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Bad Lighting: Effects of Youth Indoor Tanning Prohibitions

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ABSTRACT

Indoor tanning beds (ITBs) emit harmful UV light at high intensity and have been classified as carcinogenic to humans by the World Health Organization since 2009. In that same year, more one in three white high school girls reported using an indoor tanning bed; by 2019 that figure had fallen to fewer than one in ten. We are the first to study the role of state laws prohibiting youths from indoor tanning on many tanning-related outcomes using difference-in-differences models and staggered adoption of ITB prohibitions across states. We find that youth ITB prohibitions reduced search intensity for tanning-related information and reduced self-reported indoor tanning participation and intensity among teen girls. We also find that youth ITB prohibitions significantly reduced the size of the indoor tanning market by increasing tanning salon closures and reducing tanning salon sales. We find little evidence of unintended consequences on other youth risky behaviors, and in fact we find evidence that youth ITB prohibitions increased sun protective behaviors. Our results demonstrate the effectiveness of youth ITB prohibitions and provide novel evidence on how public health policies affect private market outcomes.

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1. Introduction

Skin cancer is the most diagnosed cancer in the United States and – unlike other cancers – has been on the rise in recent years, particularly among young women (ACS 2021). Use of indoor tanning beds – which emit cancer-causing UVA light at concentrations higher than natural sunlight – has been shown to dramatically increase the risk of developing skin cancer. In 2009, the World Health Organization officially classified UV-emitting tanning devices as carcinogenic to humans, and major medical organizations such as the American Academy of Dermatology have recommended bans on indoor tanning by minors (WHO 2017).

Despite scientific agreement regarding the health risks of indoor tanning, use of artificial tanning facilities is common in the US, particularly among white girls and young adult women. In 2009, over one in three white high school females reported indoor tanning in the past year according to estimates from the Centers for disease Control (CDC) (see Figure 1). In recognition of the popularity of indoor tanning among youths, states have adopted a variety of youth-targeted restrictions on indoor tanning to address this public health concern. As of 2020, 32 states had adopted laws completely prohibiting indoor tanning bed (ITB) use by at least some youth, and 22 states applied these ITB prohibitions to all individuals under the age of 18.[1]

[1] These restrictions in the United States mirror those adopted worldwide. Brazil has banned indoor tanning for the entire population since 2002, and Australia did the same in 2015. Several European

Very little economics research has studied skin cancer or indoor tanning, and to our knowledge no prior work examines youth prohibitions on indoor tanning. This contrasts with extensive work in the economics literature studying other modifiable risk behaviors with youth-targeted prohibitions and minimum legal ages, such as alcohol consumption (Dee 1999; Carpenter and Dobkin 2009), cigarette smoking (Gruber and Zinman 2001; Bryan et al. 2020), e-cigarette use (Friedman 2015), driving (Huh and Reif 2021, forthcoming), dropping out of high school (Anderson 2014), and gun access (Anderson and Sabia 2018). While a public health and medical literature has documented prevalence and trends in indoor tanning behavior and its association with cancer risk (see Watson et al. 2013 for a review), only a handful of studies examine relationships with state policies. Critically, all existing public health studies examining state regulations and ITB use by youths rely on cross-sectional variation in state policies or are single-state evaluations, usually without an untreated control group (Mayer et al. 2011; Guy et al. 2014; Qin et al. 2018).

In this paper we provide the first evidence on the effects of youth ITB prohibitions on a range of tanning-related outcomes. We make several contributions. First, we take an explicitly quasi-experimental approach that leverages within-state changes in youth indoor tanning prohibitions over time to

countries such as France, Spain, Belgium, Austria, and the United Kingdom prohibit indoor tanning by minors (Longo et al. 2019).

address concerns about unobserved state characteristics and preferences that may contribute both to the presence of tanning bed restrictions and to tanning-related outcomes. Second, we consider many more outcomes than have been studied in prior work, including tanning-related Google searches, self-reported indoor tanning, other youth risky behaviors, and market-wide outcomes for tanning salons. Our results are particularly relevant and timely given that the FDA has proposed a nationwide ban on indoor tanning bed use by minors in the United States (FDA 2015). The experiences of US states are likely to produce the most externally valid estimates of the effects of a federal youth indoor tanning ban.

We report several results from this research. First, we find that youth indoor tanning prohibitions significantly reduced indoor tanning behaviors. For example, we find that Google searches for 'tan' and 'tanning' were significantly less popular following age-based prohibitions on indoor tanning compared to the associated changes in states that did not impose such restrictions. Although Google search data do not indicate *whose* search behavior is affected, we use other data to provide evidence that youth ITB prohibitions significantly reduced self-reported indoor tanning participation and intensity by high school age girls. These results are observed in youth self-reports from the state Youth Risk Behavior Surveys from 2009-2019. Effects are concentrated among high school age white girls; we find no evidence that youth indoor tanning prohibitions changed tanning behaviors of identically aged boys or black girls. Among white high school age girls, we estimate

that a state ITB prohibition reduced the likelihood of indoor tanning by 5.6 percentage points, or about 15 percent relative to the 2009 average for this group. Measured differently, we estimate that youth ITB prohibitions can explain over 20 percent of the overall decline in indoor tanning rates for white high school girls over this time period.

We also find clear evidence that youth indoor tanning prohibitions significantly reduced the size of the indoor tanning market. Using panel data on a near universe of tanning salons from the National Establishment Time-Series from 1990 to 2017, we show that state youth indoor tanning prohibitions were associated with statistically significant increases in the likelihood that an indoor tanning salon closed as well as reductions in sales for surviving establishments. While we cannot disentangle whether the market size reductions were a cause, consequence, or contemporaneous correlate of the youth indoor tanning reductions, both effects are strongly linked to the state youth ITB prohibitions. Moreover, we find that the negative market size effects of youth indoor tanning prohibitions were stronger for establishments that were likely to have experienced stronger negative demand shocks as measured by nearby middle and high school girls who constitute a large part of a tanning salon's customer base.

Finally, we examine a range of outcomes intended to address possible unintended consequences of state youth ITB prohibitions. We find no evidence that ITB prohibitions were related to youth drinking, smoking, sexual behaviors, weight

perceptions, or suicidality for white high school girls, the group whose ITB use was the most directly affected by the policies. In fact, we find evidence that state ITB prohibitions were associated with significant increases in Google search popularity for sun-protective terms such as 'sunscreen', and we also find evidence that state ITB prohibitions increased regular sunscreen use by white high school girls.

Taken together, our results suggest that youth prohibitions on indoor tanning were largely successful at reducing indoor tanning by adolescent white girls with relatively little adverse effect except for a predictable and sizable reduction in the size of the indoor tanning salon market. Our results offer a novel demonstration that public health interventions can have important effects on the structure of private markets.

The paper proceeds as follows: Section 2 discusses the institutional background of state indoor tanning prohibitions and other regulations. Section 3 reviews the small economics literature and larger public health literature on skin cancer and indoor tanning, including its relationship with state policies. Section 4 describes the data and outlines our empirical approach. Section 5 presents the results, and Section 6 discusses and concludes.

2. Institutional Background

2.1 Indoor Tanning

Indoor tanning – generally inside a booth or a bed where individuals expose themselves to ultraviolet light at high intensity – has been historically popular (Cokkinides et al. 2009). Tanning beds primarily emit UVA rays which were previously thought to be less harmful than UVB rays (which cause sunburn), but more recent medical research confirms that UVA rays – which penetrate deeper than UVB rays into the skin – are also harmful.[2] ITB use is particularly popular among young women; Figure 1 shows trends in past year ITB use from the CDC's State Youth Risk Behavior Survey from 2009 to 2019 overall and separately by gender. High school girls use ITBs at much higher rates than high school boys. Indoor tanning is particularly popular around high school and college winter breaks, spring breaks, and school celebrations such as prom or homecoming. Figure 2 shows that in the United States, Google searches for 'tanning' exhibit remarkable seasonality, spiking each year in March and April.

The size of the indoor tanning market as measured by total number of tanning salon establishments, the total number of tanning salon employees, or the total sales at tanning salons in the United States grew steadily throughout the 1990s and 2000s until a notable trend change starting around 2009.[3] At its peak, Figure 3

[2] We use the phrase 'indoor tanning bed' to refer to a range of artificial tanning devices that involve UV rays (i.e., not spray-on tans or bronzers). Recent versions of these devices do not involve individuals laying down in a 'bed'; individuals can now use these devices while standing up.

[3] Little is known about what contributed to the decline in the size of the tanning salon industry in the 2010s, though there are several possibilities. One hypothesis is that the health risks of tanning have become more widely known and accepted over time, and this is reflected in major position statements such as the World Health Organization's 2009 report that labeled artificial tanning beds 'known carcinogens' to humans. A widely cited medical study reported that indoor tanning bed use

shows that tanning salon sales alone reached $2 billion USD. Although the market for artificial tanning does include a handful of large chains (e.g., Palm Beach Tan, Sun Tan City), it is not heavily concentrated. The modal tanning salon establishment has fewer than five employees, and the largest chains comprise a very small share of the indoor tanning market (IBISWorld 2021). There is an active industry association for tanning salons, and they routinely highlight purported health benefits of tanning and question the evidence regarding health risks.[4] Tanning salons also engage in extensive advertising and promotions, particularly to youths and young adults. Compared to other risky products such as cigarettes and alcohol, there are relatively few restrictions on tanning salon owners in terms of advertising or content restrictions (Seidenberg et al. 2015).

2.2 Indoor Tanning Regulations

Indoor tanning devices are regulated at both the federal and state levels in the United States. At the federal level, the FDA regulates products that emit radiation,

prior to the age of 30 increases skin cancer risk by 75 percent (IARC Working Group 2006). Partly in response to these increased health risks, the 2010 Patient Protection and Affordable Care Act included a 10 percent tax on non-medical indoor tanning. Although the decline in tanning salon sales and establishments in the US starts before the 'tanning tax', it is possible that its differential tax treatment played a role. It is also possible that the 2008-09 Great Recession reduced demand for indoor tanning and had long-lasting effects. Given the concurrent nature of the WHO report, the Great Recession, and the PPACA tax, and the associated lack of geographic variation in those treatments, it is difficult to disentangle these possibilities.

[4] Major medical organizations such as the American Academy of Dermatology insist that there is no such thing as a 'safe' tan. Historically, some medical conditions such as psoriasis and acne were thought to benefit from phototherapy, but the current medical standard in cases where this is clinically recommended involve much more concentrated doses of light than an indoor tanning bed (with appropriate protections and coverings for the other parts of the body) and require the supervision of a medical professional.

including sunlamps, sunbeds, and indoor tanning devices. In 2014 the FDA increased regulation of tanning beds from Class I medical devices to Class II, requiring increased premarket review. At the same time, the FDA began requiring that warning labels be included on sunlamp products indicating that they should not be used by youths under the age of 18. In 2015, the FDA went further in explicitly proposing that indoor tanning devices be completely prohibited for youths under the age of 18 in the United States. They also proposed requiring adults choosing to tan to sign a document indicating that they understand and accept the health risks before using a tanning bed, as well as every six months in the case of repeated use. As of the time of this writing, the nationwide ban on indoor tanning bed use by minors has not been adopted.

In addition to the federal policies related to indoor tanning, states have also been active in adopting a variety of tanning regulations. Our focus in this paper is on state laws prohibiting youths from using ITBs. Figure 4 shows the prevalence of state prohibitions on indoor tanning bed use by youths over our sample period. Throughout the mid-2000s, there was a steady growth in state policies prohibiting at least some minors from indoor tanning. In 2012, California became the first state to outlaw tanning for all individuals under age 18. Since then, there has been rapid growth in legislative activity restricting tanning, and these restrictions have tended to be broader in scope. As of 2020, 32 states prohibited at least some minors from indoor tanning, and 22 of these states went so far as to prohibit all minors. Figure

5 depicts the spatial and temporal variation associated with these changes for four selected years. Notably, the set of states adopting these regulations is geographically and politically diverse. It includes large states such as Texas and New York, as well as smaller states such as North Dakota and Vermont. The list includes traditionally liberal states, such as California and Washington, as well as more conservative states, such as Kansas and Oklahoma.

In addition to state laws prohibiting youths from using indoor tanning beds, our empirical models also control for a broad range of other policies that states have adopted to regulate indoor tanning. Two of these policies were also targeted at youths: laws requiring parents to be present when a youth uses an indoor tanning bed and laws requiring parents to provide consent for youths to use an indoor tanning bed. Both policies contain variation in the age at which a youth is no longer bound by the policy. Over our sample period, several states strengthened their youth-targeted restrictions, for example moving from a parental consent or a parental presence requirement to a full prohibition on youth indoor tanning. We control for these changes in youth targeted policies over time within each state.

Our models also control for a range of state policies related to indoor tanning that are not age targeted. For example, states adopted laws requiring information to be posted at tanning salons and/or on indoor tanning devices, similar to a ‘warning label’ that one might see on other risky products such as packages of cigarettes. States also adopted laws requiring that attendants must be present while

individuals use indoor tanning devices, and other states adopted laws requiring that goggles must be available for purchase at indoor tanning salons.

3. Literature Review

Very little research in economics has examined skin cancer in general or ITB use as a risk factor specifically. Regarding skin cancer, Kaiser et al. (2018) study the effects of a population-wide skin cancer screening program in Germany. In fixed-effects models comparing changes in skin cancer outcomes in Germany with those for other European countries, they find that the screening program significantly increased detection of skin cancers but did not decrease skin cancer mortality. Dickie and Gerking (1997) study offsetting behavior in the context of skin cancer and find that individuals with genetically determined darker skin complexion take less sun-related precautions: they are less likely to use sun protection products (e.g., sunscreen) and spend more work and leisure time in direct sunlight.

Regarding indoor tanning, Asgeirsdottir et al. (2016) examine how a variety of health behaviors including indoor tanning evolved around the timing of Iceland's severe economic crisis in 2008. They find that a range of risky behaviors among adults – including indoor tanning – declined during the economic crisis. Interestingly, they also note that in 2011 the country imposed a ban on indoor tanning for youths under the age of 18 which coincided with a 17 percent reduction in the number of tanning salons, even though Iceland had entered an economic

recovery. Yaniv and Siniver (2015) study the effects of the 2010 PPACA "tanning tax." They offer a theoretical model that accounts for substitution to outdoor tanning and outlines the conditions under which the tanning tax may perversely increase skin cancer burden.

In contrast to the very small number of studies in economics on indoor tanning and skin cancer risks, there is a substantial literature in public health, health services research, and dermatology on the prevalence, trends, and correlates of indoor tanning (Guy et al. 2017, Guy et al. 2015). Much of this work has focused on indoor tanning behaviors by high school age youths, which have shown a marked decline over the past decade (Guy et al. 2015). Several studies have gone further by linking indoor tanning restrictions for youths to reduced indoor tanning by youths, though these studies have reached mixed conclusions. Mayer et al. (2011) use data on youths from the 100 most populous cities in the United States from 2005 and find no association between youth access legislation and youths' use of indoor tanning beds. Guy et al. (2014) combine data from the 2009 and 2011 Youth Risk Behavior Surveys and find that state age-based restrictions on indoor tanning were correlated with less indoor tanning bed use by high school age females.[5] Similarly, Heckman et al. (2021) showed that states which adopted

[5] They suggest that one possible difference between their finding and the null result in Mayer et al. (2011) is the large increase in the number of states with youth access restrictions between 2005 and 2009. Readers interested in learning more about the large public health and medical literature on this topic can see Holman et al. (2013) for a summary and review.

complete youth indoor tanning bans had lower internet search rates for tanning-related terms, though the authors did not leverage the within-state variation in tanning policies. Notably, evaluations of youth-targeted indoor tanning restrictions over time in single states have found mixed evidence on the effects of age-targeted regulations on youth tanning behaviors, with evaluations in Utah finding evidence of tanning reductions (Simmons et al. 2014) but evaluations in Alabama and New Jersey finding little protective effects (Blashill and Pagoto 2017; Coups et al. 2016). The Utah and New Jersey studies did not control for associated trends in control states without tougher restrictions; the Alabama study used changes for youths in Florida as untreated control outcomes. Some research has attempted to explain the possible lack of effect of public policies at reducing indoor tanning by noting that enforcement of and compliance with tanning laws may be limited and inconsistent (Reimann et al. 2018; Williams et al. 2018; Choy et al. 2017; Pichon et al. 2009; Hester et al. 2005).

We build on prior work in several important ways. First, unlike most of the public health literature which relies on comparisons of outcomes across states with different policy contexts at a single point in time or that considers the experience of one or two states, our work explicitly examines changes in tanning-related outcomes coincident with changes in youth indoor tanning prohibitions for a large sample of states using difference-in-differences models. Thus, our estimates are purged of time-invariant differences across places in tanning-related outcomes

related to, for example, anti-tanning sentiment. This approach also allows us to account for national secular shocks to outcomes such as the publication of major public health reports outlining the dangers of indoor tanning. Second, we consider a much wider range of outcomes than has been studied in prior work, including Google search popularity for tanning-related and sun protection-related terms, as well as establishment data on tanning salons.

4. Data Description and Empirical Approach

4.1 Effects on Tanning-Related Behaviors

We begin our analysis of the effects of youth indoor tanning prohibitions by examining how the policies affected a range of tanning-related behaviors. We present evidence from Google Trends which captures searches for tanning information and may reflect demand for indoor tanning services as well as evidence from the state Youth Risk Behavior Surveys which captures self-reported indoor tanning.

