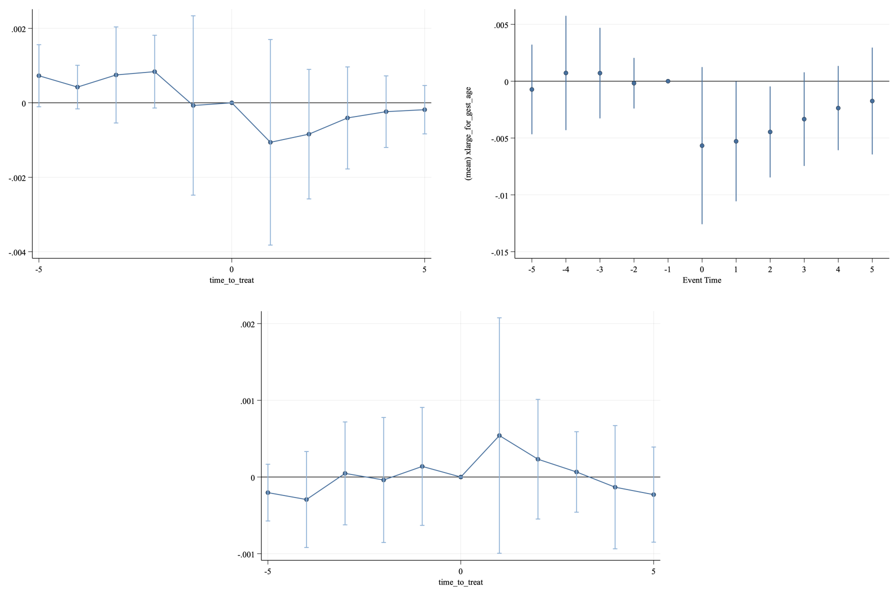

Figure 26: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on extra large for gestational age, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

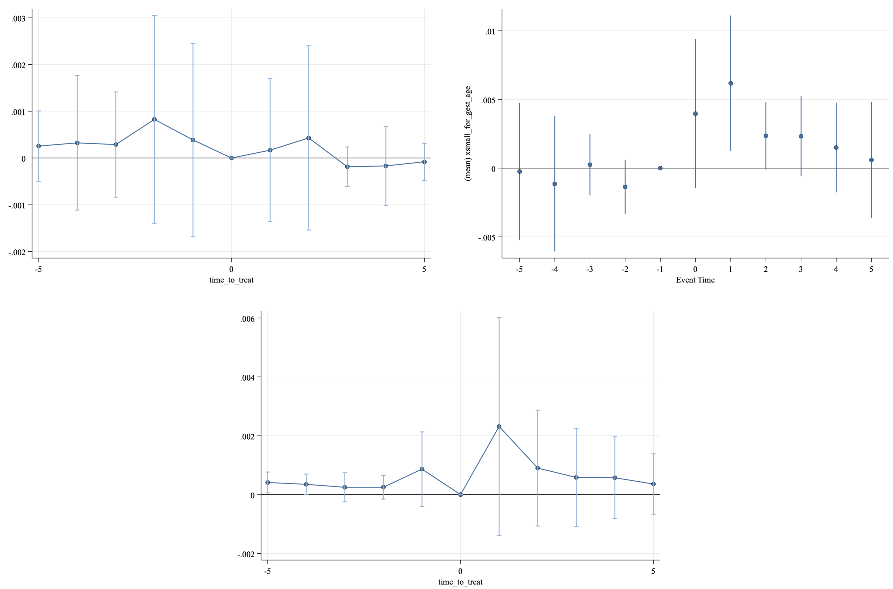

Figure 27: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on extra small for gestational age, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

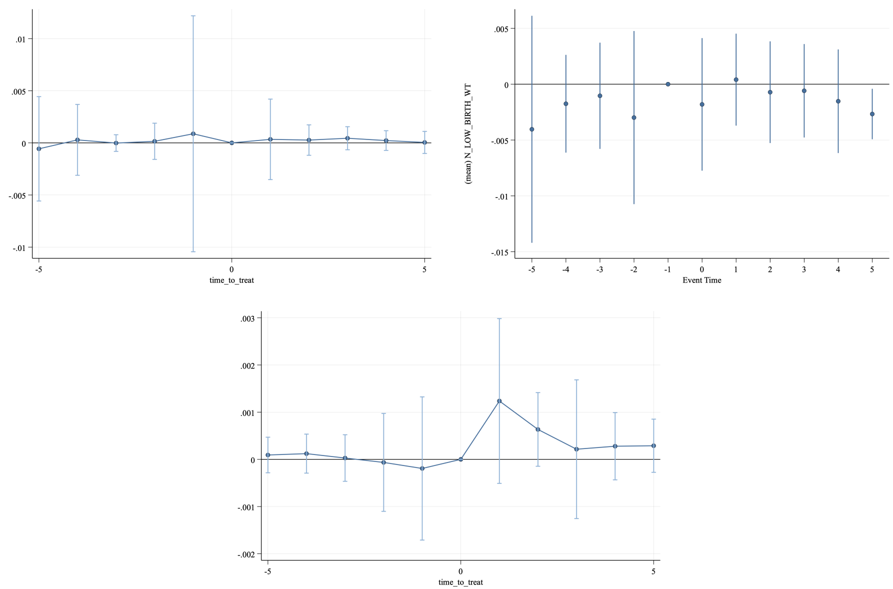

Figure 28: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on low birth weight, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

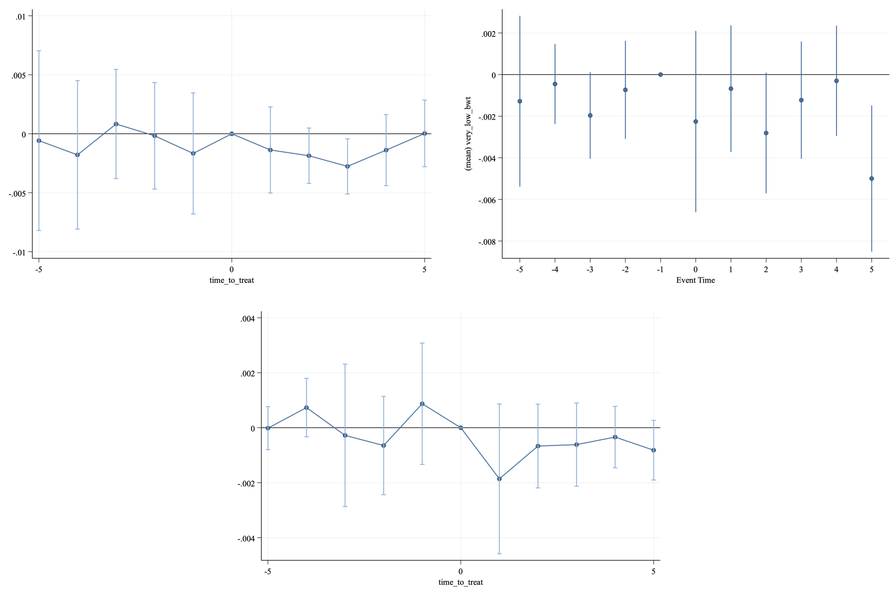

Figure 29: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on very low birth weight, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