4.1.a Google Trends

First, we test whether age-based ITB prohibitions are associated with changes in information seeking behavior. To do so, we utilize Google Trends data from 2004-2018 to understand how state youth indoor tanning prohibitions affected the relative popularity of searches for the word ‘tan’ (and other related terms) using the following fixed-effects specification:

$$(1) \quad Y_{st} = \beta_0 + \beta_1(\textit{SHARE PROHIBITED})_{st} + \beta_2 Z_{st} + \beta_3 S_s + \beta_4 T_t + \varepsilon_{st}$$

where observations are at the state-by-year-by-month level and the dependent variable, Y_{st}, is the relative popularity of various tanning-related words in state *s* during time *t*. Our independent variable of interest, *SHARE PROHIBITED*, is the fraction of teens in the state prohibited from indoor tanning.[6]

In order to account for state-level time-varying factors which may be concurrent with both the adoption of an indoor tanning prohibition and tanning-related Google searches, the vector Z_{st} includes controls for the shares of teens bound by other state-level tanning regulations (the share of teens whose parents are required to be present for every tanning session, the share of teens whose parents must sign a consent form, and whether the tanning salon must ensure a safe tanning experienced by providing goggles, having an attendant present, and/or displaying informational material related to tanning risks). The vector also includes an indicator for whether the state had a graduated driver's license law (Agrys et al. 2019) enabling teens easier access to tanning establishments. We also control for the annual state unemployment rate (BLS 2021) and the natural log of the real value of the minimum wage (Vaghul and Zipperer 2016) to account for the possibility that tanning behaviors are related to economic conditions and teen employment. Finally, the vector includes indicators for whether the state had expanded Medicaid

[6] County and state level population data for teens ages 13-17 during each year are obtained from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program.

as part of the PPACA (KFF 2021) and whether the state had implemented a SUNucate law asserting students' ability to apply sunscreen while at school (Patterson et al. 2021).

We include a vector of state fixed effects, S_s, to control for all time-invariant characteristics that may be related to demand for indoor tanning, such as risk preferences, local attitudes toward indoor tanning, latitude/longitude, and proximity to beaches/coastline. We also include a vector, T_t, of month and year fixed effects. The month fixed effects account for the strong seasonality in tanning related searches shown in Figure 2. Similarly, the year fixed effects control for national shocks to indoor tanning that are not place-specific, such as the PPACA 10 percent excise tax on indoor tanning and the WHO decision to classify indoor tanning beds as carcinogens. Standard errors are clustered at the state level (Bertrand, Duflo, and Mullainathan 2004).[7]

In the presence of the covariates, our key identifying assumption is that information-seeking outcomes in states prohibiting minors from tanning would have evolved similarly in the absence of the restriction. We test the validity of this assumption using the following event-study specification:

[7] There is an emerging literature on how to best estimate difference-in-differences models when there is variation in treatment timing (De Chaisemartin and d'Haultfoeuille 2020; Callaway and Sant'Anna 2020, forthcoming; Borusyak et al. 2021; Goodman-Bacon 2021, forthcoming). We discuss these recent advances as they relate to our analyses and show the robustness of our results to these new approaches in Appendix B.

$$(2)\quad Y_{st} = \beta_0 + \sum_{j=-8}^{-2} \beta_1^j \times I_{st}^j + \sum_{j=0}^{2} \beta_1^j \times I_{st}^j \times SHARE\ PROHIBITED_{st} + \eta_{Pre} + \eta_{Post} + \beta_2 Z_{st} + \beta_3 S_s + \beta_4 T_t + \varepsilon_{st}$$

where our independent variables of interest, I^j_{st}, are indicators for being *j* periods away from the implementation of the first ITB prohibition. In the post-period, these indicators are multiplied by the share of teens covered by the restriction. Finally, η_{Pre} measures observations occurring more than 8 years prior to the first prohibition and η_{Post} measures observations occurring more than 2 years after the policy change.[8]

4.1.b Youth Risk Behavior Survey

To directly examine how youth indoor tanning prohibitions affected self-reported indoor tanning we use the Centers for Disease Control's Youth Risk Behavior Surveys (YRBS). The YRBS is a survey of high school youths performed in-person at schools in the spring of odd-numbered years. The YRBS has included questions about indoor tanning since 2009; we use the 2009, 2011, 2013, 2015, 2017, and 2019 waves. We focus on the state YRBS, as it is designed to be state-representative and has a much larger sample than the national YRBS.[9]

[8] To ensure that the estimates are driven by changes related to the prohibition—instead of changes in the composition of states identifying the coefficient on each indicator—we limit our sample to a balanced panel of states for which we can estimate at least 8 pre-period coefficients and 3 post-period coefficients. Our results are robust to this decision.

[9] There are two versions of the YRBS: a national version with a sample of approximately 15,000 youths each year and a state version with sample sizes that vary across states. The students sampled in the national YRBS are different from the students sampled in the state YRBS, and not all states are represented in either dataset. Notably, the national data are designed to be nationally representative but are not necessarily state representative. In contrast, the state data are designed to be state representative. Because our policies are enacted at the state level, our preferred estimates

Regarding indoor tanning, the YRBS asks youths how many times in the past year they used an indoor tanning bed. Response options include zero, 1-10, 11-19, 20-29, and 30 or more. Our first outcome, ANY INDOOR TANNING IN PAST YEAR, is an indicator for whether the teen had used a tanning bed during the prior year. Our second outcome, IHS(NUMBER OF TANNING VISITS), is the inverse hyperbolic sine of the number of times the teen reports using the tanning bed, where we code the number of visits as the midpoint of each interval (for example, a teen reporting 1-10 is coded as having 5.5 visits).[10]

To estimate the effects of state youth indoor tanning prohibitions on self-reported indoor tanning by youths in the state YRBS, we estimate the following:

$$(3) \quad Y_{iast} = \beta_0 + \beta_1(PROHIBITED)_{ast} + \beta_2 A_a + \beta_3 Z_{ast} + \beta_4 S_s + \beta_5 T_t + \varepsilon_{iast}$$

where Y_{iast} are the indoor tanning outcomes described above for youth *i* of age *a* in state *s* at time *t*. Our independent variable of interest, $PROHIBITED_{ast}$, is an age-specific indicator for whether a youth is prohibited from tanning. Because older

utilize the state YRBS data. Moreover, the state YRBS has a much larger sample size than the national YRBS, allowing us to exploit differences in which ages are covered by a prohibition in a state during a given year. However, we also explore the sensitivity of our results to using the national YRBS data.

[10] The inverse hyperbolic sine transformation allows for the same interpretation as taking the natural log of the dependent variable, though does not require us to decide the best way to handle individuals who did not tan during the prior year (Burbidge et al. 1988). We also explored creating another measure of tanning intensity that has been used by prior public health literature, FREQUENT TANNING, taking on the value of 1 if an individual reported tanning more than 11 times and 0 otherwise. The pattern is very similar to using the IHS(NUMBER OF TANNING VISITS). Appendix Figure 1 shows the distribution of the number of times that white girls in the state YRBS reported indoor tanning, conditional on any past year indoor tanning. A substantial share of these youths report indoor tanning only once or twice in the past year (e.g., perhaps before a school dance), but there are also many youths who report much more regular and frequent indoor tanning.

teens are more likely to tan than young teens and adolescents, we include the vector A_a which includes indicators for each age (≤12, 13, 14, 15, 16, 17, with 18+ omitted). Throughout our analysis, we stratify results by sex and race given that there are such large differences in indoor tanning rates by these characteristics. Note that in equation (3) we also modify the *Z* vector to account for the fact that some of the other state indoor tanning regulations, such as parental presence and consent rules, are also age specific. All other variables are as described above, and we cluster standard errors at the state level. However, because of the small number of clusters in the state YRBS, we conduct inference using a cluster robust wild bootstrap procedure (Cameron et al. 2008; Cameron and Miller 2015).[11] We utilize the sample weights which are designed to make the YRBS representative at the state level. In robustness models, we also estimate models that include state-specific linear time trends (Wolfers 2006).

Next, we leverage the age-specific nature of the tanning prohibitions using the following triple difference model:

$$(4)\quad Y_{iast} = \beta_0 + \beta_1(\textit{PROHIBITED})_{ast} + \beta_2 A_a + \beta_3 Z_{ast} + \beta_4 S_s + \beta_5 T_t + \beta_6 A_a S_s + \beta_7 A_a T_t + \beta_8 S_s T_t + \varepsilon_{iast}$$

where all variables are as described above. These models compare within-state changes in outcomes for youths above and below the age-based indoor tanning

[11] There are 17 states with tanning information in the state YRBS. Of these states, 9 have adopted a youth prohibition on indoor tanning.

prohibition coincident with policy adoption to the associated within-state changes in outcomes for youths above and below that threshold in states that did not adopt a youth indoor tanning prohibition at the same time. In addition to allowing for age-by-state and age-by-year fixed effects, these triple difference models control for a full set of state-by-year fixed effects accounting for any state/time varying confounder not varying by age (e.g., laws requiring warnings be posted on tanning beds). Note that this means that any variables in the Z vector that do not vary by age (e.g., state unemployment rates, non-age-targeted tanning regulations) are not controlled for, as they are perfectly collinear with the state-by-year fixed effects.[12]

4.2 Effects on the Indoor Tanning Market: National Establishment Time Series

To study the market for indoor tanning we use data from the 1990-2017 National Establishment Time-Series (NETS) dataset. The NETS data include time-series information on over 60 million total establishments in the US from the Duns Marketing Information file. For our purposes, a key feature of the NETS data is that they include very detailed Standard Industrial Classification (SIC) codes which

[12] Unfortunately, the structure of the YRBS data prevents us from utilizing an event study specification similar to the Google Trends data. Specifically, the YRBS data do not contain observations from every state during every year. For example, the data contain observations from Vermont in years 2011 and 2015, and Vermont began prohibiting minors from tanning in July of 2012. As such, we could only identify the relationship between the prohibition and the likelihood of tanning 1 prior to implementation and 4 years after implementation. Identification of any other coefficients would be driven by both (i) the relationship between the policy and tanning and (ii) Vermont exiting the sample. To ensure that our results are not being driven by composition changes, throughout the paper we limit our event studies to settings where we can identify a balanced panel of states/counties over the sample period.

allow us to precisely identify tanning salons (SIC 72990105).[13] These data include the business name and street address, as well as estimated annual sales and employment for the firm.[14] Critically, we can follow the same establishments over time which – in combination with information on the years the firm reports being active – allows us to examine tanning salon openings and closings.[15]

To study effects of indoor tanning prohibitions for youths on tanning salon openings and closings, we estimate the following fixed effects specification:

$$(5) \quad Y_{ct} = \beta_0 + \beta_1(\textit{SHARE PROHIBITED})_{ct} + \beta_2 Z_{ct} + \beta_3 C_c + \beta_4 T_t + \varepsilon_{ct}$$

where the dependent variables are the inverse hyperbolic sine transformation on the number of tanning salon openings and closings at the county level.[16] Our independent variable of interest is the share of teens in the county prohibited from indoor tanning.

[13] This data requirement ruled out other commonly used datasets such as County Business Patterns or the Quarterly Census of Employment and Wages, neither of which provide sufficient industry level data to identify tanning salon firms.

[14] To explore whether our data might inadvertently include spray tan facilities—which may or may not also have UV emitting tanning beds—we used the Stata 'matchit' command to approximate the share of establishments with 'spray' in their name. The command generates a similarity score based on the strength of the match. For example, the company 'SPRAY' received a similarity score of 1. The next highest match was 'SUNSPRAY' with 0.76., while 'SUNKISSED SPRAYS' received a 0.52. In contrast, 'EXOTIC RAYS' received a score of 0.32 and 'TAN TAN TAN SALON & SPA' a 0.07. In total, 15% of establishments had a non-zero similarity score, 2.6% had a score of 0.2+, 1.2% of 0.3+, and 0.1% 0.5+. Overall, these patterns suggest that our data do primarily contain tanning establishments and that the fraction of establishment names specifically related to spray tanning is very small .

[15] The NETS data have been used previously in evaluations such as ours. See, for example, Neumark and Kolko (2010).

[16] As mentioned previously, the inverse hyperbolic sine transformation allows for the same interpretation as taking the natural log of the dependent variable but does not require us to decide the best way to handle counties without any openings or closings during a year.

The vector Z_{ct} accounts for the share of teens in the county covered by parental presence requirements, the share required to obtain parental consent to tan, and whether the salon is required to provide for a safe tanning experience (as measured by the policies pertaining to warning labels, attendants, and goggles). We include the same state-level time-varying covariates as before, though we replace the state-level unemployment rate with the county-level unemployment rate. We include a full set of county fixed effects, C_c, and a full set of year fixed effects, T_t. To account for the fact that small establishments in the NETS may suffer imputation issues (Barnatchez, Crane, and Decker 2017), we weight the estimates by county population.

Again, our key identifying assumption is that counties bound by youth tanning prohibitions would have experienced similar changes in the indoor tanning market as counties without such restrictions in absence of the policy. We test this assumption using the following event-study specification:

$$(6)\quad Y_{ct} = \beta_0 + \sum_{j=-8}^{-2} \beta_1^j \times I_{ct}^j + \sum_{j=0}^{2} \beta_1^j \times I_{ct}^j \times SHARE\ PROHIBITED_{ct} + \eta_{Pre} + \eta_{Post} + \beta_2 Z_{ct} + \beta_3 C_c + \beta_4 T_t + \varepsilon_{ct}$$

where the independent variables of interest are indicators for being *j* periods away from a youth tanning prohibition, and in the post-period these indicators are interacted with the share of teens in the county covered by the prohibition.

In addition to tanning salon openings and closings, which capture the effect of prohibitions on the extensive margin, we also examine how youth indoor tanning

prohibitions affected sales and employment at existing establishments using the following specification:

$$(7) \quad Y_{ict} = \beta_0 + \beta_1(\textit{SHARE PROHIBITED})_{ct} + \beta_2 Z_{ct} + \beta_3 E_i + \beta_4 T_t + \varepsilon_{ict}$$

where Y_{ict} is the natural log of sales or the natural log of employment for establishment *i* in county *c* at time *t*.[17] Almost all the other variables are the same as in equation (5). However, we replace county fixed effects, C_c, with establishment fixed effects E_i. By including establishment fixed effects, this specification captures the impact of youth prohibitions on the intensive margin, sales and employment, conditional on an establishment remaining open.

Given the age-targeted structure of state youth indoor tanning prohibitions, we also explore how these policies differentially affect establishments whose clientele are more likely to be comprised of adolescents. To do so, we geolocate establishments relative to nearby schools and use school-level information on gender-by-grade-by-race enrollment.[18] In equation (8), we interact the share of adolescents in the county prohibited from using an indoor tanning bed with an indicator for whether the establishment was within 500, 1000, or 2000 meters of a

[17] We use the natural log transformation because every open establishment reports strictly positive sales and employment.

[18] Data on public school locations for the 2017-18 school year were obtained from the National Center for Education Statistics public school shapefile. Establishments were geocoded based on latitude and longitude included in the NETS data. School enrollment by grade, gender, and race came from the 2017-18 Public Elementary/Secondary School Universe Survey Data from the Common Core of Data.

school with white girls in grades 7-12.[19] This specification allows us to disentangle the general consequence of the policy—captured by β_2—from the hyper-localized demand shock experienced by establishments within close proximity to middle and high schools—captured by β_1.

$$(8)\quad Y_{ict} = \beta_0 + \beta_1(\textit{SHARE PROHIBITED})_{ct} * (\text{NEARBY SCHOOL})_{ict} + \beta_2(\textit{SHARE PROHIBITED})_{ct} * (\text{NO NEARBY SCHOOL})_{ict} + \beta_3 Z_{ct} + \beta_4 E_i + \beta_5 T_t + \varepsilon_{ict}.$$

5. Results

5.1 Effects on Tanning-Related Behaviors

In Table 1, we begin by exploring how youth indoor tanning prohibitions affected tanning-related information seeking behavior using 2004-2018 Google Trends data. Each column is a separate regression using the specification from equation (1) where the outcome is the relative search popularity for the term in the column header. Columns 1-3 show that youth indoor tanning prohibitions were associated with statistically significant reductions in the relative search popularity of the words/phrases 'tan,' 'tanning,' and 'tanning salon,' respectively. Reassuringly, we show in Figure 6 that this relationship only existed after the prohibition was implemented: there were not systematically differential pre-trends in search

[19] In an alternative specification, we interacted the share of adolescents prohibited from using an indoor tanning bed with the number of nearby white girls in grades 7-12 in thousands. For ease of interpretation, we present the specification with an indicator for being near school-aged white girls, though we report the continuous results in the appendix.

popularity for the word 'tan' that were correlated with the eventual adoption of youth indoor tanning prohibitions. However, search intensity fell immediately following the prohibition.[20,21]

While this evidence is consistent with reduced demand for indoor tanning associated with youth indoor tanning prohibitions, a limitation of the Google search data is that we do not (and cannot) know whose search behavior is affected. While teens themselves may be searching less for places to go 'tanning' because they are prohibited from doing so in states with such restrictions, parents may also be searching for information about the health consequences of 'tanning.' To better determine whether youth indoor tanning prohibitions had their intended effect, we next examine self-reported teen behavior using the state YRBS.

In Table 2, we present results for indoor tanning participation in the top panel and for indoor tanning intensity in the bottom panel. The sample is restricted to white teen girls—the demographic group most likely to engage in indoor tanning. Each entry is the coefficient on state youth indoor tanning prohibition from a regression with increasingly saturated controls across the columns, moving from left to right. In column 1, we present results from a model that controls for individual demographic characteristics and the state/time varying characteristics

[20] Appendix Figure 2 shows the event-studies for 'tanning' (Panel A) and 'tanning salon' (Panel B). Those patterns mirror the event-study for the word 'tan.'

[21] We examine the Google Trends results using the recent diagnostic and estimation tools proposed by Goodman-Bacon (2021, forthcoming) and Callaway and Sant'Anna (2020, forthcoming) in Appendix B. Those results are consistent with our primary fixed-effects results presented here.

and policies. This is akin to the cross-sectional approaches most common in the public health and medical literatures. In column 2, we present results from a model that adds state and year fixed effects, akin to the standard difference-in-differences approach. Column 3 presents results from a model that augments the prior column's specification with state-specific linear time trends, and column 4 replaces the state trends with all two-way interactions between age, state, and year fixed effects. Column 4 is the triple differences estimate that explicitly relies on comparisons between white girls whose age makes them unaffected by the youth indoor tanning prohibitions and white girls in the same state whose younger age means they are prohibited from indoor tanning, coincident with policy adoption. While we report state-clustered standard errors below each estimate in parentheses, we also conduct inference using a wild bootstrap procedure and report the associated p-values in brackets to account for the small number of clusters (Cameron et al. 2008; Cameron and Miller 2015).