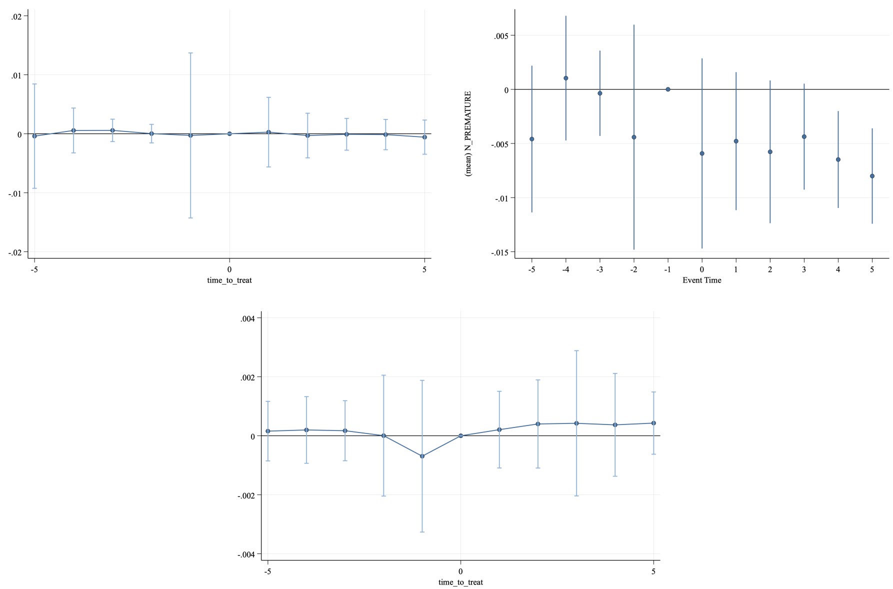

Figure 30: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on premature birth, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

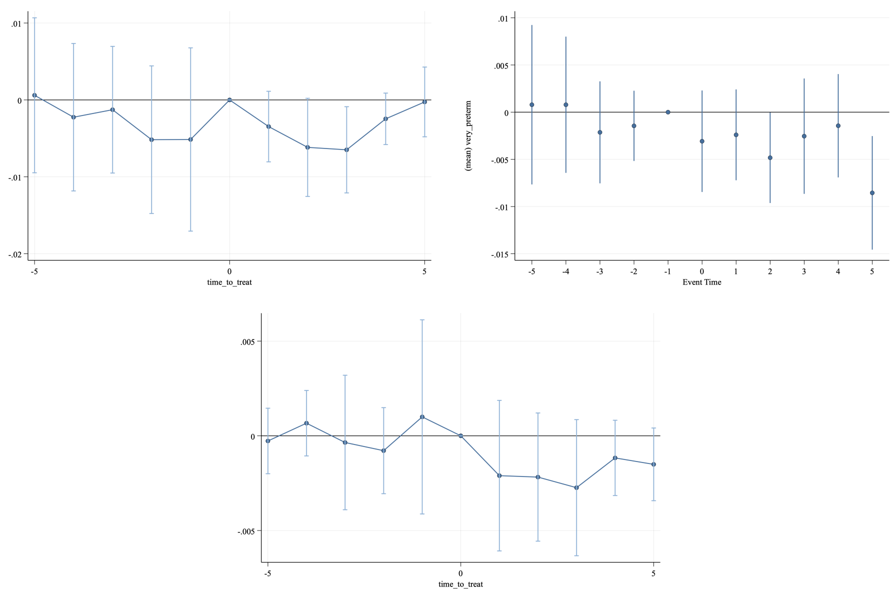

Figure 31: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on very premature birth, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

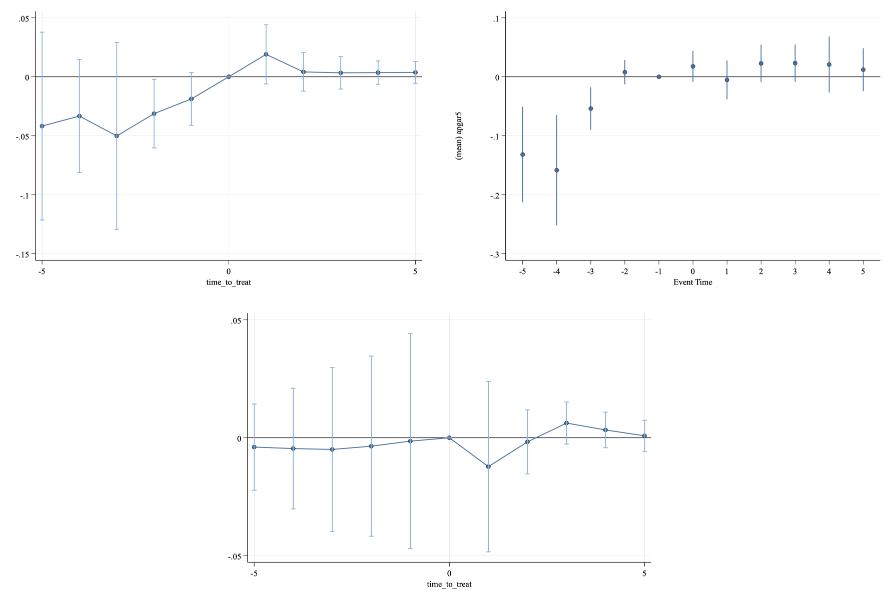

Figure 32: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on APGAR5 score, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

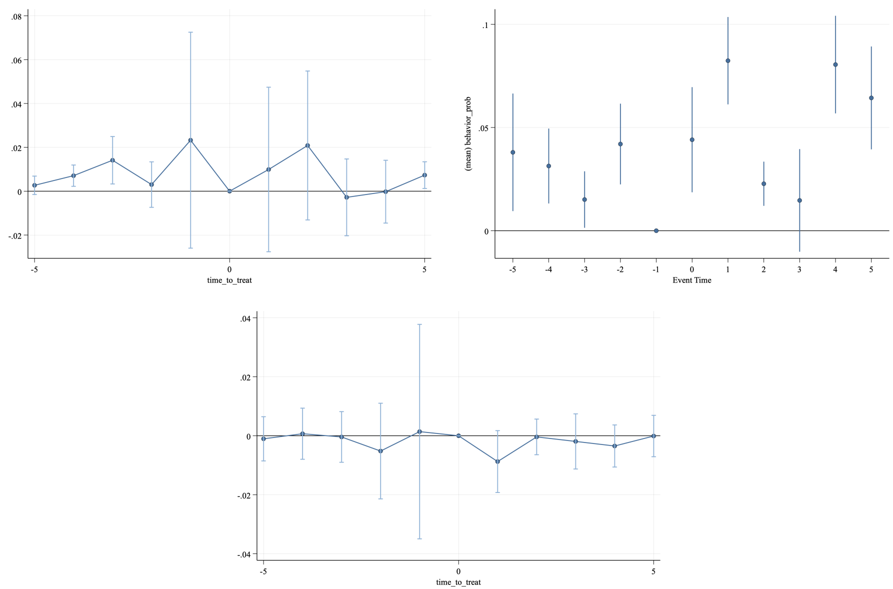

Figure 33: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on reported behavioral problems, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

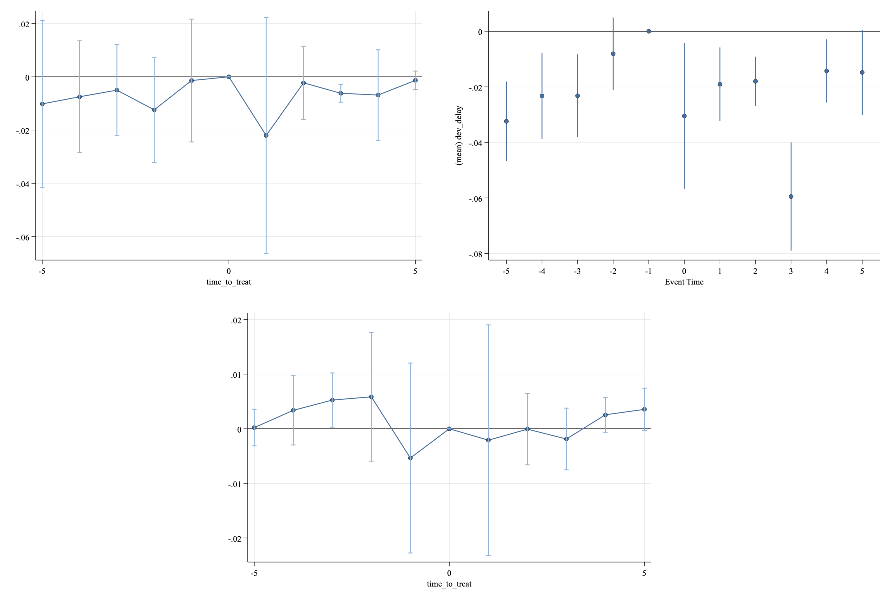

Figure 34: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on reported developmental delay, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

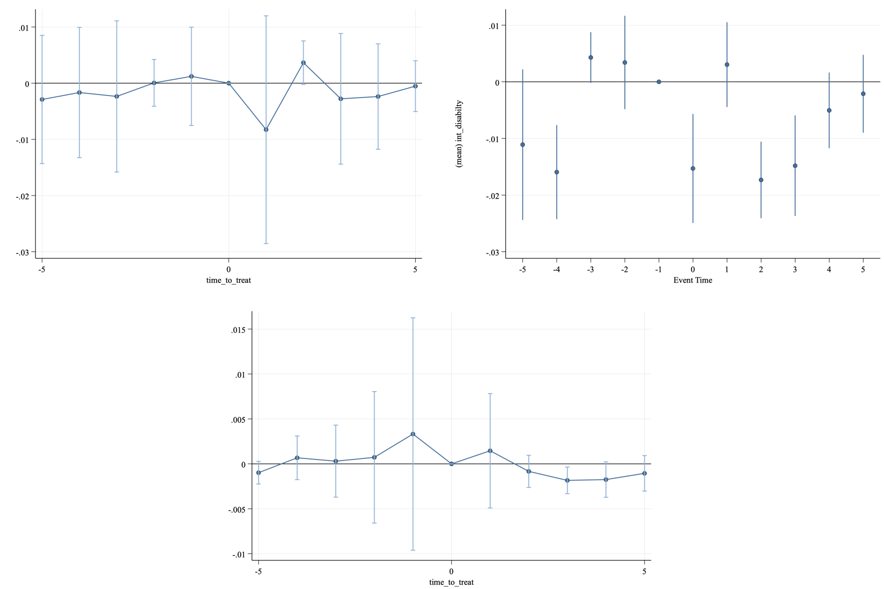

Figure 35: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on reported intellectual disability, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

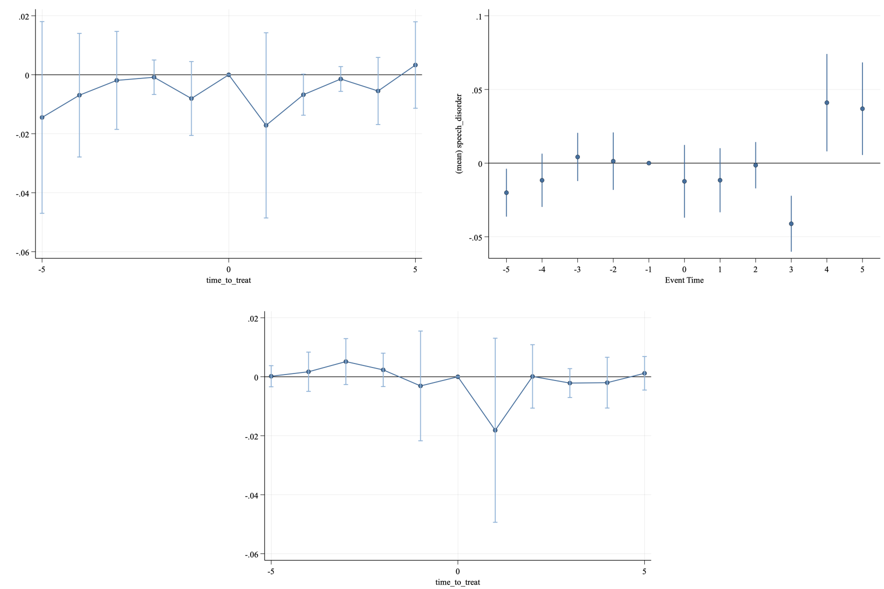

Figure 36: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on reported disorder, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

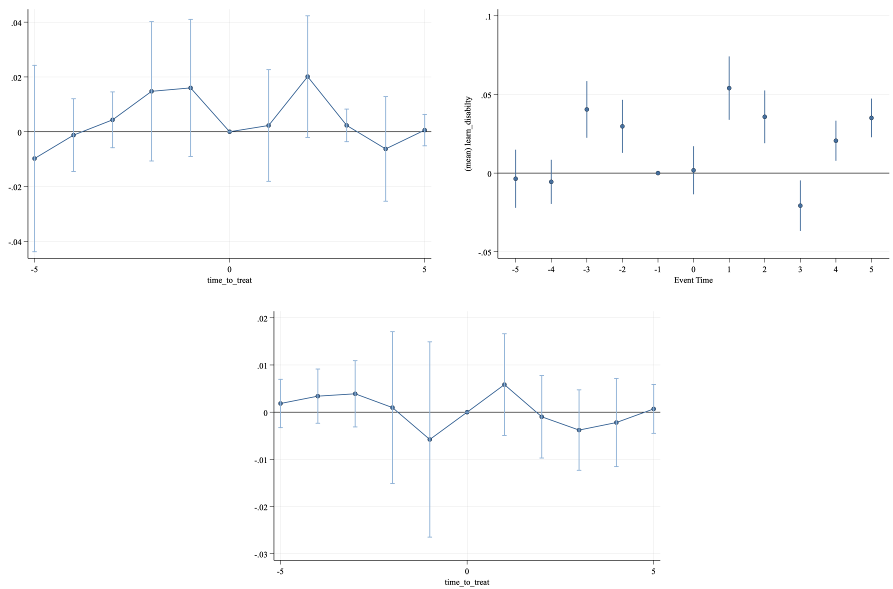

Figure 37: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on learning disability, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

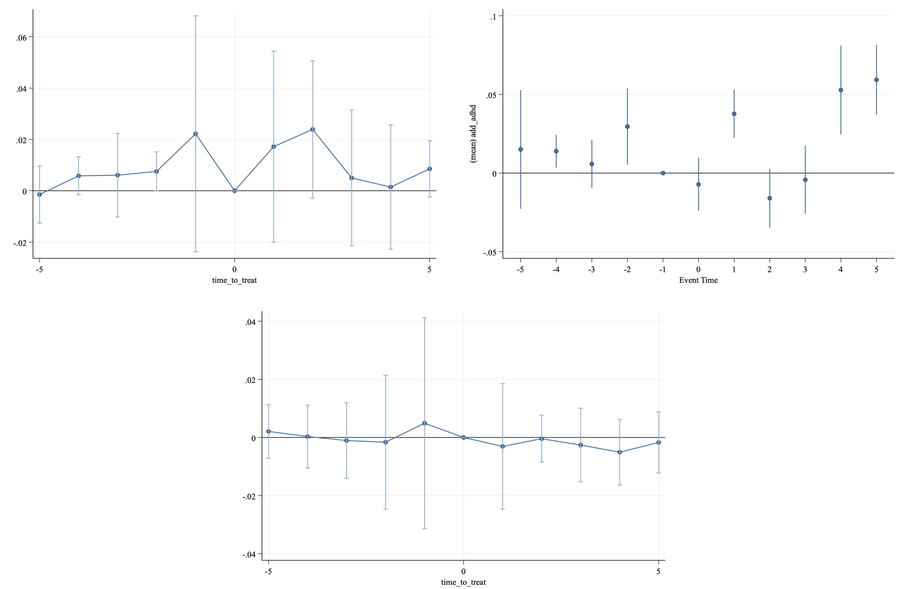

Figure 38: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on ADD/ADHD, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