Table 2 indicates that youth indoor tanning prohibitions were effective at reducing self-reported indoor tanning participation and intensity. For example, using the difference-in-differences specification, column 2 shows that these policies reduced the likelihood of indoor tanning in the prior year by a statistically significant 5.6 percentage points. Adding state-specific linear time trends to the baseline difference-in-differences estimate does not materially alter this conclusion, though statistical significance does not survive adjusting for the small

number of clusters. In column 4, when we add all two-way interactions, we estimate a 12-percentage point reduction in the likelihood of tanning, similar to the cross-sectional estimate from the first column. This pattern is also present in the bottom panel when we measure tanning intensity using the inverse hyperbolic sine of the number of times individuals used an indoor tanning bed in the prior year. Collectively, the estimates in Table 2 suggest that youth indoor tanning prohibitions reduced indoor tanning participation and intensity among white girls, who were most likely to engage in indoor tanning.[22,23]

In Table 3, we test the plausibility of the finding that state tanning prohibitions reduced youth tanning by examining the relationship with groups less likely to use indoor tanning beds. Specifically, we take the difference-in-differences style specification from column 2 of Table 2 and present results separately for white girls (column 1, reprinted from column 2 of Table 2), black girls (column 2), white boys (column 3), and black boys (column 4).[24] The results indicate that state youth

[22] Appendix Table 1 shows the results from the national YRBS, following the format of Table 2. The much smaller sample size of the national YRBS, as well as the fact that it is not designed to be state representative, precludes us from finding significant effects of youth indoor tanning prohibitions on self-reported indoor tanning behaviors. However, we present the results for completeness.

[23] Appendix Table 2 shows that the pattern in Table 2 is robust to iteratively excluding each treated state present in the state YRBS sample. In all cases, we find between a 4.6 and 6.0 percentage point reduction in the likelihood that white girls reported using an indoor tanning bed during the past year.

[24] Results using the triple difference specification from column 4 of Table 2 are provided in Appendix Table 3. Again, we estimate large reductions in the likelihood of self-reported tanning by white girls, while the point estimates for black girls, white boys, and black boys are smaller in magnitude. None of these estimates are statistically significant under the cluster robust wild bootstrap procedure.

indoor tanning prohibitions were uniquely related to reduced indoor tanning by white girls, with much smaller effects for black girls, white boys, and black boys. Moreover, the estimates for these other groups are never statistically significant, regardless of how we adjust standard errors. This broadly supports our interpretation that state indoor tanning prohibitions reduced tanning by white girls and suggests that the policies reduced disparities in indoor tanning behaviors associated with gender and race.

Taken together, Tables 1 through 3 strongly suggest that state laws prohibiting youths from indoor tanning were effective at reducing youth indoor tanning participation and intensity. The policies significantly reduced population-wide search popularity for 'tanning' and self-reported indoor tanning by high school girls. These results point to a consistent pattern that prohibitions reduced indoor tanning by youths, especially among white girls.

5.2 Effects on the Indoor Tanning Market

We next explore how state laws prohibiting youths from using indoor tanning beds affected the indoor tanning market. Table 4 reports results obtained using the two-way fixed effects specification from equation (6) estimated via OLS. The dependent variable is the inverse hyperbolic sine of the number of tanning salon openings and closings at the county level. Column 1 shows that moving from no prohibition on youth tanning to a complete prohibition was associated with a 10.5 percent reduction in the number of county-level tanning salon openings, though the

estimate is not statistically significant. This suggests that curbing youth access sufficiently reduced demand and discouraged would-be-owners from opening tanning salon establishments. Similarly, column 2 indicates that totally prohibiting youth tanning was associated with a statistically significant 15.9 percent increase in the number of county-level tanning salon closures. Overall, Table 4 indicates that state laws prohibiting ITB use by minors meaningfully reduced the size of the indoor tanning market.[25]

Next, we show that tanning salon openings and closings were not differentially trending in counties bound by youth tanning prohibitions relative to the comparison counties in the pre-period. Figure 7 plots the event-study coefficients from equation (7). For both openings (Panel A) and closings (Panel B), there is no evidence of a differential trend relative to states without prohibitions prior to the policy's implementation. After the prohibition was implemented, the estimates indicate a sharp reduction in the number of tanning salon openings and an increase in the number of tanning salon closings. Accordingly, Figure 7 indicates that the relationship between youth tanning prohibitions and the indoor tanning market was unique to the post-expansion period.[26]

[25] Appendix Table 4 shows the robustness of the estimates to county-specific linear time trends and census division-by-year fixed effects. The point estimates indicate a 5-20 percent reduction in the number of establishment openings and a 9-16 percent increase in the number of establishment closings.

[26] In Appendix B, we reach similar conclusions when employing recent advances in difference-in-differences estimation strategies (Goodman-Bacon 2021, forthcoming; Callaway and Sant'Anna 2020, forthcoming).

We next examine how youth indoor tanning prohibitions affected both firm-level sales and employment, conditional on remaining open. The dependent variable in Table 5 is the natural log of sales and the natural log of the number of employees.[27] Each column is a separate regression, and all columns include local-level time-varying controls and year fixed effects. Columns 1 and 3 include county-level fixed effects. Columns 2 and 4 include establishment-level fixed effects to leverage within establishment changes over time. The dependent variable is listed at the top of the column.

Column 1 shows that youth indoor tanning prohibitions were associated with a 6.5 percent reduction in tanning salon sales after accounting for local-level time varying controls, secular trends in tanning sales, and time-invariant county characteristics. Even after accounting for time-invariant establishment specific characteristics in column 2, we continue to find that youth indoor tanning prohibitions reduced sales at establishments which remained open by 3.3 percent.

Similarly, columns 3 and 4 indicate that youth tanning prohibitions reduced the number of employees by 2.4-4.3 percent, though the estimates are not statistically significant. It is perhaps unsurprising that we detect stronger reductions in sales than in the number of employees. For one, limiting the pool of potential customers most directly affects sales, and this reduction is likely the reason for

[27] We use the natural log in this context because we are not concerned with how to handle zeros. All active firms had strictly positive sales and number of employees.

changing the number of employees. Moreover, during our sample period the median establishment had only 2 employees, and one-third of all establishments had only 1 employee, providing these establishments with a thin (or no) margin for adjustment.[28]

Given the evidence that youth indoor tanning prohibitions reduced tanning salon sales, we explore the possibility of differential effects related to hyper-local demand shocks induced by the indoor tanning prohibitions. The dependent variable in columns 1-3 of Table 6 is the natural log of sales, while the dependent variable in columns 4-6 is the natural log of the number of employees. Each column is a separate regression, and all columns include local-level time-varying controls, year fixed effects, and establishment fixed effects. The independent variables of interest are the share of adolescents in the county prohibited from tanning, as well as this measure interacted with an indicator for whether the establishment is within proximity to a middle or high school with white girls in grades 7-12. We define proximity with circles around the establishment; in columns 1 and 4, it refers to having school-aged girls within 500 meters, in columns 2 and 5 within 1000 meters, and in columns 3 and 6 within 2000 meters.

[28] In Appendix Table 5, we test the robustness of the patterns on sales and employment to alternative specifications, including the addition of county-specific linear time trends, establishment-specific linear time trends, and census division-by-year fixed effects. These additional specifications suggest a 1.9-3.1 percent reduction in sales and a 1.5-2.4 percent reduction in the number of employees.

Column 1 shows that youth indoor tanning prohibitions were associated with a 2.9 percent reduction in tanning salon sales for establishments not located near school-aged white girls. Meanwhile, establishments in proximity to adolescent white girls – who were more likely to use indoor tanning beds – experienced an additional 5.5 percent reduction in sales. This additional reduction in sales is most salient within a narrow radius around the establishment. Columns 2 and 3 show a 3.1-3.8 percent reduction in sales for establishments not near any white girls in grades 7-12, while there is an additional 3.5 (3.2) percent for firms within 1000 (2000 meters). Columns 4-6 document a similar pattern for tanning salon employment, though the estimates are not statistically significant.[29] Overall, the results in Table 6 indicate that youth indoor tanning prohibitions were most salient for establishments with a very local customer base consisting of adolescent white girls.

5.3 Evidence on Sun Protection and Other Risky Behaviors

If youth indoor tanning prohibitions close off indoor tanning options and induce substitution to outdoor tanning, the primary public health purpose of the policies may be undone depending on the nature and extent of outdoor tanning increases. Alternatively, if the youth indoor tanning prohibitions changed youths' beliefs

[29] In Appendix Table 6, we interact the share of youths prohibited from indoor tanning with a continuous measure of the number of white girls (in thousands) in grades 7-12 within 500, 1000, and 2000 meters of the tanning establishment. Again, we show in column 1 that establishments near schools with more white girls in grades 7-12 experienced larger reductions in sales.

about the dangers of tanning, the policies may have reduced outdoor tanning as well. Unfortunately, we are not aware of any survey that directly asks about outdoor tanning. Instead, in this section we present indirect evidence for these outcomes by examining the effects of youth indoor tanning prohibitions on sun protective behaviors.

We first show in Table 7 that youth indoor tanning prohibitions were associated with *increased* popularity of Google searches related to sun protective behaviors. Specifically, column 1 shows that states enacting these prohibitions saw more intense searches for the term 'SPF', an abbreviation for 'sun protective factor' found on nearly all sunscreen products. SPF measures the amount of ultraviolet radiation required to produce a sunburn in the presence of sunscreen relative to unprotected skin (FDA 2017). Figure 8 shows that the intensity of Google searches for 'SPF' was unrelated to the eventual adoption of a tanning prohibition and that the intensity increased only in the post-prohibition period. We also show in Table 7 that these states saw increased Google searches for 'sunscreen,' 'UVA,' and 'UVB,' consistent with the idea that youth indoor tanning prohibitions increased information seeking behavior related to sun protection.[30,31]

[30] We present event-study estimates for 'sunscreen,' 'UVA,' and 'UVB' in Appendix Figure 3. The patterns indicate an increase in searches for 'sunscreen', though the larger confidence intervals preclude us from a definitive conclusion.

[31] In results not reported but available upon request, we failed to find evidence of a relationship between youth indoor tanning prohibitions and Google searches for 'melanoma' or 'skin cancer.'

Next, we explore whether youth indoor tanning prohibitions were related to likelihood that white teen girls reported regular sunscreen use in the 2009-2019 YRBS data.[32] The first three columns of Table 8 examine white teen girls—the group for which we detected a significant reduction in indoor tanning use. Column 1 presents our preferred estimate obtained using the two-way fixed effects specification from equation (3). Column 2 reports the estimate obtained from augmenting our preferred model with state-specific linear time trends, while column 3 presents the estimate obtained after replacing those trends with all two-way interactions between age, state, and year fixed effects. Columns 4-6 again uses our preferred specification but examines groups less likely to engage in indoor tanning—black girls, white boys, and black boys. Again, we adjust for a small number of clusters by conducting inference using a wild bootstrap procedure and report the associated p-values in brackets (Cameron et al. 2008; Cameron and Miller 2015).

Column 1 shows that youth indoor tanning prohibitions were associated with a 3.8 percentage point *increase* in the likelihood that white teen girls reported regular sunscreen use when using our preferred two-way fixed effects specification. This relationship increases in magnitude when we add increasingly saturated sets

[32] Respondents were asked, 'When you are outside for more than one hour on a sunny day, how often do you wear sunscreen with an SPF of 15 or higher?' and could respond 'Never,' 'Rarely,' 'Sometimes,' 'Most of the Time,' or 'Always.' Following the CDC's recommendation in the YRBS codebook, we define a teen as regularly using sunscreen if s/he wore it 'Most of the Time' or 'Always.'

of controls. Column 2 shows that these prohibitions were associated with a 4.2 percentage point increase in regular sunscreen use after including state-specific linear time trends, and the estimate remains statistically significant after adjusting for a small number of clusters. Using the triple-difference specification, column 3 finds a 5.2 percentage point increase, though the estimate is statistically insignificant after adjusting for the small number of clusters. Consistent with the evidence on past year indoor tanning, we do not detect any meaningful relationship between youth indoor tanning prohibitions and regular sunscreen use by black girls (column 4), white boys (column 5), or black boys (column 6).[33]

Table 9 presents evidence on a range of other youth risky behaviors, including alcohol consumption and sexual activity. On one hand, these outcomes may be views as falsification tests to support our claim that we are documenting a causal relationship between youth indoor tanning prohibitions, past year indoor tanning, and regular sunscreen use, rather than picking up on general changing attitudes toward risky activities. However, many young women report indoor tanning in part to increase mental health or to look thinner, so one might be concerned that the policies reduce youth mental health and/or induce substitution

[33] Appendix Table 7 shows results for regular sunscreen use obtained from the national YRBS, following the format of Table 9. The much smaller sample size of the national YRBS, as well as the fact that it is not designed to be state representative, precludes us from finding significant effects. Again, we present the results for completeness.

to other unhealthy weight control strategies such as smoking. As such, Table 9 may also capture downstream effects of tanning prohibitions.

Using our preferred specification from equation (3), the results in Table 9 provide little evidence that state laws prohibiting youths from indoor tanning induced increases in other unhealthy behaviors reported by white teen girls—the group for which we detected reductions in tanning and increases in regular sunscreen use. We find no significant effects on any of the outcomes under study in Table 9, regardless of how we address standard errors for statistical inference, and the economic importance of the implied estimates is also very small. Overall, we conclude that the youth indoor tanning prohibitions significantly reduced indoor tanning and increased sun protective behaviors without meaningfully altering other risky behaviors.

6. Discussion and Conclusion

We provide the first evidence that state prohibitions on indoor tanning use by youths affected information-seeking behavior and the size of the indoor tanning market, as well as the first plausibly causal evidence that these prohibitions were successful in reducing youth indoor tanning. Our difference-in-differences estimate implies that white teen girls were 5.6 percentage points less likely to report using an indoor tanning bed in the past year, a 15 percent reduction relative to the share of white girls tanning at the start of our sample period in 2009. The triple-difference

specification—which fully leverages the prohibitions' age cutoffs for the prohibition—suggests a 12.3 percentage point, or 33 percent, reduction in the likelihood of tanning relative to the share tanning in 2009. We also estimate that these policies significantly reduced the size of the tanning salon market, with sales reductions on the order of 3 to 6 percent. Given that industry experts suggest that youths constitute about 17 percent of the indoor tanning market (IBISWorld 2021), these aggregate sales effects are plausible in magnitude (.15 × .17 = .0255; .33 × .17 = .0561).

It is also useful to think about how many cases of skin cancer youth indoor tanning prohibitions may help prevent.[34] Wehner et al. (2014) estimated that 413,045 cases of non-melanoma skin cancer and 6,199 cases of melanoma skin cancer each year are attributable to indoor tanning.[35] With these estimates in mind, our results imply between 23,130 (413,045 × 0.056) and 50,804 (413,045 × 0.123) fewer cases of non-melanoma skin cancer annually. Similar calculations yield between 347 and 762 fewer cases of melanoma skin cancer each year. Meanwhile, skin cancer surgery is estimated to cost between $5,437 and $8,434 (Mariotto et al.

[34] The American Academy of Dermatology Association (2018) states that even one indoor tanning session can increase the risk of developing melanoma by 20 percent, squamous cell carcinoma by 67 percent, and basal cell carcinoma by 29 percent. Indeed, these correlational risks are higher when individuals begin tanning at an earlier age. The AADA estimates that indoor tanning bed use before age 35 increases the risk of melanoma by 59 percent, and women younger than 30 are 6 times more likely to develop melanoma if they tan indoors.

[35] For reference, the American Cancer Society (2021a) estimates that there are 5.8 million cases of non-melanoma skin cancer and over 100,000 cases of melanoma skin cancer each year.

2011; Kittinger et al. 2014).[36] Our estimates imply between $128 and $435 million in annual health care savings ((23,130 + 347) × $5,437 to (50,804 + 762) × $8,434). However, these public health improvements came at a cost; we estimate that youth indoor tanning prohibitions reduced tanning salon sales by between 3.3 and 6.5 percent. If we use 2009 as our reference year—our peak year for tanning salon sales—this reduction implies that youth indoor tanning prohibitions cost between $67 and $132 million annually ($2.03 billion × 0.033 to $2.03 billion × 0.065). Overall, these back-of-the-envelope calculations suggest that the estimated benefits of youth indoor tanning prohibitions exceeded the cost of reduced sales at tanning establishments.

Our study is subject to some notable limitations. First, we are unable to control for the arguably important effects of enforcement, outreach, or media campaigns. This would be especially important if, for example, the adoption of a youth tanning bed prohibition is correlated with other state efforts to improve skin health. Although this is a limitation common to most papers in this literature, we cannot rule out that failing to account for these efforts may have inflated our estimates. Unfortunately, we are also unable to examine whether youths substituted toward outdoor tanning. While we present evidence suggesting improvements in

[36] Mariotto et al. (2011) estimated the initial cost of cancer care for women with melanoma to be between $5,437 and $6,524, depending on the age of the woman. In reviewing billing records, Kittinger et al. (2014) found the average cost of basal cell carcinoma to be $6,444 for surgical excision and $8,433 for Moh's micrographic surgery.

sun-protective behaviors consistent with overall tanning reductions—including more frequent Google searches for 'SPF' and increased use of sunscreen—we cannot directly test whether teens substituted away from indoor tanning to outdoor tanning. Such substitution would dampen the public health benefits of these youth tanning prohibitions.

Despite these limitations, our results provide the most comprehensive evidence that youth indoor tanning prohibitions were effective at reducing indoor tanning by youths with little evidence of substitution to other risky behaviors. These results suggest that a federal ban on indoor tanning would likely further reduce indoor tanning by youths and, by implication, the population burden of skin cancer.

BIBLIOGRAPHY

American Academy of Dermatology (2014). "Indoor tanning." Report and position statement at the American Academy of Dermatology website http://www.aad.org/media-resources/stats-and-facts/prevention-and-care/indoor-tanning, accessed September 8, 2014.

American Cancer Society (2021). "Skin cancer." Accessed at: https://www.cancer.org/cancer/skin-cancer.html (May 2021).

Anderson, D. Mark (2014). "In school and out of trouble? The minimum dropout age and juvenile crime," *Review of Economics and Statistics*, 96(2): 318-331.

Anderson, D. Mark and Joseph J. Sabia (2018). "Child access prevention laws, youth gun carrying, and school shootings," *Journal of Law and Economics*, 61(3): 489-524.

Argys, Laura M., Thomas A. Mroz, and Melinda M. Pitts (2019). "Driven from work: Graduated driver license programs and teen labor market outcomes," Working Paper No. 2019-16. Federal Reserve Bank of Atlanta, Accessed at: https://www.econstor.eu/bitstream/10419/228246/1/1670332020.pdf.

Asgeirsdottir, Tinna Laufey, Hope Corman, Kelly Noonan, and Nancy E. Reichman (2016). "Lifecycle effects of a recession on health behaviors: Boom, bust, and recovery in Iceland," *Economics and Human Biology*, 20: 90-107.

Barnatchez, Keith, Leland D. Crane, and Ryan A. Decker (2017). "An assessment of the National Establishment Time Series (NETS) database," *Finance and Economics Discussion Series 2017-110*, Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.110.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan (2004). "How Much Should We Trust Difference-In-Differences Estimates?," *Quarterly Journal of Economics*.

Blashill, Aaron J., and Sherry Pagoto (2017). "Effect of Legislation on Indoor Tanning Prevalence in Alabama," *American Journal of Public Health*, 107(6): 966-968.

Boruysak, Kirill, Xavier Jaravel, and Jann Spiess (2021). "Revisiting event study designs: Robust and efficient estimation," *Working Paper*, Accessed at: https://6cd96a90-e111-4c99-bb2c-0fdc17ec7c2d.filesusr.com/ugd/bacd2d_c1d299c975204d57b2067545d51630e2.pdf

Bryan, Calvin, Benjamin Hansen, Drew McNichols, and Joseph J. Sabia (2020). "Do State Tobacco 21 Laws Work?" NBER Working Paper #28173.

Burbidge, John B., Lonnie Magee, and A. Leslie Robb (1988). "Alternative transformations to handle extreme values of the dependent variable," *Journal of the American Statistical Association*, 83(401): 123-127.

Bureau of Labor Statistics (2021). "Local area unemployment statistics," Accessed at: https://www.bls.gov/lau/ (June 2021).

Callaway, Brant and Pedro H.C. Sant'Anna (2020, forthcoming). "Difference-in-differences with multiple time periods," *Journal of Econometrics*, forthcoming.

Cameron, A. Colin and Douglas L. Miller (2015). "A practitioner's guide to cluster-robust inference," *The Journal of Human Resources*, 50(2): 317-372.

Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller (2008). "). Bootstrap-based improvements for inference with clustered errors," *The Review of Economics and Statistics*, 90(3): 414-427.

Carpenter, Christopher and Carlos Dobkin (2009). "The effect of alcohol consumption on mortality: Regression discontinuity evidence from the minimum drinking age," *American Economic Journal: Applied Economics*, 1(1): 164-182.

Choy, Courtney C., Brenda Cartmel, Rachel A. Clare, and Leah M. Ferrucci (2017). "Compliance with indoor tanning bans for minors among businesses in the USA," *TBM*, 7: 637-644.

Cokkinides, Vilma, Martin Weinstock, DeAnn Lazovich, Elizabeth Ward, and Michael Thun (2009). "Indoor Tanning Use Among Adolescents in the US, 1998 to 2004," *Cancer*, 190-198.

Coups, Elliot J., Jerod L. Stapleton, and Cristine D. Delnevo (2016). "Indoor tanning among New Jersey high school students before and after the enactment of youth access restrictions," *Journal of the American Academy of Dermatology*, 75(2): 440-442.

De Chaisemartin, Clement, and Xavier d'Haultfoeuille (2020). "Two-way fixed effects estimators with heterogeneous treatment effects," *American Economic Review*, 110(9), 2964-96.

Dee, Thomas S. (1999). "State alcohol policies, teen drinking and traffic fatalities," *Journal of Public Economics*, 72(2): 289-315.

Dickie, Mark and Shelby Gerking (1997). "Genetic Risk Factors and Offsetting Behavior: The Case of Skin Cancer," *Journal of Risk and Uncertainty*, 15: 81-97.

Food and Drug Administration (2017). "Sun protection factor (SPF)," Accessed at: https://www.fda.gov/about-fda/center-drug-evaluation-and-research-cder/sun-protection-factor-spf (May 2021).

Food and Drug Administration (2015). "Indoor tanning: The risks of ultraviolet rays," Accessed at: https://www.fda.gov/consumers/consumer-updates/indoor-tanning-risks-ultraviolet-rays. (May 2021).

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

Goodman-Bacon, Andrew (2021, forthcoming). "Difference-in-differences with variation in treatment timing," *Journal of Econometrics*, forthcoming.

Gruber, Jonathan and Jonathan Zinman (2001). "Youth Smoking in the United States: Evidence and Implications," in *Risky Behavior among Youths: An Economic Analysis*, Jonathan Gruber, Ed. University of Chicago Press: Chicago, Illinois.

Guy, Gery P., Meg Watson, Andrew B. Seidenberg, Anne M. Hartman, Dawn M. Holman, and Frank Perna (2017). "Trends in indoor tanning and its association with sunburn among US adults," *Journal of the American Academy of Dermatology*, 76(6): 1191-1193.

Guy, Gery P., Zahava Berkowitz, Dawn M. Holman, and Anne M. Hartman (2015). "Recent changes in the prevalence of and factors associated with frequency of indoor tanning among US adults," *Journal of the American Medical Association: Dermatology*, 151(11): 1256-1259.

Guy, Gery P., Zahava Berkowitz, Sherry E. Jones, Emily O. Olsen, Justin N. Miyamoto, Shannon L. Michael, and Mona Saraiya (2014). "State Indoor Tanning Laws and Adolescent Indoor Tanning," *American Journal of Public Health*, 104(4): e69-e74.

Heckman, Carolyn, Yong Lin, Mary Riley, Yaqun Wang, Trishnee Bhurosy, Anna Mitarotondo, Baichen Xu, and Jerod Stapleton (2021). "Association between state indoor tanning legislation and Google search trends data in the United States from 2006 to 2019: Time-series analysis," *Journal of Medical Internet Research: Dermatology*, 4(1). Accessed at: https://derma.jmir.org/2021/1/e26707.

Hester, Eric, Lauren Heilig, Renee D'Ambrosia, Amanda Drake, Lisa Schilling, and Robert Dellavalle (2005). "Compliance with Youth Access Regulations for Indoor UV Tanning," *Archives of Dermatology*, 141: 959-962.

Holman, Dawn, Kathleen Fox, Jeffrey Glenn, Gery Guy, Meg Watson, Katie Baker, Vilma Cokkinides, Mark Gottlieb, DeAnn Lazovich, Frank Perna, Blake Sampson, Andrew Seidenberg, Craig Sinclair, and Alan Geller (2013). "Strategies to Reduce Indoor Tanning: Current Research Gaps and Future Opportunities for Prevention," *American Journal of Preventive Medicine*, 44(6): 672-681.

Huh, Jason U. and Julian Reif (forthcoming). "Teenage driving, mortality, and risky behaviors," *American Economic Review: Insights*, forthcoming.

IARC Working Group (2006). "The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: a systematic review," *International Journal of Cancer*, 120: 1116-1122.

IBISWorld (2021). "Tanning Salons in the US," Industry Report 81219C.

Internal Revenue Service (2021). "Excise Tax on Indoor Tanning Services Frequently Asked Questions," Accessed at: https://www.irs.gov/businesses/small-businesses-self-employed/excise-tax-on-indoor-tanning-services-frequently-asked-questions (May 2021).

Kaiser Family Foundation (2021). "Status of state action on the Medicaid expansion decision," Accessed at: https://www.kff.org/health-reform/state-indicator/state-activity-around-expanding-medicaid-under-the-affordable-care-act (June 2021).

Kaiser, Micha, Jorg Schiller, and Christopher Schreckenberger (2018). "The effectiveness of a population-based skin cancer screening program: evidence from Germany," *European Journal of Health Econmics*, 19: 355-367.

Kittinger, Benjamin J., Jennifer, Gosney, and Raman Mahabir (2014). "Cost-effective treatment of basal cell carcinoma: Moh's surgery or surgical excision?" *Plastic and Reconstructive Surgery*, 134(4S-1): 147-148.

Longo, M. I., J. L. Bulliard, O. Correia, H. Maier, S. M. Magnusson, P. Konno, N. Goad, A. F. Duarte, J. Olah, L. T. N. Nilsen, K. Peris, R. Karls, A. M. Forsea, and V. del Marmol (2019). "Sunbed use legislation in Europe: assessment of current status," *Journal of the European Academy of Dermatology and Venereology*, 33(S2): 89-96.

Mariotto, Angela B., K. Robin Yabroff, Yongwu Shao, Eric J. Feuer, and Martin L. Brown (2011). "Projections of the cost of cancer care in the United States: 2010-2020," *Journal of the National Cancer Institute*, 103(2): 117-128.

Mayer, Joni A., Susan I. Woodruff, Donald J. Slymen, James F. Sallis, Jean L. Forster, Elizabeth J. Clapp, Katherine D. Hoerster, Latrice C. Pichon, John R. Weeks, George E. Belch, Martin A. Weinstock, and Todd Gilmer (2011). "Adolescents' Use of Indoor Tanning: A Large-Scale Evaluation of Psychosocial, Environmental, and Policy-Level Correlates," *American Journal of Public Health*, 101(5): 930-938.

Neumark, David and Jed Kolko (2010). "Do enterprise zones create jobs? Evidence from California's enterprise zone program," *Journal of Urban Economics* 68(1): 1-19.

Patterson, Bridget, Dawn M. Holman, Jin Qin, Kimberly Smith, and Ying Zhou (2021). "Examination of laws allowing sunscreen use in schools in the context of UV levels by state," *Journal of Adolescent Health*, 68: 407-410.

Pichon, Latrice, Joni Mayer, Katherine Hoerster, Susan Woodruff, Donald Slymen, George Belch, Elizabeth Clapp, Ami Hurd, Jean Forster, and Martin Weinstock (2009). "Youth Access to Artificial UV Radiation Exposure: Practices of 3647 US Indoor Tanning Facilities," *Archives of Dermatology*, 145(9): 997-1002.

Qin, Jin, Dawn M. Holman, Sherry E. Jones, Zahava Berkowitz, and Gery P. Guy Jr. (2018). "State indoor tanning laws and prevalence of indoor tanning among US high school students, 2009-2015," *American Journal of Public Health*, 108(7): 951-956.

Reimann, Jessica, Jennifer E. McWhirter, Andrew Papadopoulos, and Cate Dewey (2018). "A systematic review of compliance with indoor tanning legislation," *BMC: Public Health*, 18-1096.

Seidenberg, Andrew B., Aditya Mahalingam-Dhingra, Martin A. Weinstock, Craig Sinclair, and Alan C. Geller (2015). "Youth indoor tanning and skin cancer prevention: Lessons from tobacco control," *American Journal of Preventive Medicine*, 48(2): 188-194.

Vaghul, Kavya and Ben Zipperer (2016). "Historical state and sub-state minimum wage data," Washington Center for Equitable Growth, Accessed at: https://github.com/benzipperer/historicalminwage

Watson, Meg, Dawn Holman, Kathleen Fox, Gery Guy, Andrew Seidenberg, Blake Sampson, Craig Sinclair, and DeAnn Lazovich (2013). "Preventing Skin Cancer Through Reduction of Indoor Tanning: Current Evidence," *American Journal of Preventive Medicine*, 44(6): 682-689.

Wehner, Mackenzie R., Mary-Margaret Chren, Danielle Nameth, Aditi Choudhry, Matthew Gaskins, Kevin T. Nead, W. John Boscardin, and Eleni Linos (2014). "International prevalence of indoor tanning: A systematic review and meta-analysis," *Journal of the American Medical Association: Dermatology*, 150(4): 390-400.

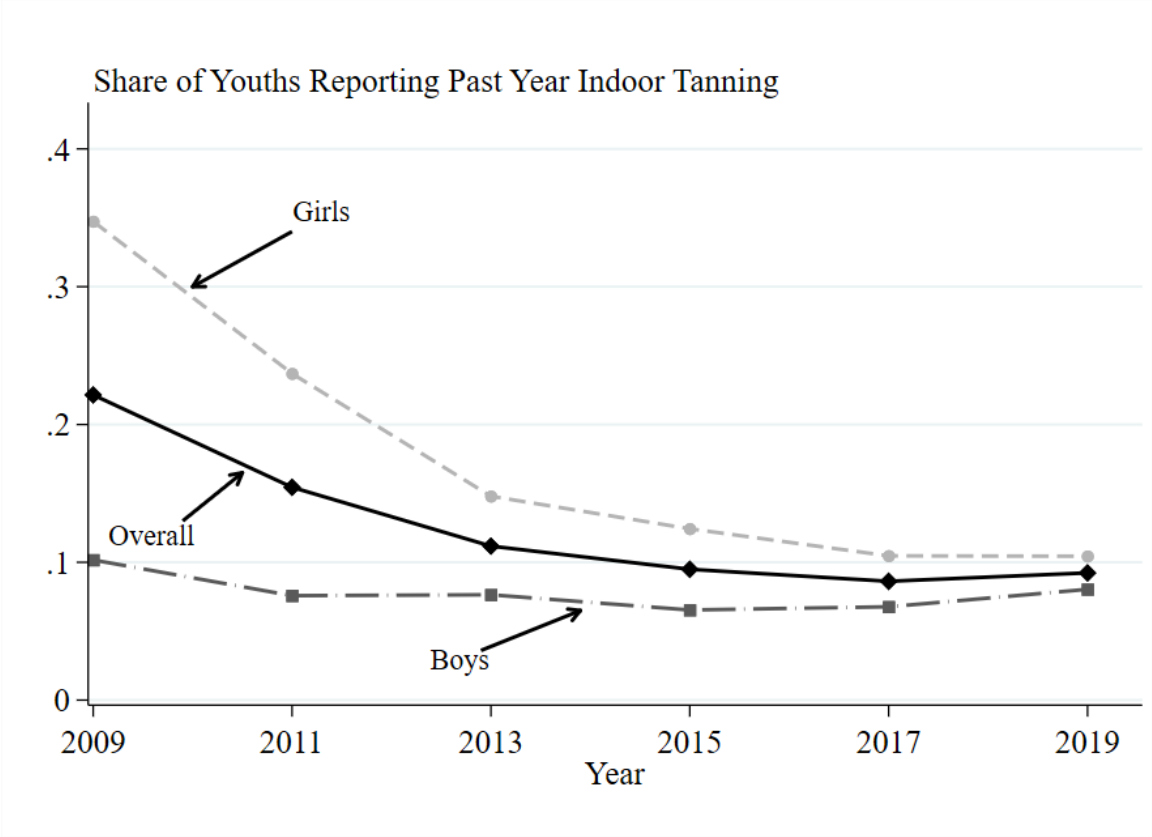
Williams, Melissa S., Brittany Buhalog, Laura Blumenthal, and Erik J. Stratman (2017). "Tanning salon compliance rates in states with legislation to protect youth access to UV tanning," *Journal of the American Medical Association: Dermatology*, 154(1): 67-72.

Wolfers, Justin (2006). "Did unilateral divorce laws raise divorce rates? A reconciliation and new results," *American Economic Review*, 96(2): 1802-1820.

World Health Organization (2017). "More can be done to restrict sunbeds to prevent increasing rates of skin cancer." Accessed at: https://www.who.int/phe/news/sunbeds-skin-cancer/en/ (May 2021).

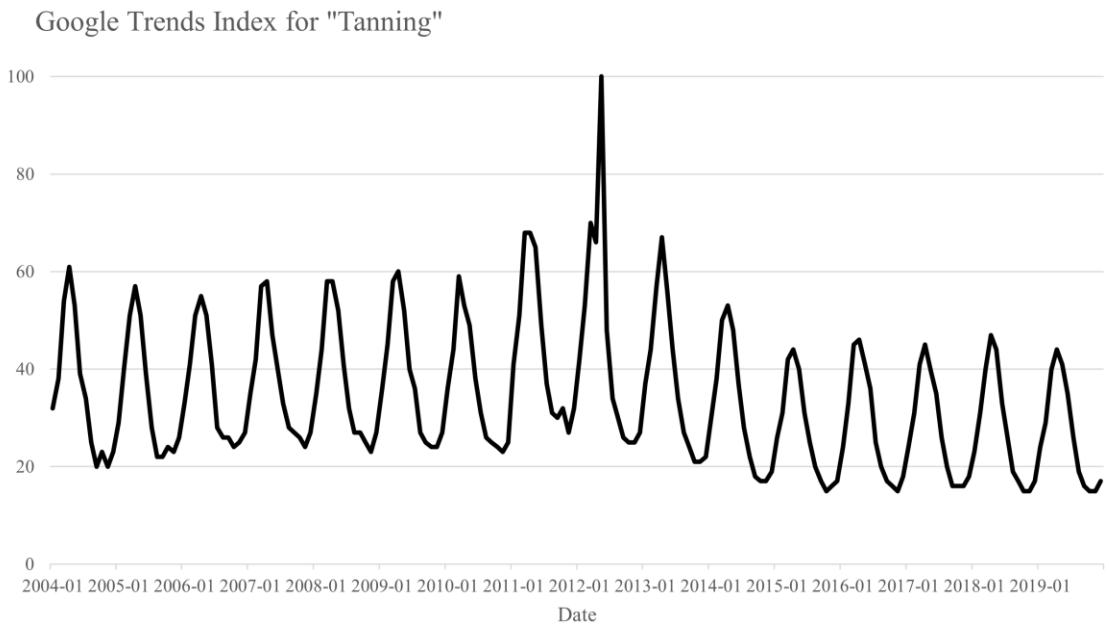
Yaniv, Gideon and Erez Siniver (2015). "Indoor Tanning, Sunbathing, and the Hazard of Skin Cancer: The Effect of the Tan Tax," *Theoretical Economics Letters*, 5: 36-43.