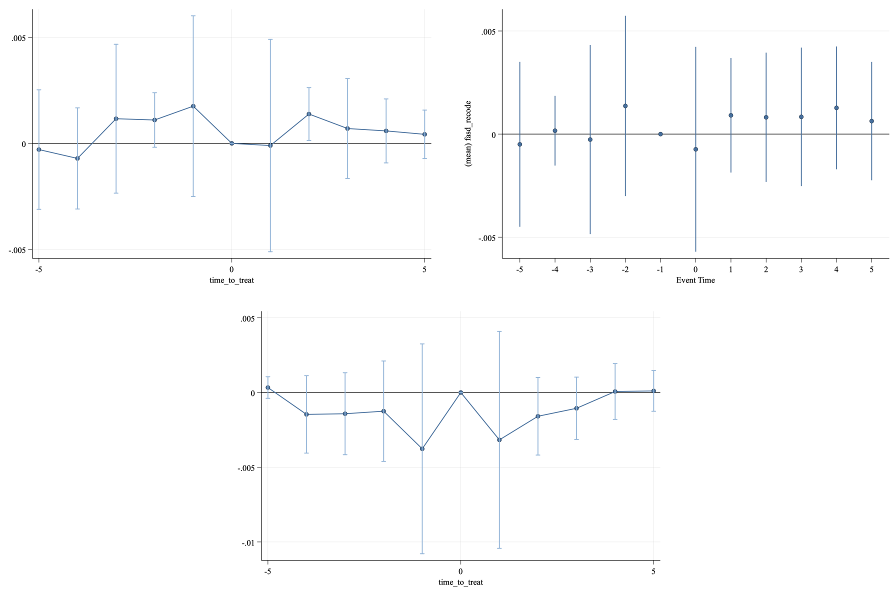

Figure 39: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on FASD, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

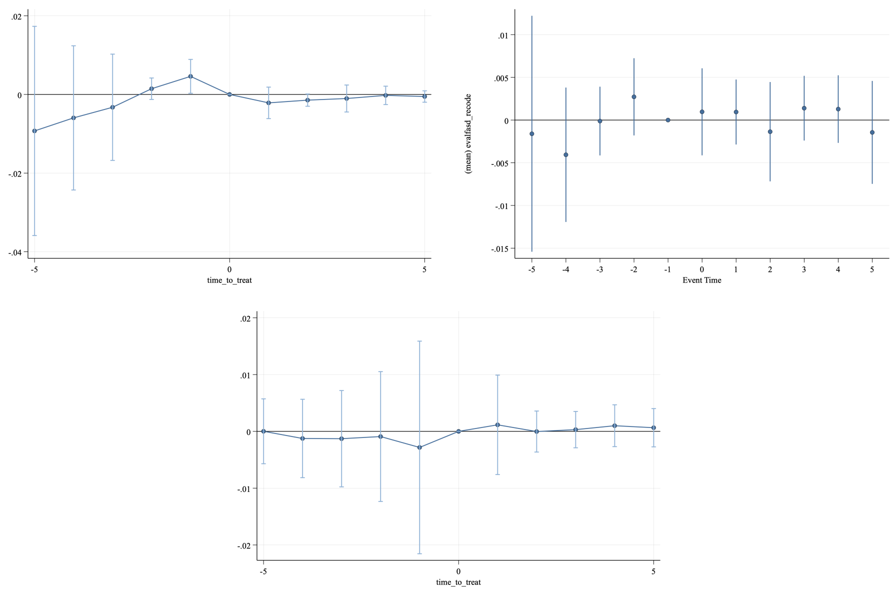

Figure 40: Event study, warning sign law passage (top) and composite alcoholic beverage tax (bottom), effect on recommendation for FASD evaluation, using De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH) and Wing et al. (2024) stacked difference-in-difference estimator. Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

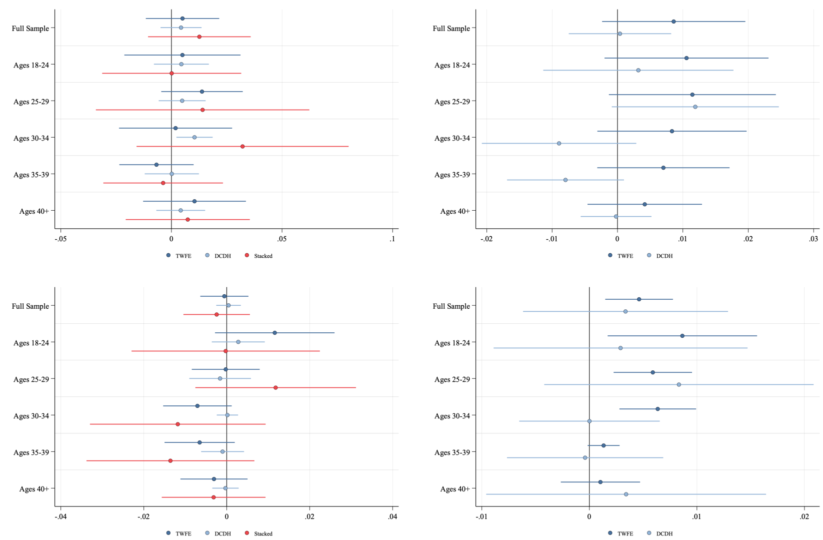

Figure 41: Estimated effects stratified by age group, from warning sign law passage (left) and composite alcoholic beverage taxes (right), on any alcohol use in the last 30 days (top) and any binge drinking in the last 30 days (bottom), using two-way fixed effects (TWFE) and De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH). Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

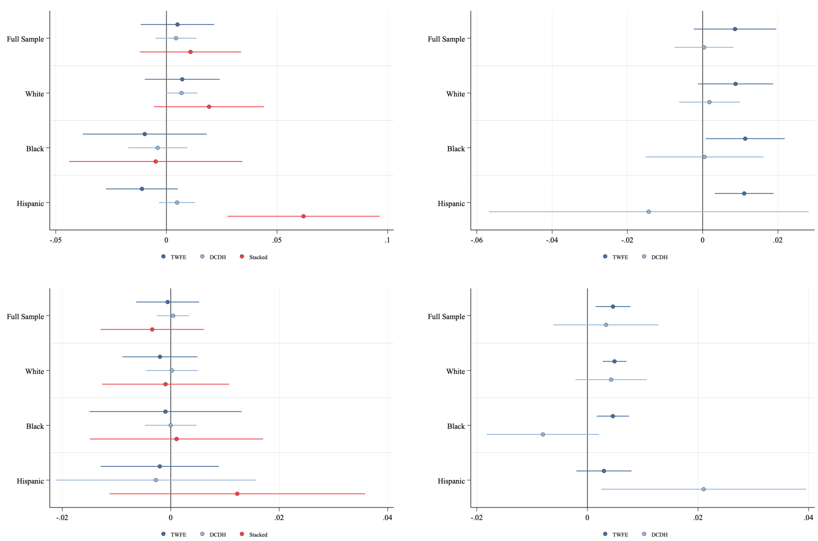

Figure 42: Estimated effects stratified by race, from warning sign law passage (left) and composite alcoholic beverage taxes (right), on any alcohol use in the last 30 days (top) and any binge drinking in the last 30 days (bottom), using two-way fixed effects (TWFE), De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH), and Wing et al. (2024) stacked difference-in-difference (Stacked). Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