Figure 1
Trends in Self-Reported Indoor Tanning
2009-2019 State YRBS



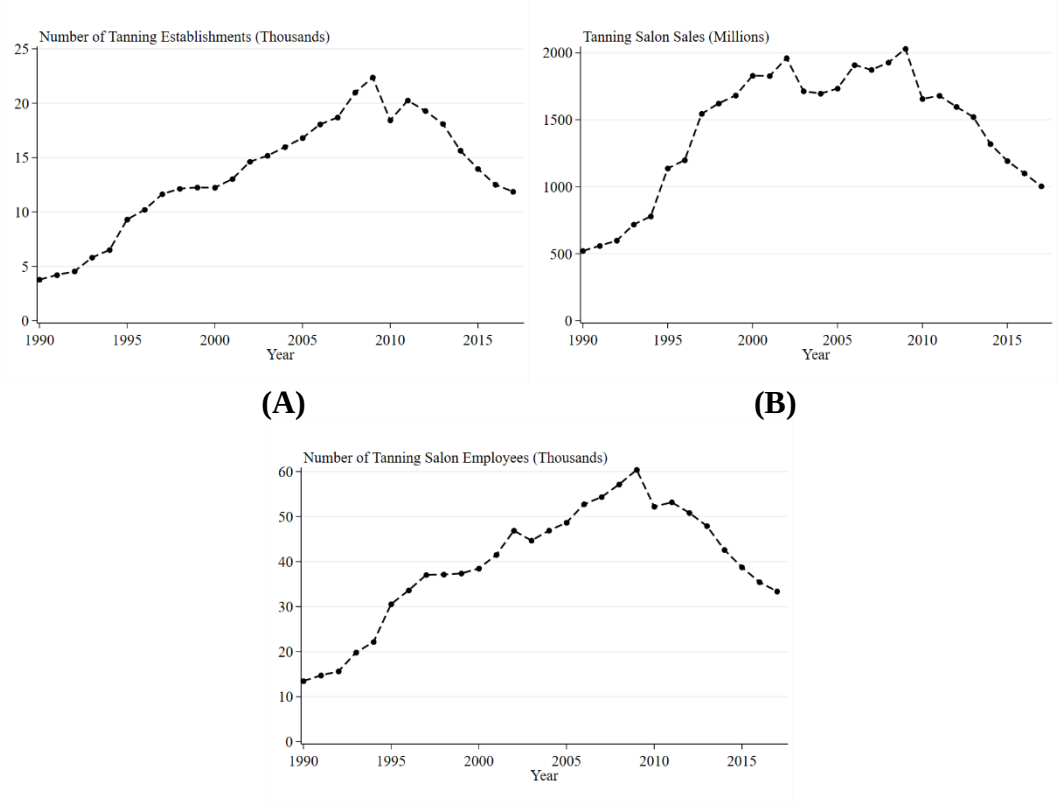
Source: State Youth Risk Behavior Survey, 2009-2019
Note: Figure shows the share of youths reporting past year indoor tanning over time and by gender. Summary statistics utilize the sample weights.

Figure 2
Google Trends Search Popularity for 'Tanning', 2004-2019



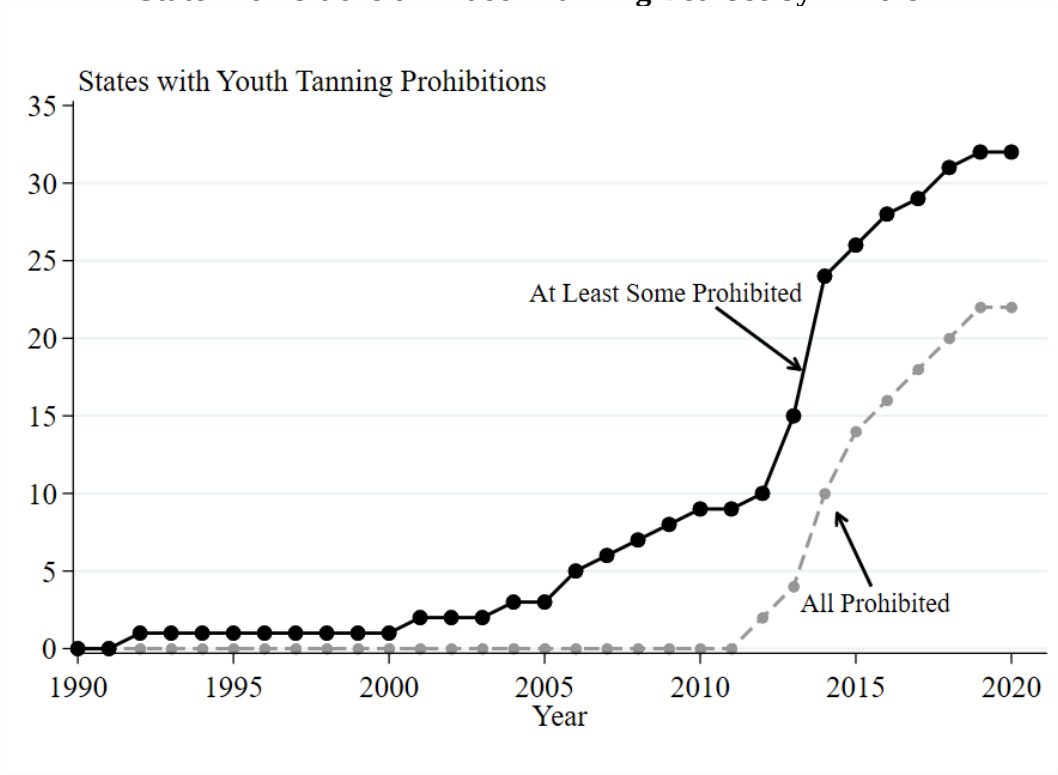
Source: Google Trends Data, 2004-2019
Note: Figure shows national Google trend in searches for 'Tanning' at the year-by-month level. The y-axis shows relative search popularity on a scale of 1 to 100, where the data are normalized relative to the highest point, which is given a value of 100.

Figure 3
Trends in Establishments, Sales, and Employment at Tanning Salons in the US, 1990-2017



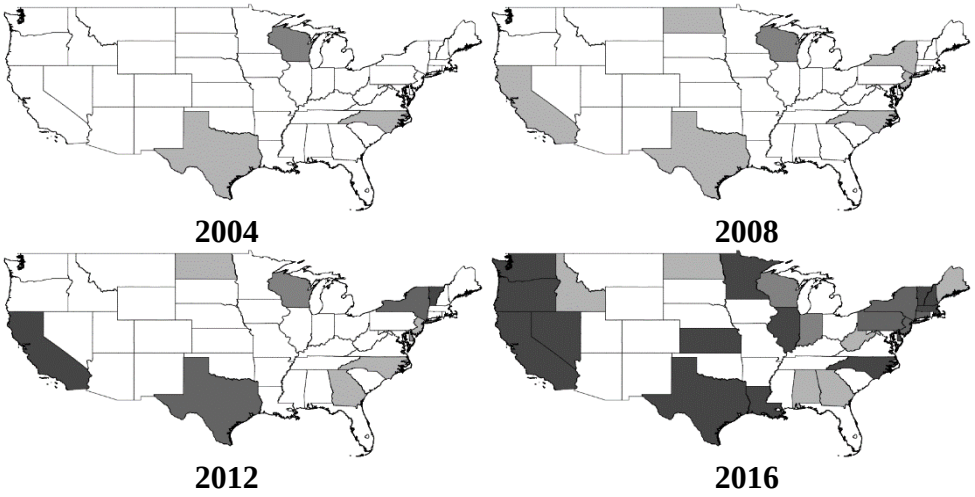
Source: National Establishment Time-Series, 1990-2017
Note: Panel (A) depicts the total number of tanning establishments in the US over time in thousands, Panel (B) shows the real value of total tanning salon sales in millions, and Panel (C) reports the number of workers employed by tanning salons in thousands.

Figure 4
State Prohibitions on Indoor Tanning Bed Use by Minors



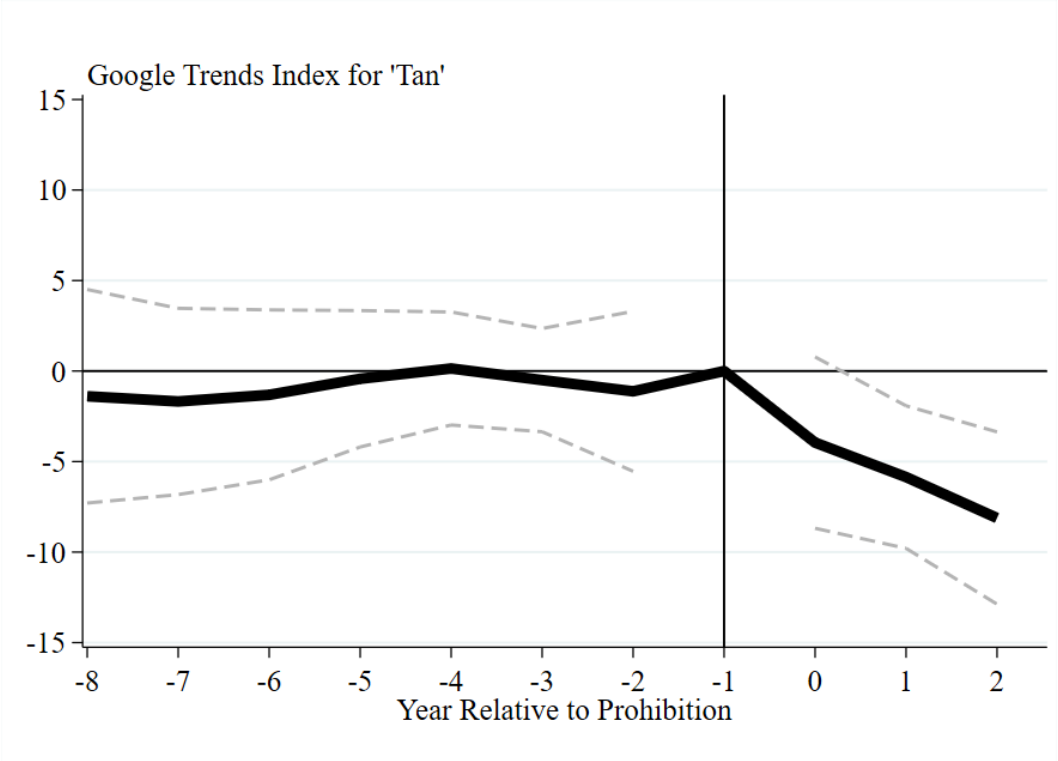
Source: Original analysis of statutes from Westlaw and Lexis-Nexis.
Note: The solid dark line depicts the number of states prohibiting at least some minors from using indoor tanning beds, while the lighter dashed line shows the number of states prohibiting all minors from tanning.

Figure 5
Spatial and Temporal Variation in Legislation
Prohibiting Minors' Tanning Bed Use



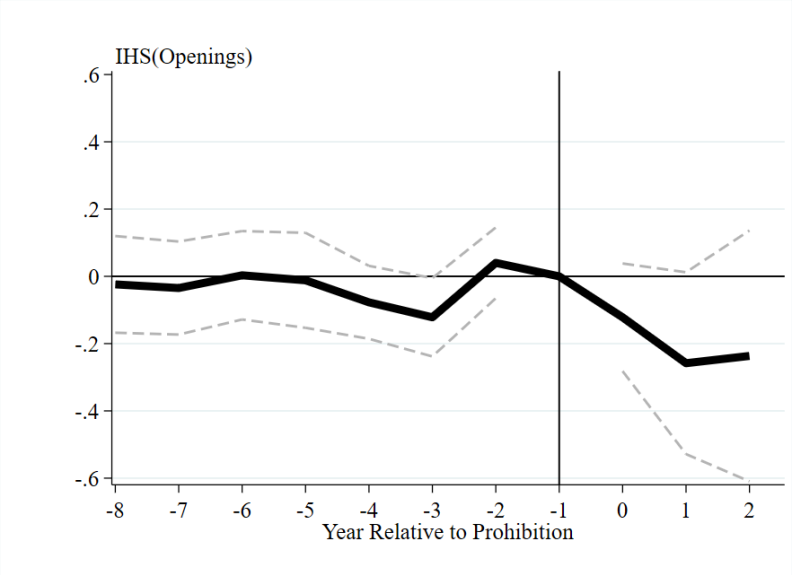
Note: The figures depict – for four representative years (2004, 2008, 2012, and 2016) – the share of teenagers in each state prohibited from using a tanning bed, ranging from no prohibition (no shading) up through all teenagers below age 18 prohibited from using a tanning bed (darkest shading).

Figure 6
Event Study Estimates of Youth Indoor Tanning Prohibitions on Google Trends Searches for 'Tan'

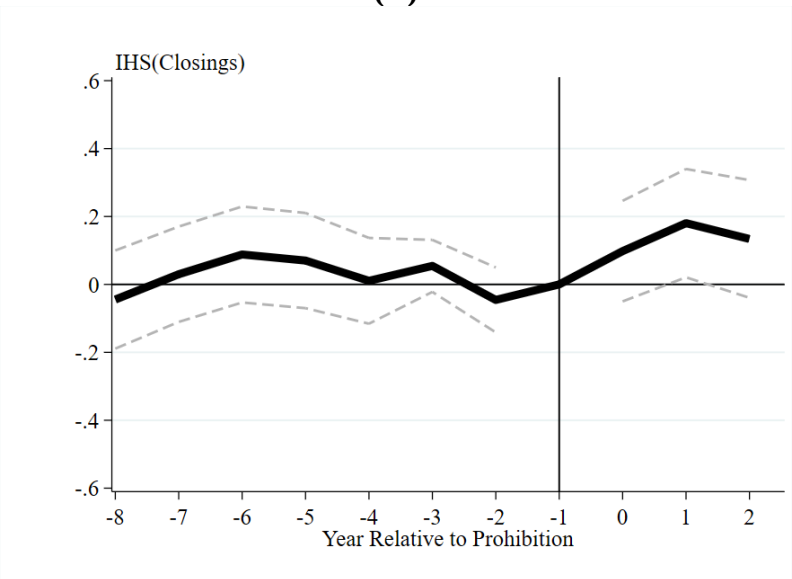


Source: Google Trends Data, 2004-2018
Note: The figure plots the event-study coefficients (solid black line) from equation (2), as well as the associated 95 percent confidence interval (dashed grey lines). The dependent variable is average annual Google Trends Index measuring relative search intensity for the word "tan" during a given year. The independent variables of interest are indicators measuring the year relative to the first law prohibiting minors from using indoor tanning beds. In the post-period, these indicators are interacted with the share of teens prohibited from tanning. We restrict the sample to a balanced panel of states during the event window. The regression includes the full set of controls from equation (2). Standard errors are clustered at the state level.

Figure 7
Event-Study Estimates of Youth Indoor Tanning Prohibitions on Openings and Closings within the Indoor Tanning Salon Industry



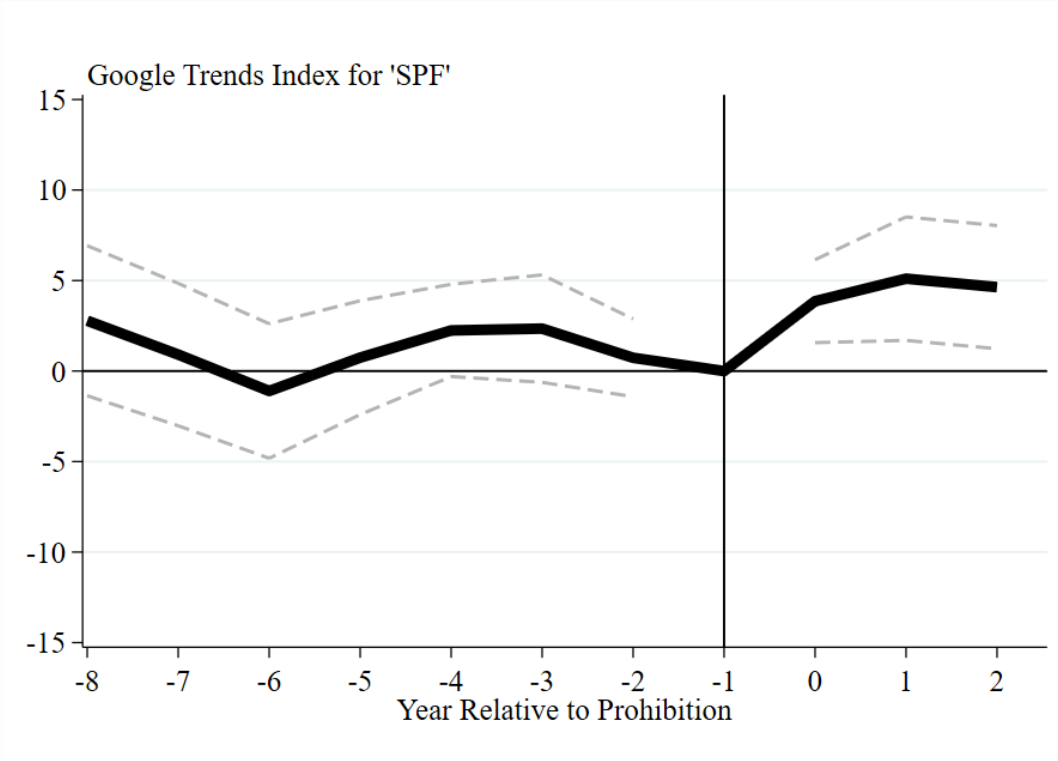
(A)



(B)

Note: The dependent variable in Panel (A) is the inverse hyperbolic sine of the number of county level tanning establishment openings, while the dependent variable in Panel (B) is the inverse hyperbolic sine of the number of tanning establishment closings. The solid dark line is the event study estimate where the post-period indicators are interacted with the share of teens covered by the requirement. The lighter dashed lines are the 95 percent confidence intervals. We restrict the sample to a balanced panel of states during the event window. The regression includes the full set of controls from equation (6). Estimates are weighted by county population.