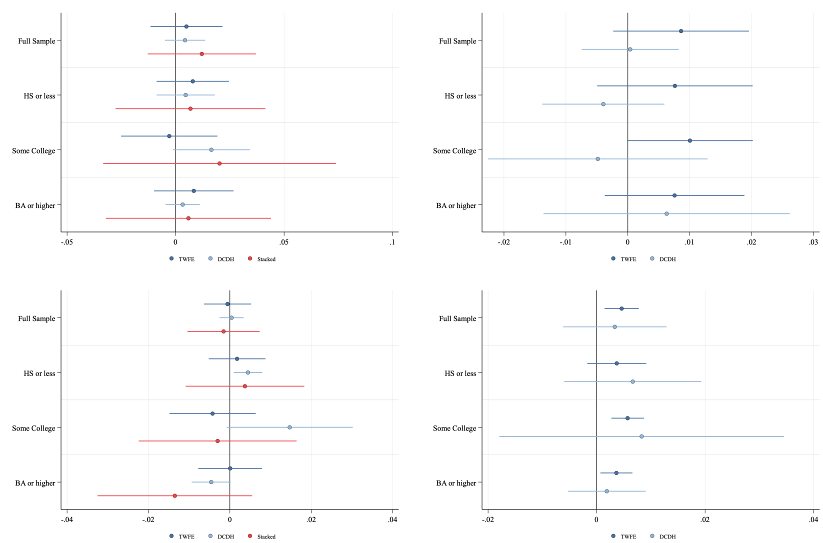

Figure 43: Estimated effects stratified by education level, from warning sign law passage (left) and composite alcoholic beverage taxes (right), on any alcohol use in the last 30 days (top) and any binge drinking in the last 30 days (bottom), using two-way fixed effects (TWFE), De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH), and Wing et al. (2024) stacked difference-in-difference (Stacked). Demographic controls include age, race, marital status, and education. State policy controls include BAC laws, Sunday sales laws, state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

8 Tables

State	Liquor Tax Change	Wine Tax Change	Beer Tax Change
Alaska	July 2002 ($7.20)	July 2002 ($1.65)	July 2002 ($0.72)
Connecticut	July 2011 ($1.00) October 2019 ($0.54)	July 2011 ($0.12) October 2019 ($0.07)	July 2011 ($0.05)
Delaware	September 2017 ($3.00) 2021 (-$3.00)	September 2017 ($1.33) 2021 (-$1.33)	September 2017 ($0.17) 2021 (-$0.17)
D.C.	2021 ($3.00)	2021 ($1.33)	2021 ($0.17)
Illinois	September 2009 ($4.05)	September 2009 ($0.66)	September 2009 ($0.05)
Louisiana	2017 ($0.53)	2017 ($0.65)	2017 ($0.08)
Missouri		2003 ($0.06)	
Nebraska	June 2003 ($0.75)	June 2003 ($0.20)	June 2003 ($0.08)
Nevada	August 2003 ($1.55)	August 2003 ($0.30)	August 2003 ($0.07)
New Jersey	August 2009 ($1.10)	August 2009 ($0.17)	
New York		2010 ($0.11)	2004 (-$0.01) 2010 ($0.03)
North Carolina[a]		2010 ($0.20)	2010 ($0.08)
Rhode Island	July 2013 ($1.65)	July 2013 ($0.80)	July 2013 ($0.01)
Tennessee	2003 ($0.40)	2003 ($0.11)	2003 ($0.01) 2014 ($1.01) 2016 ($0.14)
Utah[a,b]			2004 ($0.05)
Washington[a]	June 2012 ($14.27)		2011 ($0.50) 2014 (-$0.50)
Wisconsin	September 2005 ($0.06)		

Table 1: Month and year of alcohol excise tax changes by type, 2000-2021. Amount of (liquor/wine/beer) excise tax change in parentheses, as documented in state's legislation. When multiple changes occur they are listed sequentially. [a] denotes liquor monopoly state. [b] denotes wine monopoly state. Note that Washington state ended its liquor monopoly in 2012, and New Hampshire ended its wine monopoly in 2023. Refer to Tax Policy Center (2023).

State	Effective Date	On-premises sale	Off-premises sale
Alaska	8/30/1989	Yes	Yes
Arizona	1/1/1992	Yes	Yes
Arkansas	7/24/2019	Yes	Yes
California	11/7/1988	Yes	Yes
Delaware	1/1/1990	Yes	Yes
District of Columbia	11/19/1985	Yes	Yes
Georgia	7/1/1986	Yes	No
Illinois	1/1/1990	Yes	Yes
Kentucky	7/14/1992	Yes	Yes
Minnesota	4/2/1996	Yes	Yes
Missouri	8/28/2001	Yes	Yes
Nebraska	2/17/1990	Yes	Yes
Nevada	10/1/2003	Yes	No
New Hampshire	8/19/1991	Yes	Yes
New Jersey	9/1/1993	Yes	Yes
New Mexico	6/14/1991	Yes	Yes
New York	4/1/1992	Yes	Yes
North Carolina	7/20/2003	No	Yes
Oregon	1/1/1992	Yes	Yes
South Dakota	7/1/1986	Yes	Yes
Tennessee	7/1/1997	Yes	Yes
Texas	9/1/2007	Yes	No
Utah	7/1/2010	Yes	Yes
Washington	8/4/1993	Yes	Yes
West Virginia	7/1/1998	Yes	Yes

Table 2: Alcohol and pregnancy point-of-sale and other location warning sign laws by state. On- and off-premises sale refers to retailers that sell alcoholic beverages either for on- or off-premises consumption, respectively. Note that Delaware and Kentucky also require posting warning signs in physician's offices. Data sourced from National Institute on Alcohol Abuse and Alcoholism (2023c) and Cil (2017).

	(1)		
	mean	sd	count
Standard drinks per capita age 14+	509.866	121.177	2040
Tax per Std. Drink	1.045	0.533	2036
Warning Sign	0.331	0.471	2040
Cigarette Tax	0.799	0.882	2040
Smoke-free Law	0.188	0.389	2040
Vertical ID Law	0.428	0.495	2040
State Minimum Wage (Real 2022$)	8.904	1.581	2040
State Unemployment Rate	5.834	2.102	2040
State Poverty rate	12.881	3.805	2040
BAC threshold law	0.089	0.010	2040
Sunday alcohol sales limit	0.462	0.499	2040
Observations	2040		

Table 3: Descriptive statistics for state-level alcohol consumption (Slater and Alpert, 2023) and various policy variables, 1982-2021.

	(1)		
	mean	sd	count
Any alcohol use last 30 days	0.512	0.500	1748769
Any binge drinking last 30 days	0.143	0.350	1755176
Currently pregnant	0.045	0.207	1929460
White	0.641	0.480	1992580
Black	0.122	0.327	1992580
Hispanic	0.118	0.322	1992580
Othre Race	0.120	0.325	1992580
18-24	0.248	0.432	1992580
25-29	0.173	0.378	1992580
30-34	0.203	0.402	1992580
35-39	0.186	0.389	1992580
40-44	0.190	0.392	1992580
High School or less	0.439	0.496	1992580
Some College	0.268	0.443	1992580
BA or Higher	0.293	0.455	1992580
Married	0.518	0.500	1992580
Cellphone	0.257	0.437	1992580
Observations	1992580		

Table 4: Descriptive statistics for BRFSS data, 1984-2022, women of reproductive age, using BRFSS sample weights (U.S. Department of Health and Human Services and Centers for Disease Control and Prevention, 2024).