Figure 8
Event Study Estimates of Youth Indoor Tanning Prohibitions on Google Trends Searches for 'SPF'



Source: Google Trends Data, 2004-2018
Note: The figure plots the event-study coefficients (solid black line) from equation (2), as well as the associated 95 percent confidence interval (dashed grey lines). The dependent variable is average annual Google Trends Index measuring relative search intensity for the phrase 'SPF' during a given year. The independent variables of interest are indicators measuring the year relative to the first law prohibiting minors from using indoor tanning beds. In the post-period, these indicators are interacted with the share of teens prohibited from tanning. We restrict the sample to a balanced panel of states during the event window. The regression includes the full set of controls from equation (2). Standard errors are clustered at the state level.

Table 1
Youth Indoor Tanning Prohibitions Reduced Tanning-Related Searches
Google Trends, 2004-2018

	(1) Tan	(2) Tanning	(3) Tanning Salon
Share Prohibited	-5.358**	-3.205***	-3.091**
	(2.298)	(1.184)	(1.500)
Mean	48.496	32.581	15.225
R^2	0.656	0.613	0.272
Observations	9,180	9,180	8,100

Source: Google Trends Data, 2004-2018
Notes: The dependent variable in column (1) is the Google Trends Index for the word "tan." Similarly, the dependent variable in column (2) is the Index for the word 'tanning' and in column (3) the Index for the phrase 'tanning salon.' The independent variable of interest is the fraction of teens in the state prohibited from indoor tanning. The regression includes the full set of controls from equation (1). Standard errors, shown in parentheses, are clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 2
Youth Indoor Tanning Prohibitions Reduced Self-Reported Indoor Tanning
State YRBS 2009-2019, White Girls

	(1) White Girls	(2) White Girls	(3) White Girls	(4) White Girls
Panel A. ***Any Past Year Indoor Tanning***				
Prohibited	-0.112***	-0.056***	-0.051**	-0.123***
	(0.020)	(0.010)	(0.021)	(0.024)
	[0.003]	[0.046]	[0.352]	[0.216]
Mean	0.175	0.175	0.175	0.175
R^2	0.057	0.082	0.083	0.092
Observations	78,922	78,922	78,922	78,922
Panel B. ***IHS(Number of Times Tanning)***				
Prohibited	-0.327***	-0.141***	-0.124	-0.556***
	(0.065)	(0.036)	(0.081)	(0.117)
	[0.009]	[0.107]	[0.475]	[0.172]
Mean	2.324	2.324	2.324	2.324
R^2	0.062	0.093	0.095	0.107
Observations	78,922	78,922	78,922	78,922
Individual Demographics?	Y	Y	Y	Y
State-Level Time Varying Controls?	Y	Y	Y	Y
State and Year FE?		Y	Y	Y
State-Specific Linear Time Trends?			Y	
State-Age, Year-Age, and State-Year FE?				Y

Source: State Youth Risk Behavior Survey, 2009-2019

Note: The dependent variable in Panel (A) is an indicator for whether the teen reported any indoor tanning bed use during the prior year. The dependent variable in Panel (B) is the inverse hyperbolic sine of the number of times using indoor tanning during the prior year. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. Column (1) includes indicators for the teen's age (≤ 12, 13, 14, 15, 16, 17, with 18+ omitted) and state-level time varying covariates, including an indicator for the presence of a graduated driver's license law, an indicator for whether the state had expanded Medicaid as part of the Affordable Care Act, an indicator for the presence of a SUNucate law, the annual state-level unemployment rate, the natural log of the real value of the state cigarette excise tax, and the natural log of the real value of the effective minimum wage. The specification also controls for the share of teens required to have a parent presence to use an indoor tanning bed, the share of teens required to obtain parental consent to use an indoor tanning bed, and an indicator for whether the tanning salon is required to provide general safety information. Column (2) also includes time-invariant state fixed effects and location-invariant year fixed effects. Column (3) augments this specification with state-specific linear time trends. Finally, column (4) replaces the state-specific trends with a full set of state-by-age, year-by-age, and state-by-year fixed effects. Standard errors, shown in parentheses, are clustered at the state level. Given the small number of treated clusters, inference is also conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 3
Youth Indoor Tanning Prohibitions Did Not Affect Indoor Tanning for Boys or Black Girls
State YRBS 2009-2019

Sample is ➔	(1) White Girls	(2) Black Girls	(3) White Boys	(4) Black Boys
Panel A. ***Any Past Year Indoor Tanning***				
Prohibited	-0.056***	-0.020	-0.008	-0.001
	(0.010)	(0.025)	(0.006)	(0.009)
	[0.046]	[0.715]	[0.355]	[0.905]
Mean	0.175	0.058	0.061	0.101
R^2	0.082	0.023	0.016	0.012
Observations	78,922	16,117	76,435	14,854
Panel B. ***IHS(Number of Times Tanning)***				
Prohibited	-0.141***	-0.066	-0.005	0.009
	(0.036)	(0.065)	(0.021)	(0.028)
	[0.107]	[0.540]	[0.931]	[0.764]
Mean	2.324	0.438	0.645	0.955
R^2	0.093	0.020	0.014	0.014
Observations	78,922	16,117	76,435	14,854

Source: State Youth Risk Behavior Survey, 2009-2019
Note: The dependent variable in Panel (A) is an indicator for whether the teen reported any indoor tanning bed use during the prior year. The dependent variable in Panel (B) is the inverse hyperbolic sine of the number of times using indoor tanning during the prior year. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. The regressions include the controls from column (2) of Table 2. Column (1) reprints the baseline estimate for white girls from Table 2. Column (2) limits the sample to black girls, column (3) to white boys, and column (4) to black boys. Standard errors, shown in parentheses, are clustered at the state level. Given the small number of treated clusters, inference is conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 4
Youth Indoor Tanning Prohibitions Increased Tanning Salon Closures
NETS 1990-2017

Outcome is ➔	(1) OLS on inverse hyperbolic sine transformation on the **number of tanning salon openings**	(2) OLS on inverse hyperbolic sine transformation on the **number of tanning salon closures**
Share Prohibited	-0.105	0.159***
	(0.073)	(0.058)
R^2	0.728	0.729
Observations	87,628	87,628

Source: National Establishment Time-Series, 1990-2017

Note: The dependent variable in column (1) is the inverse hyperbolic sine of the number of tanning salon openings in a county during a given year, while the dependent variable in column (2) is the inverse hyperbolic sine of the number of tanning salon closures in a county during a given year. Columns (1) and (2) are estimated using ordinary least squares. The independent variable of interest is the share of teens in a county prohibited from using an indoor tanning bed. The regressions include state-level time varying controls, including an indicator for the presence of a graduated driver's license law, an indicator for whether the state had expanded Medicaid as part of the Affordable Care Act, an indicator for the presence of a SUNucate law, the natural log of the real value of the state cigarette excise tax, and the natural log of the real value of the effective minimum wage. The regressions also control for the share of teens required to have a parent presence to use an indoor tanning bed, the share of teens required to obtain parental consent to use an indoor tanning bed, and an indicator for whether the tanning salon is required to provide general safety information. The regressions also include the county-level unemployment rate, time-invariant county fixed effects, and location-invariant year fixed effects. The estimates are weighted by county population. Standard errors, shown in parentheses, are clustered at the state level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 5
Youth Indoor Tanning Prohibitions Reduced Tanning Salon Sales
NETS 1990-2017

	(1) ln(Annual Sales)	(2) ln(Annual Sales)	(3) ln(Employees)	(4) ln(Employees)
Share Prohibited	-0.065**	-0.033**	-0.043	-0.024
	(0.025)	(0.014)	(0.026)	(0.014)
State-Level Time Varying Controls?	Y	Y	Y	Y
County and Year FE?	Y		Y	
Establishment and Year FE?		Y		Y
R^2	0.138	0.812	0.063	0.817
Observations	377,533	377,533	377,533	377,533

Source: National Establishment Time-Series, 1990-2017

Note: The dependent variable in columns (1) and (2) is the natural log of annual sales at an establishment during a given year. The dependent variable in columns (3) and (4) is the natural log of the number of employees at an establishment during a given year. The independent variable of interest is the share of teens in a county prohibited from using an indoor tanning bed. The regressions also control for the share of teens required to have a parent presence to use an indoor tanning bed, the share of teens required to obtain parental consent to use an indoor tanning bed, and an indicator for whether the tanning salon is required to provide general safety information. The regressions include state-level time varying controls, including an indicator for the presence of a graduated driver's license law, an indicator for whether the state had expanded Medicaid as part of the Affordable Care Act, an indicator for the presence of a SUNucate law, the natural log of the real value of the state cigarette excise tax, and the natural log of the real value of the effective minimum wage, and the annual county-level unemployment rate. Columns (1) and (3) include time-invariant county fixed effects and location-invariant year fixed effects. Columns (2) and (4) include time-invariant establishment fixed effects and location-invariant year fixed effects. The estimates are weighted by county population. Standard errors, shown in parentheses, are clustered at the state level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 6
Youth Indoor Tanning Prohibitions Had Larger Negative Sales Effects for Establishments Near Schools
NETS 1990-2017

	(1)	(2)	(3)	(4)	(5)	(6)
	ln(Annual Sales)			ln(Employees)		
'Nearby' is ➔	500 Meters	1000 Meters	2000 Meters	500 Meters	1000 Meters	2000 Meters
Share Prohibited × No Nearby School	-0.029*	-0.031**	-0.038*	-0.021	-0.022	-0.030
	(0.015)	(0.015)	(0.021)	(0.016)	(0.015)	(0.022)
Share Prohibited × Any Nearby School	-0.055**	-0.035*	-0.032**	-0.034	-0.026	-0.022
	(0.022)	(0.016)	(0.014)	(0.023)	(0.016)	(0.014)
State-Level Time Varying Controls?	Y	Y	Y	Y	Y	Y
Establishment and Year FE?	Y	Y	Y	Y	Y	Y
R^2	0.812	0.812	0.812	0.817	0.817	0.817
Observations	377,533	377,533	377,533	377,533	377,533	377,533

Source: National Establishment Time-Series, 1990-2017

Note: The dependent variable in columns (1)-(3) is the natural log of annual sales at an establishment during a given year. The dependent variable in columns (4)-(6) is the natural log of the number of employees at an establishment during a given year. The independent variables of interest are the share of teens in a county prohibited from using an indoor tanning bed, as well as this measure interacted with indicators for whether or not the establishment has any nearby white girls in grades 7-12. In columns (1) and (4), the indicator denotes the presence of these girls within 500 meters of the establishment, in columns (2) and (5) 1000 meters, and in columns (3) and (6) 2000 meters. The regressions also control for the share of teens required to have a parent presence to use an indoor tanning bed, the share of teens required to obtain parental consent to use an indoor tanning bed, and an indicator for whether the tanning salon is required to provide general safety information. The regressions include state-level time varying controls, including an indicator for the presence of a graduated driver's license law, an indicator for whether the state had expanded Medicaid as part of the Affordable Care Act, an indicator for the presence of a SUNucate law, the natural log of the real value of the state cigarette excise tax, and the natural log of the real value of the effective minimum wage, and the annual county-level unemployment rate. Finally, all columns include time-invariant establishment fixed effects and location-invariant year fixed effects. The estimates are weighted by county population. Standard errors, shown in parentheses, are clustered at the state level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 7
Youth Indoor Tanning Prohibitions Increased Searches for Sun Protective Phrases
Google Trends, 2004-2018

	(1) SPF	(2) Sunscreen	(3) UVA	(4) UVB
Share Prohibited	2.783**	2.528*	2.992*	1.332*
	(1.211)	(1.449)	(1.517)	(0.690)
Mean	19.661	19.664	21.345	8.883
R^2	0.400	0.570	0.359	0.182
Observations	9,180	9,180	9,180	9,000

Source: Google Trends Data, 2004-2018
Notes: The dependent variable in column (1) is the Google Trends Index for the phrase 'SPF,' the common abbreviation for 'sun protective factor.' Similarly, the dependent variables in columns (2)-(4) use Google Trends to measure search intensity for the words and phrases 'sunscreen,' 'UVA,' and 'UVB.' The independent variable of interest is the fraction of teens in the state prohibited from indoor tanning. The regression includes the full set of controls from equation (1). Standard errors, shown in parentheses, are clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 8
Youth Indoor Tanning Prohibitions Increased Regular Sunscreen Use for White Girls
State YRBS 2009-2019

	(1)	(2)	(3)	(4)	(5)	(6)
Sample is ➔	White Teen Girls	White Teen Girls	White Teen Girls	Black Teen Girls	White Teen Boys	Black Teen Boys
Prohibited	0.038***	0.042***	0.052***	-0.086**	-0.014	0.010
	(0.007)	(0.005)	(0.004)	(0.035)	(0.010)	(0.026)
	[0.063]	[0.012]	[0.525]	[0.545]	[0.245]	[0.805]
Individual Demographics?	Y	Y	Y	Y	Y	Y
State-Level Time Varying Controls?	Y	Y	Y	Y	Y	Y
State and Year FE?	Y	Y	Y	Y	Y	Y
State-Specific Linear Time Trends?		Y				
State-Age, Year-Age, and State-Year FE?			Y			
Mean	0.179	0.179	0.179	0.052	0.092	0.060
R^2	0.007	0.008	0.013	0.009	0.011	0.015
Observations	15,125	15,125	15,125	2,624	14,537	2,457

Source: State Youth Risk Behavior Survey, 2009-2019

Note: The dependent variable is an indicator for whether the teen regularly used sunscreen. Columns (1)-(3) limit the sample to white teen girls. Column (4) examines black teen girls, column (5) white teen boys, and column (6) black teen girls. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. Columns (1) and (4)-(6) use the baseline difference-in-differences specification from column (2) of Table 2. Column (2) augments this specification with state-specific linear time trends. Column (3) replaces the state-specific trends with a full set of state-by-age, year-by-age, and state-by-year fixed effects. Standard errors, shown in parentheses, are clustered at the state level. Given the small number of treated clusters, inference is conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 9
Youth Indoor Tanning Prohibitions Did Not Affect Other Youth Risky Behaviors
State YRBS 2009-2019, White Girls

Outcome is ➔	(1) Any Smoking in Past Month	(2) Any Drinking in Past Month	(3) Any Sexual Intercourse in Past 3 Months	(4) Currently Trying to Lose Weight	(5) Suicide Ideation in Past Year
Prohibited	-0.001	-0.021	0.012	-0.010	-0.006
	(0.011)	(0.014)	(0.012)	(0.010)	(0.013)
	[0.957]	[0.261]	[0.516]	[0.469]	[0.832]
Mean	0.099	0.312	0.297	0.581	0.201
R^2	0.023	0.042	0.083	0.003	0.007
Observations	77,386	75,830	70,256	62,548	66,428

Source: State Youth Risk Behavior Survey, 2009-2019
Note: The dependent variable in column (1) is an indicator for whether the teen reports smoking during the past month, while the dependent variable in column (2) is an indicator for whether the teen reports drinking alcohol during the past month. The dependent variable in column (3) is an indicator for whether the teen reported having sexual intercourse during the past 3 months, while the dependent variable in column (4) is an indicator for whether the teen is trying to lose weight. Finally, the dependent variable in column (5) is an indicator for whether the teen reports considering suicide. The sample is limited to white teen girls. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. All regressions use the preferred set of controls from column (2) of Table 2. Given the small number of treated clusters, inference is conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

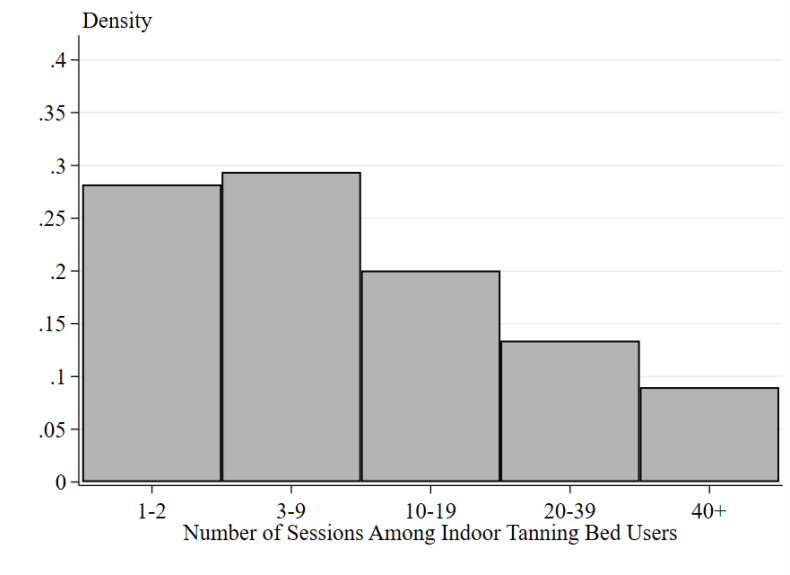
Bad Lighting: Effects of Youth Indoor Tanning Prohibitions

Christopher S. Carpenter, Brandyn F. Churchill, and Michelle Marcus

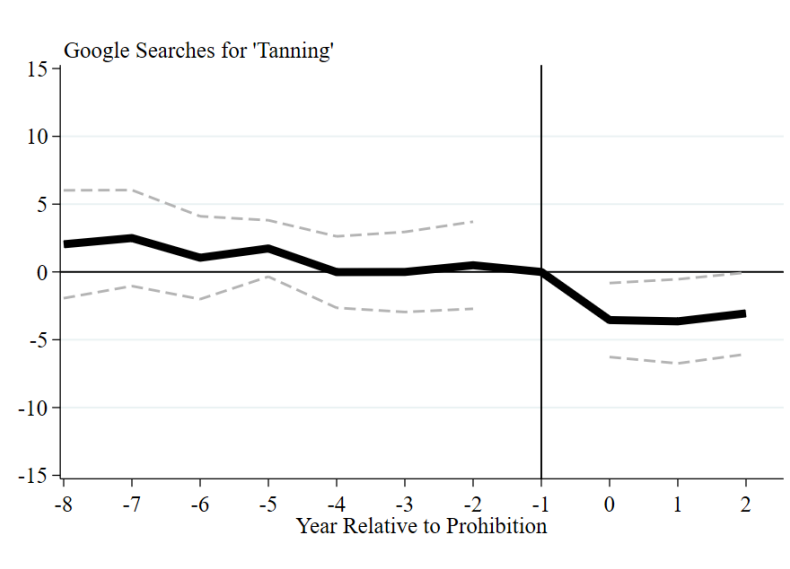
Online Appendix

Appendix A

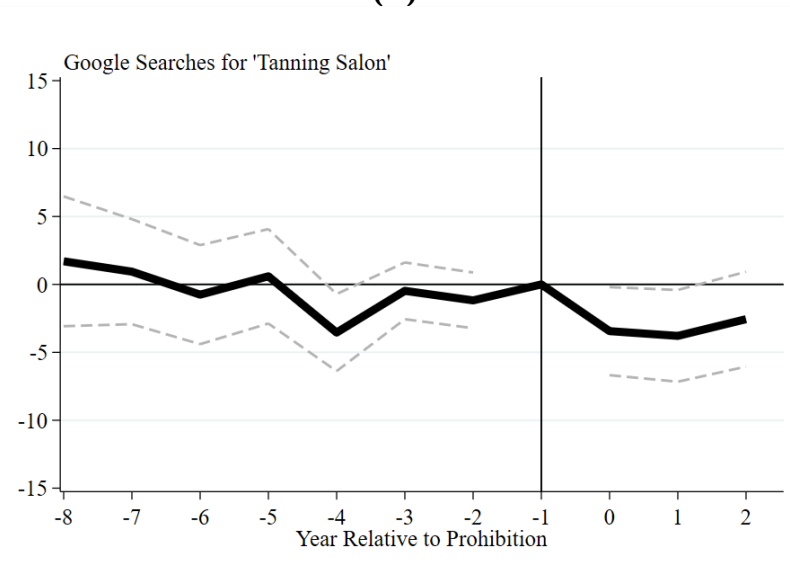
Appendix Figure 1
Distribution of the Number of Times in Past Year White Girls Reported Indoor Tanning, 2009-2019 State YRBS



Appendix Figure 2
Event Study Estimates of Youth Indoor Tanning Prohibitions on Google Trends Searches for 'Tanning' and 'Tanning Salon'



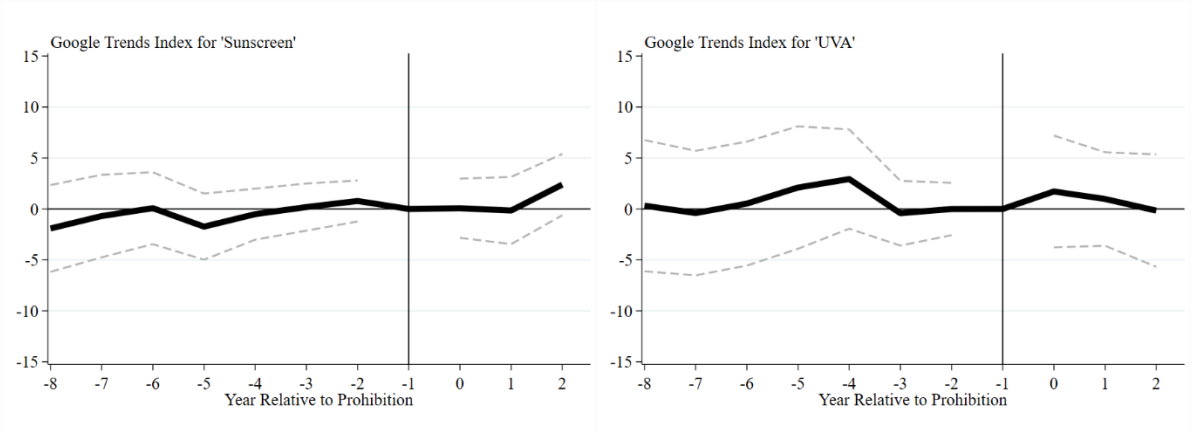
(A)



(B)

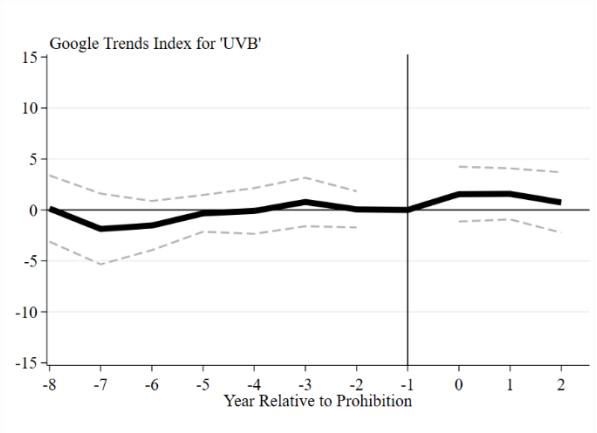
Source: Google Trends Data, 2004-2018
Note: The figure plots the event-study coefficients (solid black line) from equation (2), as well as the associated 95 percent confidence interval (dashed grey lines). The dependent variable in Panel (A) is average annual Google Trends Index measuring relative search intensity for the word 'tanning' during a given year. The dependent variable in Panel (B) is the average annual Google Trends Index measuring relative search intensity for the phrase 'tanning salon.' The independent variables of interest are indicators measuring the year relative to the first law prohibiting minors from using indoor tanning beds. In the post-period, these indicators are interacted with the share of teens prohibited from tanning. Standard errors are clustered at the state level.

Appendix Figure 3
Event Study Estimates of Youth Indoor Tanning Prohibitions on Google Trends Searches for 'Sunscreen,' 'UVA,' and 'UVB'



(A)

(B)



(C)

Source: Google Trends Data, 2004-2018
Note: The figure plots the event-study coefficients (solid black line) from equation (2), as well as the associated 95 percent confidence interval (dashed grey lines). The dependent variable in Panel (A) is average annual Google Trends Index measuring relative search intensity for the word 'sunscreen' during a given year. The dependent variable in Panel (B) is the average annual Google Trends Index measuring relative search intensity for the phrase 'UVA,' and the dependent variable in Panel (C) is the average annual Google Trends Index measuring relative search intensity for the phrase 'UVB.' The independent variables of interest are indicators measuring the year relative to the first law prohibiting minors from using indoor tanning beds. In the post-period, these indicators are interacted with the share of teens prohibited from tanning. Standard errors are clustered at the state level.

Appendix Table 1
National YRBS is Inconclusive About the Effects of Youth Indoor Tanning Prohibitions On Self-Reported Indoor Tanning
National YRBS 2009-2019, White girls

	(1)	(2)	(3)	(4)
Panel A. ***Any past year tanning***				
Prohibited	-0.029	-0.013	0.004	0.024
	(0.027)	(0.033)	(0.046)	(0.029)
	[0.363]	[0.736]	[0.933]	[0.418]
Pre-reform mean	0.302	0.302	0.302	0.302
R squared	0.107	0.141	0.148	0.175
N	15,896	15,896	15,896	15,896
Panel B. ***IHS(Number of Times Tanning)***				
Prohibited	-0.065	-0.004	0.031	0.079
	(0.087)	(0.106)	(0.154)	(0.099)
	[0.491]	[0.974]	[0.865]	[0.437]
Pre-reform mean	1.520	1.520	1.520	1.520
R squared	0.112	0.146	0.153	0.182
N	15,896	15,896	15,896	15,896
Individual demographics?	Y	Y	Y	Y
State/time varying controls?	Y	Y	Y	Y
State and year fixed effects?		Y	Y	Y
Linear state trends?			Y	
State-age, year-age, and state-year fixed effects?				Y

Source: National Youth Risk Behavior Survey, 2009-2019

Note: The dependent variable in Panel (A) is an indicator for whether the teen reported any indoor tanning bed use during the prior year. The dependent variable in Panel (B) is the inverse hyperbolic sine of the number of times using indoor tanning during the prior year. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. Column (1) includes indicators for the teen's age (≤ 12, 13, 14, 15, 16, 17, with 18+ omitted) and state-level time carrying covariates, including an indicator for the presence of a graduated driver's license law, an indicator for whether the state had expanded Medicaid as part of the Affordable Care Act, an indicator for the presence of a SUNucate law, the annual state-level unemployment rate, the natural log of the real value of the state cigarette excise tax, and the natural log of the real value of the effective minimum wage. The specification also controls for the share of teens required to have a parent presence to use an indoor tanning bed, the share of teens required to obtain parental consent to use an indoor tanning bed, and an indicator for whether the tanning salon is required to provide general safety information. Column (2) also includes time-invariant state fixed effects and location-invariant year fixed effects. Column (3) augments this specification with state-specific linear time trends. Finally, column (4) replaces the state-specific trends with a full set of state-by-age, year-by-age, and state-by-year fixed effects. Standard errors, shown in parentheses, are clustered at the state level. Given the small number of treated clusters, inference is conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 2
The Relationship Between Youth Indoor Tanning Prohibitions and Self-Reported Indoor Tanning Is Robust to Excluding Each Treated State
State YRBS 2009-2019, White Girls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Full Sample	Excluded State						
		Idaho	Kansas	New Hampshire	North Carolina	North Dakota	Vermont	Wisconsin
Prohibited	-0.056***	-0.058***	-0.059***	-0.058***	-0.060**	-0.057***	-0.057***	-0.046***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.025)	(0.010)	(0.010)	(0.015)
	[0.046]	[0.047]	[0.035]	[0.031]	[0.599]	[0.066]	[0.039]	[0.272]
Mean	0.175	0.171	0.174	0.173	0.180	0.171	0.173	0.170
R squared	0.082	0.083	0.084	0.083	0.087	0.082	0.082	0.082
N	78,922	75,110	77,777	71,592	75,930	75,750	67,018	77,245

Source: Youth Risk Behavior Surveillance System, 2009-2019

Note: The dependent variable is an indicator for whether the teen reported any indoor tanning bed use during the prior year. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. The regressions include the controls from column (2) of Table 2. Column (1) presents the baseline estimate, while the subsequent columns iteratively drop each state containing a treated observation. Robust standard errors, shown in parentheses, are clustered at the state level. Given the small number of treated clusters, inference is also conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 3
Youth Indoor Tanning Prohibitions Did Not Affect Indoor Tanning for Boys or Black Girls, Triple Difference Specification
State YRBS 2009-2019

	(1)	(2)	(3)	(4)
	White Girls	Black Girls	White Boys	Black Boys
Panel A. ***Any Past Year Indoor Tanning***				
Prohibited	-0.123***	-0.019	-0.049***	-0.000
	(0.024)	(0.012)	(0.009)	(0.029)
	[0.216]	[0.262]	[0.119]	[0.997]
Mean	0.175	0.058	0.061	0.101
R squared	0.092	0.040	0.026	0.038
N	78,922	16,117	76,435	14,854
Panel B. ***IHS(Number of Times Tanning)***				
Prohibited	-0.556***	-0.093*	-0.142***	0.080
	(0.117)	(0.045)	(0.029)	(0.046)
	[0.172]	[0.447]	[0.219]	[0.270]
Mean	2.324	0.438	0.645	0.955
R squared	0.107	0.041	0.025	0.046
N	78,922	16,117	76,435	41,844

Source: Youth Risk Behavior Surveillance System, 2009-2019

Note: The dependent variable in Panel (A) is an indicator for whether the teen reported any indoor tanning bed use during the prior year. The dependent variable in Panel (B) is the inverse hyperbolic sine of the number of times using indoor tanning during the prior year. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. The regressions include the controls from column (4) of Table 2. Column (1) reprints the baseline estimate for white girls from Table 2. Column (2) limits the sample to black girls, column (3) to white boys, and column (4) to black boys. Standard errors, shown in parentheses, are clustered at the state level. Given the small number of treated clusters, inference is conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 4
Robustness of the Effects of Youth Indoor Tanning Prohibitions on Openings and Closings of Tanning Salons
NETS 1990-2017

	(1)	(2)	(3)
*Panel A. Outcome is **IHS(Number of Openings)***			
Share Prohibited	-0.105	-0.194*	-0.047
	(0.073)	(0.106)	(0.092)
R^2	0.728	0.756	0.753
Observations	87,628	87,628	87,628
*Panel B. Outcome is **IHS(Number of Closings)***			
Share Prohibited	0.159***	0.137*	0.087
	(0.058)	(0.078)	(0.057)
R^2	0.729	0.764	0.752
Observations	87,628	87,628	87,628
County and Year FE?	Y	Y	Y
County-Level Time Varying Controls?	Y	Y	Y
County-Specific Linear Time Trends?		Y	
Census Division-by-Year FE?			Y

Source: National Establishment Time-Series, 1990-2017

Note: The dependent variable in Panel A is the inverse hyperbolic sine of the number of tanning salon openings in a county during a given year, while the dependent variable in Panel B is the inverse hyperbolic sine of the number of tanning salon closures in a county during a given year. Column 1 includes the full set of controls from equation (6). Column (2) augments that specification with county-specific linear time trends. Column (3) replaces the county-specific trends with census division-by-year fixed effects. The estimates are weighted by county population. Standard errors, shown in parentheses, are clustered at the state level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 5
Robustness of the Effects of Youth Indoor Tanning Prohibitions on Sales and Employment at Tanning Salon Establishments
NETS 1990-2017

	(1)	(2)	(3)	(4)
*Panel A. Outcome is **ln(Annual Sales)***				
Share Prohibited	-0.033**	-0.029*	-0.019	-0.031***
	(0.014)	(0.015)	(0.014)	(0.010)
R^2	0.812	0.815	0.912	0.813
Observations	377,533	377,533	377,533	377,533
*Panel B. Outcome is **ln(Employees)***				
Share Prohibited	-0.024	-0.024*	-0.015	-0.022
	(0.014)	(0.014)	(0.014)	(0.011)
R^2	0.817	0.820	0.916	0.818
Observations	377,533	377,533	377,533	377,533
Establishment and Year FE?	Y	Y	Y	Y
County-Level Time Varying Controls?	Y	Y	Y	Y
County-Specific Linear Time Trends?		Y		
Establishment-Specific Linear Time Trends?			Y	
Census Division-by-Year FE?				Y

Source: National Establishment Time-Series, 1990-2017

Note: The dependent variable in Panel A is the natural log of the real value of annual sales at the establishment during a given year, while the dependent variable in Panel B is the natural log of the number of employees at the establishment during a given year. Column 1 includes the full set of controls from equation (8). Column (2) augments that specification with county-specific linear time trends. Column (3) replaces the county-specific trends with establishment-specific linear time trends. Column (4) replaces these trends with census division-by-year fixed effects. The estimates are weighted by county population. Standard errors, shown in parentheses, are clustered at the state level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 6
Youth Indoor Tanning Prohibitions Were More Salient For Establishments Near More Adolescent White Girls
NETS 1990-2017

	(1)	(2)	(3)	(4)	(5)	(6)
	ln(Annual Sales)			ln(Employees)		
	500 Meters	1000 Meters	2000 Meters	500 Meters	1000 Meters	2000 Meters
Share Prohibited	-0.028*	-0.041**	-0.039**	-0.021	-0.031*	-0.036**
	(0.014)	(0.017)	(0.015)	(0.015)	(0.017)	(0.022)
Share Prohibited × Number of	-0.225***	0.081	0.019	-0.106	0.085	0.037**
White Girls in Grades 7-12	(0.050)	(0.092)	(0.015)	(0.095)	(0.102)	(0.016)
State-Level Time Varying Controls?	Y	Y	Y	Y	Y	Y
Establishment and Year FE?	Y	Y	Y	Y	Y	Y
R^2	0.812	0.812	0.812	0.817	0.817	0.817
Observations	377,533	377,533	377,533	377,533	377,533	377,533

Source: National Establishment Time-Series, 1990-2017

Note: The dependent variable in columns (1)-(3) is the natural log of annual sales at an establishment during a given year. The dependent variable in columns (4)-(6) is the natural log of the number of employees at an establishment during a given year. The independent variables of interest are the share of teens in a county prohibited from using an indoor tanning bed, as well as this measure interacted with the number (in thousands) of nearby white girls in grades 7-12. In columns (1) and (4), this latter indicator denotes the presence of these girls within 500 meters of the establishment, in columns (2) and (5) 1000 meters, and in columns (3) and (6) 2000 meters. The regressions also control for the share of teens required to have a parent presence to use an indoor tanning bed, the share of teens required to obtain parental consent to use an indoor tanning bed, and an indicator for whether the tanning salon is required to provide general safety information. The regressions include state-level time varying controls, including an indicator for the presence of a graduated driver's license law, an indicator for whether the state had expanded Medicaid as part of the Affordable Care Act, an indicator for the presence of a SUNucate law, the natural log of the real value of the state cigarette excise tax, and the natural log of the real value of the effective minimum wage, and the annual county-level unemployment rate. Finally, all columns include time-invariant establishment fixed effects and location-invariant year fixed effects. The estimates are weighted by county population. Standard errors, shown in parentheses, are clustered at the state level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 7
National YRBS is Inconclusive About the Effects of Youth Indoor Tanning Prohibitions On Regular Sunscreen Use for White Girls
National YRBS 2009-2019