	(1)		
	mean	sd	count
Birth weight	3279.000	66.855	1428
APGAR Score	8.806	0.117	1428
Any abnormalities	0.044	0.024	1426
Premature	0.121	0.021	1428
Low birth weight	0.082	0.016	1428
Small for gest. age	0.097	0.016	1428
Large for gest. age	0.101	0.017	1428
White	0.631	0.181	1428
Black	0.132	0.124	1428
Hispanic	0.147	0.126	1428
Other race	0.090	0.102	1428
Married	0.627	0.075	1428
18-24	0.294	0.074	1428
25-29	0.285	0.027	1428
30-34	0.249	0.048	1428
35-39	0.119	0.036	1428
40 plus	0.026	0.010	1428
High school or less	0.417	0.126	1428
Some college	0.250	0.072	1428
BA or higher	0.271	0.094	1428
Observations	1428		

Table 5: Descriptive statistics for NVSS Natality data, 1995-2022, state-year cells (U.S. Department of Health and Human Services et al., 2024).

	(1)		
	mean	sd	count
Fetal deaths per 1000 births	4.461	1.857	830
White	0.610	0.175	830
Black	0.135	0.118	830
Hispanic	0.160	0.123	830
Other race	0.094	0.101	830
Married	0.605	0.070	830
18-24	0.275	0.069	830
25-29	0.292	0.027	830
30-34	0.260	0.046	830
35-39	0.125	0.037	830
40 plus	0.028	0.010	830
High school or less	0.367	0.123	830
Some college	0.260	0.086	830
BA or higher	0.280	0.104	830
Observations	830		

Table 6: Descriptive statistics for NVSS Fetal Death data, 2005-2021, state-year cells (U.S. Department of Health and Human Services et al., 2024).

	(1)		
	mean	sd	count
Unintended pregnancy	0.429	0.495	856475
Gestational age	37.718	3.061	880366
Large for gestational age	0.089	0.285	839867
Small for gestational age	0.164	0.370	839867
Infant Low Birth Weight ($<$ 2500 grams)	0.263	0.440	878877
Infant Premature Birth ($<$ 37 weeks)	0.215	0.411	880366
Infant admitted to NICU	0.207	0.405	730711
Infant deceased	0.016	0.125	862387
Drank alcohol 3 mo. before pregnancy	0.506	0.500	859210
$>$ 3 drinks/week 3 mo. before pregnancy	0.157	0.364	503630
Very low birth weight ($<$ 1500 grams)	0.056	0.230	880366
Very preterm birth ($<$ 32 weeks)	0.074	0.262	880366
17-20	0.135	0.342	880366
21-24	0.191	0.393	880366
25-29	0.277	0.447	880366
30-34	0.244	0.430	880366
35-39	0.125	0.331	880366
40 plus	0.028	0.166	880366
High school or less	0.164	0.370	880366
Some college	0.255	0.436	880366
BA or higher	0.285	0.452	880366
White	0.550	0.497	880366
Black	0.171	0.376	880366
Hispanic	0.134	0.341	880366
Other race	0.145	0.352	880366
Married	0.614	0.487	880366
Observations	880366		

Table 7: Descriptive statistics for CDC PRAMS data, 1987-2021 (Centers for Disease Control and Prevention, 2024).

	(1)		
	mean	sd	count
Behavioral Problems	0.077	0.267	278713
Developmental Delay	0.066	0.249	278448
Intellectual Disability	0.011	0.103	278525
Speech Disorder	0.080	0.271	278591
Learning Disability	0.067	0.250	278603
ADD/ADHD	0.086	0.281	277665
FASD	0.002	0.049	53842
Evaluation for FASD Recommended	0.003	0.052	53798
White	0.501	0.500	279546
Black	0.132	0.339	279546
Other race	0.107	0.310	279546
Hispanic	0.260	0.438	279546
High school or less	0.286	0.452	279546
Some college	0.211	0.408	279546
BA or higher	0.498	0.500	279546
Observations	279546		

Table 8: Descriptive statistics for NSCH data, 2016-2022 (U.S. Department of Health and Human Services et al., 2024).

	mean	sd	count
Abortion Rater	16.2873	8.772	1734
Teen abortion rate	17.926	13.100	1734
Observations	1734		

Table 9: Descriptive statistics for abortion data, 1988-2021, state-year cells (Maddow-Zimet and Kost, 2021, 2022).

		(1)	(2)	(3)	(4)	(5)
		Std. Drk.	**Any Alc**	**Binge**	**3mo Bef**	**>3 drk/wk**
WS	TWFE	-19.58**	0.00501	-0.000573	0.00195	0.0171
		(9.591)	(0.00847)	(0.00296)	(0.0194)	(0.0104)
	DCDH	-6.40	0.0087	0.0009	-0.0106	-0.0054
		(4.49)	(0.0095)	(0.0030)	(0.0169)	(0.0160)
	Stacked	-4.62	0.00677	-0.00276	0.108*	0.0548*
		(9.313)	(0.0126)	(0.00494)	(0.0599)	(0.0317)
Tax	TWFE	-7.299***	0.00860	0.00462***	0.00434**	0.00307
		(2.403)	(0.00559)	(0.00161)	(0.00177)	(0.00186)
	DCDH	-2.49	0.0008	0.0067	-0.0135	-0.0098
		(6.25)	(0.0090)	(0.0097)	(0.0156)	(0.0200)
Mean of Dep. Var.		509.9	0.511	0.142	0.539	0.180

Standard errors in parentheses

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

Table 10: Full sample estimated effects on primary drinking outcomes from warning sign laws and composite alcoholic beverage taxes. Note that coefficient estimates for composite taxes in DCDH row are for 2 cent bins, so the actual estimate has been halved for comparison. Standard drinks per capita 14+ comes from NIAAA data; indicators for any alcohol use in the last 30 days and any binge drinking in the last 30 days come from BRFSS. Difference-in-difference methods are: two-way fixed effects (TWFE), De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH), and Wing et al. (2024) stacked difference-in-difference (Stacked). Demographic controls include age, race, marital status, and education. State policy controls include state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. NIAAA regressions do not include demographic covariates. Standard errors are clustered at the state level.

		(1) Std. Drk.	(2) Any Alc	(3) Binge
WS	TWFE	-19.23	-0.00935	-0.0131**
		(12.91)	(0.0116)	(0.00517)
	DCDH	0.4031	0.0066	0.0019
		(14.99)	(0.0115)	(0.0044)
	Stacked	-26.63*	-0.0108	-0.00360
		(14.51)	(0.0154)	(0.00929)
Tax	TWFE	-7.416	0.00360	0.00161
		(5.194)	(0.00358)	(0.00144)
	DCDH	11.4219	0.0045	0.0305
		(14.81)	(0.0232)	(0.0197)
Mean of Dep. Var.		53.16	0.122	0.0266

Standard errors in parentheses

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

Table 11: Pregnant subsample estimated effects on primary drinking outcomes from warning sign laws and composite alcoholic beverage taxes. Note that coefficient estimates for composite taxes in DCDH row are for 2 cent bins, so the actual estimate has been halved for comparison. Standard drinks per year, indicators for any alcohol use in the last 30 days, and any binge drinking in the last 30 days come from BRFSS. Difference-in-difference methods are: two-way fixed effects (TWFE), De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH), and Wing et al. (2024) stacked difference-in-difference (Stacked). Demographic controls include age, race, marital status, and education. State policy controls include state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

		(1) Unintended	(2) Abortion	(3) Abortion (Teen)
WS	TWFE	-0.0116	-0.905	-0.397
		(0.0135)	(0.906)	(1.642)
	DCDH	0.0146	-0.1799	-0.3244
		(0.0362)	(0.2032)	(0.3627)
	Stacked	0.0242*	0.199	0.406
		(0.0124)	(0.731)	(1.160)
Tax	TWFE	-0.00144	-0.408**	-0.544
		(0.00205)	(0.171)	(0.330)
	DCDH	0.0112	-0.2628	-0.4593
		(0.0122)	(0.2721)	(0.5779)
Mean of Dep. Var.		0.415	15.80	17.53

Standard errors in parentheses

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

Table 12: Full sample estimated effects on pregnancy-related outcomes from warning sign laws and composite alcoholic beverage taxes. Note that coefficient estimates for composite taxes in DCDH row are for 2 cent bins, so the actual estimate has been halved for comparison. Unintended pregnancy indicator comes from PRAMS data. Abortion rate data from Maddow-Zimet and Kost (2021, 2022). Difference-in-difference methods are: two-way fixed effects (TWFE), De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH), and Wing et al. (2024) stacked difference-in-difference (Stacked). Demographic controls include age, race, marital status, and education. State policy controls include state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

		(1) Stillbirth	(2) XLGA	(3) XSGA	(4) LBW	(5) VLBW	(6) Preterm	(7) V Preterm	(8) APGAR
WS	TWFE	-0.0837	0.000977	0.0000222	-0.0000699	0.00114	-0.000901	0.00180	0.0598
		(0.356)	(0.000995)	(0.000803)	(0.000492)	(0.000898)	(0.00136)	(0.00158)	(0.0366)
	DCDH	-0.0256	-0.0006	-0.0001	0.0003	-0.0032*	-0.0004	-0.0082**	0.0069
		(0.4553)	(0.0009)	(0.0006)	(0.0009)	(0.0019)	(0.0022)	(0.0039)	(0.0082)
	Stacked	0.192	-0.00381*	0.00282	-0.00115	-0.00204*	-0.00589**	-0.00381	0.0152
		(0.176)	(0.00223)	(0.00167)	(0.00205)	(0.00117)	(0.00285)	(0.00228)	(0.016)
Tax	TWFE	0.184***	0.000640	-0.000142	-0.000246	-0.000139	0.000232	-0.000268*	0.00120
		(0.0348)	(0.000513)	(0.000285)	(0.000222)	(0.000112)	(0.000347)	(0.000150)	(0.00503)
	DCDH	0.3120***	.	0.001	0.0006	-0.001	0.0006	-0.0025	0.0018
		(0.0936)	(0.0005)	(0.0011)	(0.0004)	(0.0007)	(0.0009)	(0.0016)	(0.0069)
Mean of Dep. Var.		5.172	0.0994	0.0979	0.0802	0.0123	0.119	0.0184	8.823

Standard errors in parentheses

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

Table 13: Full sample estimated effects on pregnancy-related outcomes from warning sign laws and composite alcoholic beverage taxes. Note that coefficient estimates for composite taxes in DCDH row are for 2 cent bins, so the actual estimate has been halved for comparison. Stillbirth data comes from CDC WONDER. Other outcomes taken from NVSS Natality data (U.S. Department of Health and Human Services et al., 2024; NCHS, 2024). Difference-in-difference methods are: two-way fixed effects (TWFE), De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH), and Wing et al. (2024) stacked difference-in-difference (Stacked). Demographic controls include age, race, marital status, and education. State policy controls include state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

		(1) **B. Prob**	(2) **Dev. Delay**	(3) **Int.**	(4) **Speech**	(5) **Learn**	(6) **ADD/ADHD**	(7) **FASD**	(8) **FASD Eval**
WS	TWFE	0.00979**	-0.00720	-0.00472*	-0.00477	0.00447	-0.000732	0.00182	0.00406**
		(0.00466)	(0.00451)	(0.00261)	(0.00555)	(0.00429)	(0.00911)	(0.00138)	(0.00201)
	DCDH	0.0083**	-0.0078	-0.0021	-0.0039	0.0029	0.0131	0.0009	-0.0012
		(0.0041)	(0.0076)	(0.0055)	(0.0027)	(0.0046)	(0.0133)	(0.0009)	(0.0013)
	Stacked	0.0514***	-0.0260***	-0.00859**	0.00190	0.0211***	0.0204**	0.000621	0.000296
		(0.00964)	(0.00634)	(0.00344)	(0.00893)	(0.00639)	(0.00894)	(0.00156)	(0.00202)
Tax	TWFE	-0.00136	-0.000324	0.000213	-0.00166	0.000238	-0.00147	-0.000168	0.000268
		(0.00120)	(0.000680)	(0.000669)	(0.00121)	(0.000474)	(0.00183)	(0.000378)	(0.000293)
	DCDH	-0.003	0.0018	-0.0018*	-0.0028	-0.0013	-0.004	-0.0009	0.0009
		(0.0046)	(0.0024)	(0.0010)	(0.0047)	(0.0054)	(0.0081)	(0.0015)	(0.0025)
Mean of Dep. Var.		0.0772	0.0662	0.0107	0.0798	0.0671	0.0862	0.00166	0.00241

Standard errors in parentheses

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

Table 14: Full sample estimated effects on pregnancy-related outcomes from warning sign laws and composite alcoholic beverage taxes. Note that coefficient estimates for composite taxes in DCDH row are for 2 cent bins, so the actual estimate has been halved for comparison. Outcomes taken from NSCH: Behavioral Problems, Developmental Delay, Intellectual Disability, Speech Disorder, Learning Disability, ADD/ADHD, FASD, Evaluation for FASD Recommended by Physician (U.S. Department of Health and Human Services et al., 2024). Difference-in-difference methods are: two-way fixed effects (TWFE), De Chaisemartin and d'Haultfoeuille (2024) dynamic estimator (DCDH), and Wing et al. (2024) stacked difference-in-difference (Stacked). Demographic controls include age, race, marital status, and education. State policy controls include state cigarette taxes, smoke-free policy laws, vertical ID laws, state minimum wage in 2022 dollars, unemployment rate, and poverty rate. Standard errors are clustered at the state level.

	(1) Unintended	(2) Unintended	(3) Gest Age	(4) Gest Age	(5) LGA	(6) LGA	(7) SGA	(8) SGA
Drank 3 months before pregnancy	-0.0157**	0.0465***	0.123***	0.0696***	-0.00144	-0.00569***	-0.00582***	0.00137
	(0.00763)	(0.00295)	(0.00795)	(0.00732)	(0.00142)	(0.00150)	(0.00134)	(0.00106)
Marital Status		-0.287***		0.0322**		0.0260***		-0.0305***
		(0.00559)		(0.0120)		(0.00173)		(0.00185)
High school or GED or less		0.0301***		0.0128		-0.0121***		0.0150***
		(0.00536)		(0.0173)		(0.00180)		(0.00238)
Some college or Associate's		-0.0297***		0.0153		0.0117***		-0.0193***
		(0.00328)		(0.0123)		(0.00227)		(0.00238)
BA or higher		-0.148***		0.110***		0.0121***		-0.0253***
		(0.00515)		(0.0152)		(0.00255)		(0.00207)
White NH		-0.0581***		0.132***		0.00824*		-0.0163***
		(0.00400)		(0.0192)		(0.00416)		(0.00373)
Black NH		0.0723***		-0.228***		0.0223***		-0.0328***
		(0.00687)		(0.0248)		(0.00496)		(0.00440)
Hispanic		-0.0612***		0.120***		0.0204***		-0.0345***
		(0.00618)		(0.0292)		(0.00480)		(0.00382)
Other race		0		0		0		0
		(.)		(.)		(.)		(.)
Observations	797064	797064	815467	815467	778794	778794	778794	778794
Mean of Dep. Var	0.413	0.413	38.64	38.64	0.103	0.103	0.0970	0.0970
Demographic controls	No	Yes	No	Yes	No	Yes	No	Yes

Standard errors in parentheses

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

Table 15: Birth outcome regressions on drinking in the three months before pregnancy indicator, PRAMS data, 1995-2021. Columns 1,2 unintended pregnancy; 3,4 gestational age in weeks; 5,6 large for gestational age (90th percentile or higher); 7,8 small for gestational age (10th percentile or lower). Control variables include mother's age, race, education level, and marital status. All regressions include state and year fixed effects. Estimates are weighted using PRAMS analytic weights. Standard errors are clustered at the state level.