	(1)	(2)	(3)	(4)	(5)	(6)
Sample is ➔	White Teen Girls	White Teen Girls	White Teen Girls	Black Teen Girls	White Teen Boys	Black Teen Boys
Prohibited	-0.047	-0.019	0.094	-0.091	0.035	0.077
	(0.036)	(0.036)	(0.073)	(0.094)	(0.031)	(0.032)
	[0.234]	[0.634]	[0.552]	[0.498]	[0.329]	[0.210]
Individual Demographics?	Y	Y	Y	Y	Y	Y
State-Level Time Varying Controls?	Y	Y	Y	Y	Y	Y
State and Year FE?	Y	Y	Y	Y	Y	Y
State-Specific Linear Time Trends?		Y				
State-Age, Year-Age, and State-Year FE?			Y			
Mean	0.408	0.408	0.408	0.158	0.274	0.107
R^2	0.044	0.050	0.071	0.103	0.035	0.043
Observations	10,606	10,606	10,606	1,230	10,856	1,166

Source: National Youth Risk Behavior Survey, 2009-2019

Note: The dependent variable is an indicator for whether the teen regularly used sunscreen. Columns (1)-(3) limit the sample to white teen girls. Column (4) examines black teen girls, column (5) white teen boys, and column (6) black teen girls. The independent variable of interest is an indicator for whether the teen was bound by an indoor tanning prohibition. Columns (1) and (4)-(6) use the baseline difference-in-differences specification from column (2) of Table 2. Column (2) augments this specification with state-specific linear time trends. Column (3) replaces the state-specific trends with a full set of state-by-age, year-by-age, and state-by-year fixed effects. Standard errors, shown in parentheses, are clustered at the state level. Given the small number of treated clusters, inference is conducted using a cluster robust wild bootstrap procedure, and the corresponding p-value is reported in brackets. Estimates utilize the sample weights.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix B. Differences-in-differences with variation in treatment timing, robustness to alternate methods

A recent literature on differences-in-differences with variation in treatment timing has demonstrated that the traditional two-way fixed effect (TWFE) estimate can only be interpreted as a weighted average of causal effects, and problematically, some of these weights can be negative (see, for example, Callaway and Sant'Anna (2020), Goodman-Bacon (2018), Borusyak and Jaravel (2017), De Chaisemartin and d'Haultfoeuille (2020)). To address the concern that negative weights might bias our TWFE estimates, we first break down our TWFE estimates and weights using the Bacon Decomposition proposed by Goodman-Bacon (2021, forthcoming) and shown in Figure B1.

Figure B1
Bacon decomposition, Google Trends Searches for 'Tan'

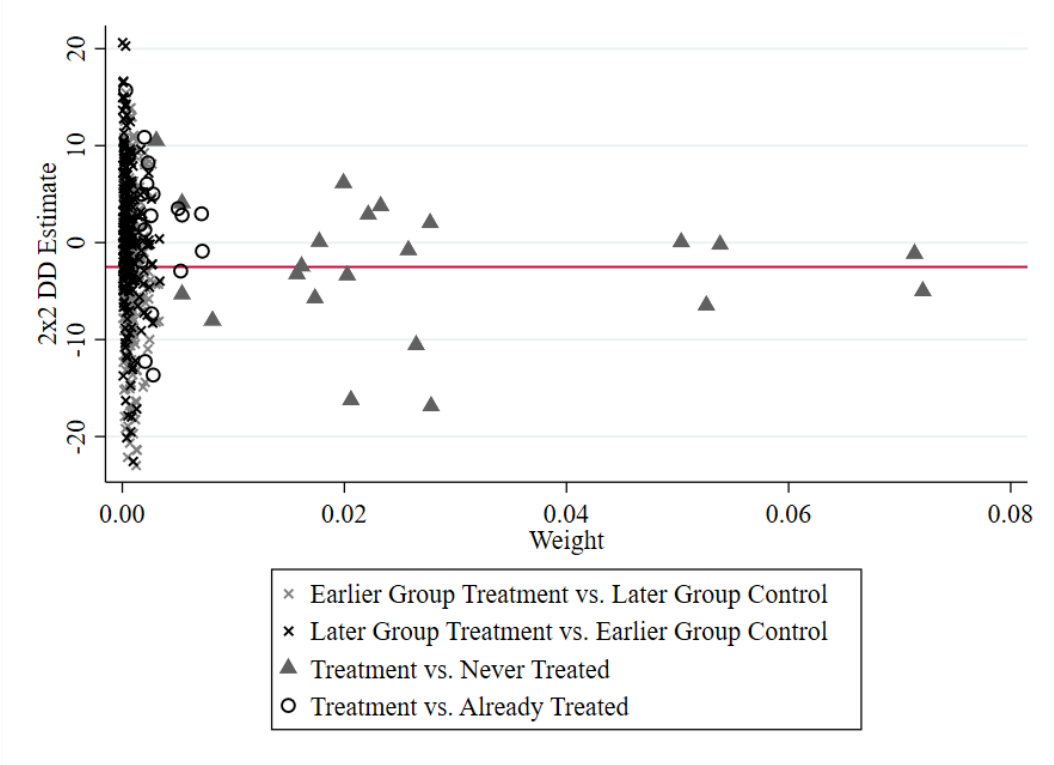


Table B1 Bacon Decomposition
Google Trends Searches for 'Tan'

	(1)	(2)
	Weight	Avg DD Estimate
Earlier Treated vs. Later Control	0.198	-2.824
Later Treated vs. Earlier Control	0.139	-1.048
Treated vs. Never Treated	0.603	-3.076
Treated vs. Already Treated	0.060	0.778

In Figure B1, we observe that the greatest weight in our estimates is from comparing treated units with never treated units, which is reassuring. We report the exact breakdown of average effect estimates and their associated weights in Table B1. Consistent with Figure B1, 60 percent of the weight from our estimate is obtained from comparing treated to never treated units. Meanwhile, the estimate associated with these comparisons is large and negative. In contrast, the comparisons between treated and already treated units are small and positive, but fortunately only receive 6 percent of the total weight.

While the results from Table B1 suggest that negative weighting in TWFE estimates is not a substantial problem in our context, we also adopt the methodology proposed by Callaway and Sant'Anna (2020) to summarize the effect of youth indoor tanning prohibitions in a way that removes negative weighting from estimates of the causal effect. Specifically, we estimate group-time average treatment effects, ATT(g,t), for groups g and time periods t. Groups comprise all units treated in a particular period, and we estimate the group-time average treatment effect for each group g in each time period t by comparing units in g to one of two control groups: never treated units or units that were not-yet treated in time t. Practically speaking, each ATT(g,t) provides a 2x2 difference-in-difference estimate without variation in treatment timing by comparing the relative

difference in outcomes for group *g* and a control group between period *t* and the reference period prior to treatment, *g*-1.[37] Callaway and Sant'Anna (2020) provide several sensible ways to aggregate these estimates into summary measures of the effect of prohibitions, including an overall aggregation by group and event-study style aggregation.

For all estimates, our standard errors are clustered at the state level with a multiplier bootstrap procedure. Unlike the commonly used pointwise confidence bands, this approach obtains simultaneous confidence bands that asymptotically cover the entire path of the group-time average treatment effects with a fixed probability. This approach accounts for the dependency across group-time average treatment effect estimators, which is arguably more suitable for visualizing the overall estimation uncertainty.

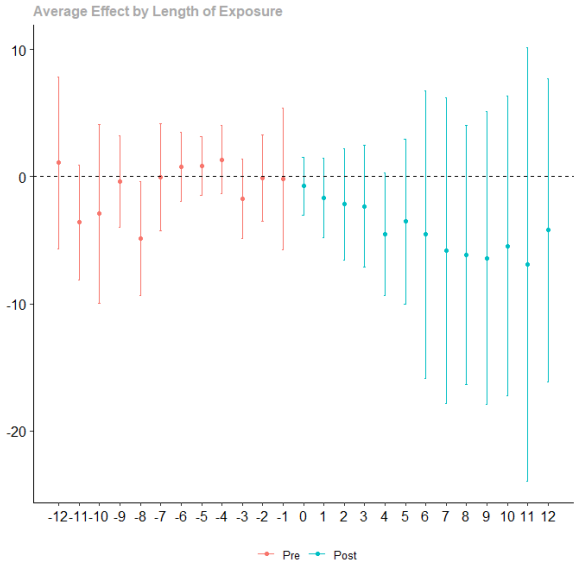
However, it is important to note that, the implementation of this approach requires several adjustments relative to our baseline specification. First, states treated before the start of the sample period are considered "always treated" units and necessarily dropped from the analysis. For the Google Trends data, this necessitates dropping all states with youth indoor tanning prohibitions prior to 2004. Secondly, unlike our main estimates that make use of variation in the age of restriction, treatment here is binary and occurs at the first year a youth indoor tanning prohibition is implemented, regardless of which ages are restricted. Finally, we are unable to include the time-varying controls used in our main specifications, such as controls for other tanning-related policies, graduated driver's license laws, unemployment, minimum wage, Medicaid expansion, and SUNucate laws.

Despite these limitations, we find similar results to our main TWFE estimates. Admittedly, the similarity is perhaps unsurprising, given that the Bacon Decomposition

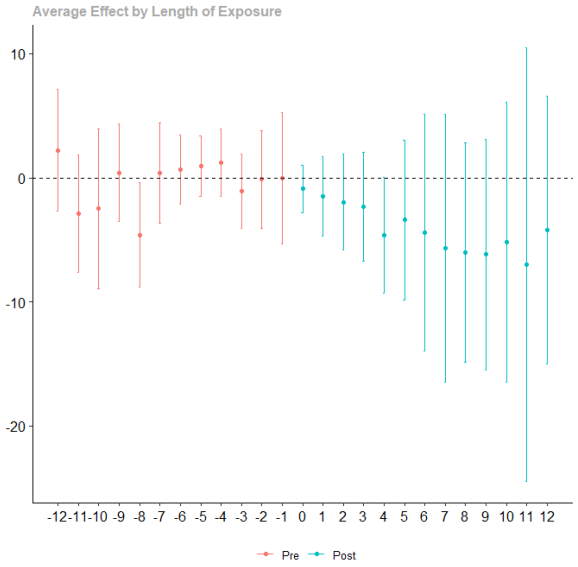
[37] Note that we assume zero anticipation in our context.

suggested that the TWFE estimator placed the greatest weight on sensible comparisons. Figure B3 shows the event-study style figures for Google trends searches for ‘tan.’ Panel (A) shows the results when the never treated group is used as the counterfactual, while

Figure B3
Youth Indoor Tanning Prohibitions on Google Trends Searches for 'Tan'
Callaway & Sant'Anna (2020) Event Study Style Aggregation Estimates



(A)



(B)

Source: Google Trends Data, 2004-2018
Note: The figure plots the event-study coefficients, as well as the associated 95 percent confidence intervals. The dependent variable is average annual Google Trends Index measuring relative search intensity for the word "tan" during a given year. Pre-treatment estimates are relative to the previous year and are shown in orange. Post-treatment estimates are relative to the period before treatment (-1) and are shown in blue. Estimates allow for an unbalanced panel. Panel (A) uses the never treated group as the counterfactual, while panel (B) uses the not-yet-treated group as the counterfactual. Standard errors are clustered at the state level with a multiplier bootstrap procedure (see Callaway & Sant'Anna (2020) for details).

panel (B) shows results based on the not-yet-treated counterfactual group. Both figures show a decline in searches for the word 'tan' after the first youth indoor tanning prohibition was implemented. Overall aggregations of these estimates are reported in Table B2, which shows that these youth indoor tanning prohibitions led to statistically significant reductions in tanning-related searches for both methods of aggregation and both counterfactual groups.

Table B2
Youth Indoor Tanning Prohibitions Reduced Searches for 'Tan'
Callaway & Sant'Anna (2020) Estimates

	(1)	(2)	(3)	(4)
Share Prohibited	-2.056**	-4.187*	-2.010**	-4.103*
	(0.920)	(2.522)	(0.849)	(2.520)
Aggregation	Group	Event	Group	Event
Control Group	Never	Never	Not Yet	Not Yet

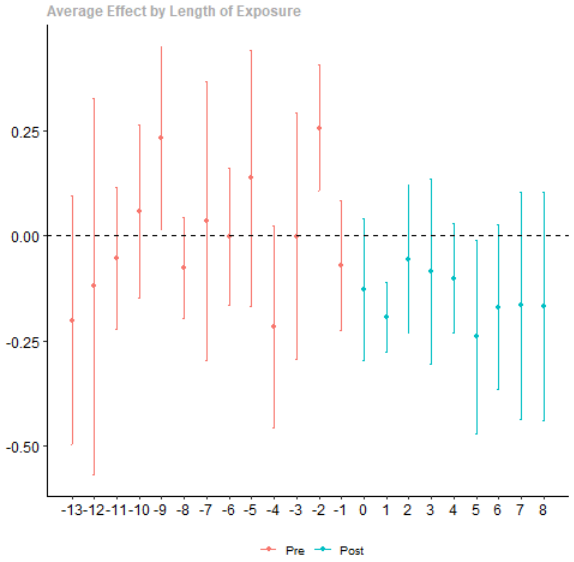
Source: Google Trends Data, 2004-2018
Notes: The dependent variable is the Google Trends Index for the word "tan." Standard errors, shown in parentheses, are clustered at the state level with a multiplier bootstrap procedure (see Callaway & Sant'Anna (2020) for details).
*** p < 0.01, ** p < 0.05, * p < 0.10

Next, we employ Callaway and Sant'Anna's (2020) methodology using the NETS data, requiring us to drop all states with youth indoor tanning prohibitions prior to 1990. The results in Figure B4 and Table B3 for openings and closings of tanning establishments are generally consistent with our main estimates. Figure B4 shows the event-study style figures where the outcome is the inverse hyperbolic sine of openings in panel (A) and closings in panel (B). The counterfactual comparison for both panels is the never treated group, though the results are similar when using the not-yet-treated group as the counterfactual. In panel (A), we estimate a reduction in the number of tanning

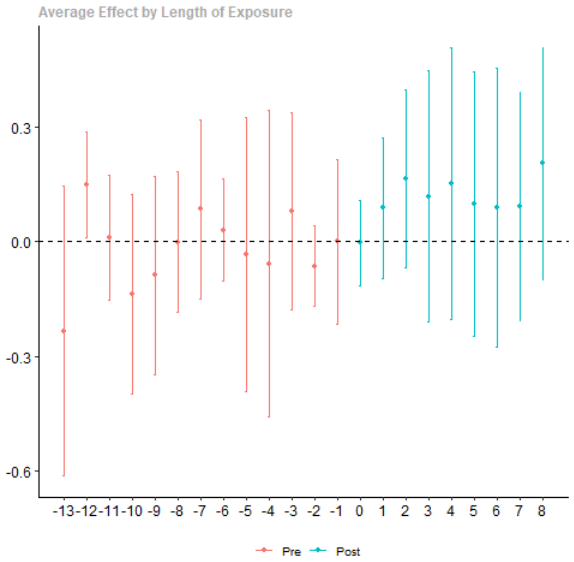
establishment openings following the first youth indoor tanning prohibition, and in Panel (B) we detect an increase in the number of tanning establishment closings. Aggregations of these estimates are reported in Table B3.

Taken together, the results from these additional exercises confirm that our main results on the effects of state youth indoor tanning prohibitions are robust to addressing recently highlighted concerns regarding inference in two-way fixed effects settings with variation in treatment timing such as ours.

Figure B4
Youth Indoor Tanning Prohibitions on Openings and Closings of Establishments
Callaway & Sant'Anna (2020) Event Study Style Aggregation Estimates



(A)



(B)

Note: The dependent variable in Panel (A) is the inverse hyperbolic sine of the number of county level tanning establishment openings, while the dependent variable in Panel (B) is the inverse hyperbolic sine of the number of tanning establishment closings. Pre-treatment estimates are relative to the previous year and are shown in orange. Post-treatment estimates are relative to the period before treatment (-1) and are shown in blue. Estimates allow for an unbalanced panel and use the never treated group as the counterfactual. Sample is limited to groups exposed to a prohibition for at least 8 post periods. Standard errors are clustered at the state level with a multiplier bootstrap procedure (see Callaway & Sant'Anna (2020) for details). Estimates are weighted by county population.

Table B3
Youth Indoor Tanning Prohibitions and Tanning Salon Openings and Closures
Callaway & Sant'Anna (2020) Estimates

	(1)	(2)	(3)	(4)
Panel A.	inverse hyperbolic sine transformation on the **number of tanning salon openings**			
Share Prohibited	-0.128	-0.146***	-0.143	-0.155***
	(0.110)	(0.049)	(0.124)	(0.051)
Panel B.	inverse hyperbolic sine transformation on the **number of tanning salon closures**			
Share Prohibited	0.026	0.112	0.033	0.128*
	(0.055)	(0.093)	(0.062)	(0.077)
Aggregation	Group	Event	Group	Event
Control Group	Never	Never	Not Yet	Not Yet

Source: National Establishment Time-Series, 1990-2017
Note: The dependent variable in Panel A is the inverse hyperbolic sine of the number of tanning salon openings in a county during a given year, while the dependent variable in Panel B is the inverse hyperbolic sine of the number of tanning salon closures in a county during a given year. The estimates are weighted by county population. Standard errors, shown in parentheses, are clustered at the state level with a multiplier bootstrap procedure (see Callaway & Sant'Anna (2020) for details).
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$