	(1) LBW	(2) LBW	(3) Prem	(4) Prem	(5) NICU	(6) NICU	(7) Deceased	(8) Deceased
Drank 3 months before pregnancy	-0.0136***	-0.00510***	-0.0135***	-0.00806***	-0.0156***	-0.00874***	-0.00179***	-0.000845**
	(0.00111)	(0.000734)	(0.00109)	(0.000970)	(0.00149)	(0.00102)	(0.000338)	(0.000332)
Marital Status		-0.0183***		-0.0111***		-0.0144***		-0.000924***
		(0.000892)		(0.00141)		(0.00210)		(0.000261)
High school or GED or less		0.00517***		0.00361**		0.00534**		0.00141***
		(0.00159)		(0.00169)		(0.00200)		(0.000319)
Some college or Associate's		-0.00810***		-0.00424***		-0.00165		-0.000933***
		(0.000971)		(0.00153)		(0.00154)		(0.000287)
BA or higher		-0.0116***		-0.00928***		-0.00779***		-0.00172***
		(0.00114)		(0.00152)		(0.00136)		(0.000227)
White NH		-0.0183***		-0.00473**		-0.0151***		-0.00111***
		(0.00193)		(0.00207)		(0.00283)		(0.000287)
Black NH		0.0353***		0.0322***		0.0210***		0.00346***
		(0.00240)		(0.00276)		(0.00371)		(0.000537)
Hispanic		-0.0232***		-0.00921***		-0.0105***		-0.00142***
		(0.00237)		(0.00268)		(0.00330)		(0.000425)
Other race		0		0		0		0
		(.)		(.)		(.)		(.)
Observations	814340	814340	815467	815467	672061	672061	802462	802462
Mean of Dep. Var	0.0715	0.0715	0.0885	0.0885	0.109	0.109	0.00514	0.00514
Demographic controls	No	Yes	No	Yes	No	Yes	No	Yes

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Birth outcome regressions on drinking in the three months before pregnancy indicator, PRAMS data, 1995-2021. Columns 1,2 low birth weight (¡2500g); 3,4 premature birth (¡37 weeks); 5,6 admitted to NICU after birth; 7,8 infant deceased at time of interview (live birth). Control variables include mother's age, race, education level, and marital status. All regressions include state and year fixed effects. Estimates are weighted using PRAMS analytic weights. Standard errors are clustered at the state level.

	(1) Unintended	(2) Unintended	(3) Gest Age	(4) Gest Age	(5) LGA	(6) LGA	(7) SGA	(8) SGA
Drank 3+ drinks/week	0.0310***	0.0828***	0.255***	0.205***	-0.0123***	-0.0151***	0.00579***	0.0101***
	(0.0101)	(0.00389)	(0.0126)	(0.0124)	(0.00183)	(0.00188)	(0.00174)	(0.00148)
Marital Status		-0.270***		0.0704***		0.0277***		-0.0312***
		(0.00705)		(0.0160)		(0.00275)		(0.00222)
High school or GED or less		0.0329***		0.0338		-0.0116***		0.0140***
		(0.00645)		(0.0207)		(0.00235)		(0.00229)
Some college or Associate's		-0.0284***		0.00163		0.0123***		-0.0169***
		(0.00401)		(0.0170)		(0.00229)		(0.00212)
BA or higher		-0.151***		0.0933***		0.00991***		-0.0246***
		(0.00662)		(0.0193)		(0.00263)		(0.00223)
White NH		-0.0561***		0.116***		0.0156***		-0.0195***
		(0.00445)		(0.0198)		(0.00481)		(0.00398)
Black NH		0.0832***		-0.202***		0.0269***		-0.0367***
		(0.00736)		(0.0242)		(0.00584)		(0.00542)
Hispanic		-0.0773***		0.136***		0.0252***		-0.0398***
		(0.00713)		(0.0340)		(0.00502)		(0.00463)
Other race		0		0		0		0
		(.)		(.)		(.)		(.)
Observations	462856	462856	475024	475024	453882	453882	453882	453882
Mean of Dep. Var	0.429	0.429	38.61	38.61	0.101	0.101	0.101	0.101
Demographic controls	No	Yes	No	Yes	No	Yes	No	Yes

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Birth outcome regressions on drinking 3+ drinks per week in the three months before pregnancy indicator, PRAMS data, 1995-2021. Columns 1,2 unintended pregnancy; 3,4 gestational age in weeks; 5,6 large for gestational age (90th percentile or higher); 7,8 small for gestational age (10th percentile or lower). Control variables include mother's age, race, education level, and marital status. All regressions include state and year fixed effects. Estimates are weighted using PRAMS analytic weights. Standard errors are clustered at the state level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LBW	LBW	Prem	Prem	NICU	NICU	Deceased	Deceased
Drank 3+ drinks/week	-0.0169***	-0.00873***	-0.0203***	-0.0156***	-0.0204***	-0.0129***	-0.00219***	-0.00112**
	(0.00166)	(0.00117)	(0.00160)	(0.00157)	(0.00239)	(0.00244)	(0.000506)	(0.000471)
Marital Status		-0.0204***		-0.0153***		-0.0172***		-0.000914***
		(0.00133)		(0.00179)		(0.00216)		(0.000293)
High school or GED or less		0.00318*		0.00164		0.00458*		0.00154***
		(0.00181)		(0.00188)		(0.00257)		(0.000474)
Some college or Associate's		-0.00733***		-0.00206		-0.00127		-0.000856**
		(0.00110)		(0.00192)		(0.00259)		(0.000325)
BA or higher		-0.0104***		-0.00839***		-0.00806***		-0.00170***
		(0.00127)		(0.00225)		(0.00216)		(0.000372)
White NH		-0.0189***		-0.00267		-0.0171***		-0.00139***
		(0.00194)		(0.00254)		(0.00273)		(0.000456)
Black NH		0.0325***		0.0320***		0.0215***		0.00289***
		(0.00252)		(0.00380)		(0.00389)		(0.000727)
Hispanic		-0.0263***		-0.00951**		-0.0119***		-0.00162***
		(0.00240)		(0.00357)		(0.00342)		(0.000576)
Other race		0		0		0		0
		(.)		(.)		(.)		(.)
Observations	474349	474349	475024	475024	396162	396162	466539	466539
Mean of Dep. Var	0.0761	0.0761	0.0926	0.0926	0.114	0.114	0.00574	0.00574
Demographic controls	No	Yes	No	Yes	No	Yes	No	Yes

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Birth outcome regressions on drinking 3+ drinks per week in the three months before pregnancy indicator, PRAMS data, 1995-2021. Columns 1,2 low birth weight (¡2500g); 3,4 premature birth (¡37 weeks); 5,6 admitted to NICU after birth; 7,8 infant deceased at time of interview (live birth). Control variables include mother's age, race, education level, and marital status. All regressions include state and year fixed effects. Estimates are weighted using PRAMS analytic weights. Standard errors are clustered at the state level.