Let it Ride! An Empirical Investigation of Problem Gambling and the Implications of Legalized Online Sports Betting

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Abstract

In 2018, the Supreme Court of the United States struck down the Professional and Amateur Sports Protection Act (PASPA), ending a nearly 30-year federal ban on sports betting and paving the way for dozens of states to legalize such operations. The impact has been pronounced, with the sports betting market reaching nearly $120 billion in 2023, a 27% year on year increase. Yet, we know little of the implications of the rapid digitization of sports betting witnessed through apps like DraftKings, FanDuel, and Caesars Sportsbook. In this work, we examine the downstream implications of the PASPA decision in the form of calls to the National Problem Gambling Hotline and the number of suicides reported per state. Using a difference in differences approach to exploit the phased legalization of sports betting at the state level, results indicate that while the number of calls associated with problem gambling is uncorrelated with the legalization of physical sportsbooks, it is strongly correlated with the legalization of online sports betting. Further, results suggest that the legalization of online betting is correlated with an increase in suicides, an outcome historically associated with problem gambling. Theoretical and practical implications are discussed within.

Keywords: *Online Sports Betting, Proposition Bets, Gambling, Mental Health, Difference in Differences*

Introduction

In 2018, the Supreme Court of the United States (SCOTUS) struck down the Professional and Amateur Sports Protection Act,[1] eliminating a near thirty-year federal ban on sports betting. Colloquially referred to as the *Murphy* decision, the visible effects of this decision have been pronounced in the United States despite its relative recency. As of June 2024, thirty-eight states and the District of Columbia have legalized sports betting, and the market has experienced double digit growth each year. Aided by the liberalization of the betting market, nationwide sports betting revenue grew by 44.5 percent in 2023, increasing to $10.92 billion, with individual wagers reaching $119.84.[2,3] Moreover, the nature of sports betting has begun to change. Whereas gamblers were once compelled to visit a sportsbook or enlist the assistance of a bookmaker (bookie) to place bets, the entry of *digital* sportsbooks (e.g. Caesars, BetMGM, and FanDuel) has made the ability to place bets near ubiquitous.[4] At the same time, the move to digitized betting has introduced gamified elements into the process. Beyond traditional wagers (i.e. bets placed on a game's outcome), the combination of technology and gamification in the form of prop bets and parlays, wherein a wager is made on a part of a game that may have little or nothing to do with the outcome (e.g., wagers on a coin toss, a player's foul count); which prior work suggests enhances the appeal of gaming and increases its addictive nature (Macey & Hamari, 2022).

These developments notwithstanding, little is known about the downstream implications of the digitization and subsequent mass adoption of online sports betting for society. Further, the addition of gamification to online betting, based on affordances provided by mobile and web-based technologies, has the potential to exacerbate the downstream effects on bettors and their wellbeing (Gibson et al., 2022). The addictive nature of gambling has been well-established in the literature (Potenza et al., 2002), even without the

[1] This is referred to as PASPA in *Murphy v. National Collegiate Athletic*, 138 S. Ct. 1461, 584 U.S., 200 L. Ed. 2d 854 (2018). Note that PASPA, which was passed in 1992 and signed into law by then President George H. W. Bush, made exemptions for four states which already had sports betting in place: Nevada, Delaware, Oregon, and Montana.
[2] See the tracker and report by the American Gaming Association at americangaming.org/resources/aga-commercial-gaming-revenue-tracker
[3] A wager is the amount of money risked or staked on a bet. Revenue in sports betting is defined as the amount of money a sportsbook retains from total handles after paying out winners; handle is the total amount of money wagered.
[4] A sportsbook is an establishment that takes bets on sporting events and pays out winnings and the term is associated with physical licensed establishments where individuals place bets in person.

reach and ubiquity offered by online options. In this work, we take a first step towards understanding how the legalization of online sports betting affects personal wellbeing, rather than probe market or financial outcomes (e.g., Hollenbeck et al., 2024).

While the financial costs associated with legalized betting are more visible (Hollenbeck et al. 2024), the deleterious effects on the well-being of individuals who participate in these markets are also likely to manifest in subtle and insidious ways. In this work, we focus on two downstream outcomes that represent the extent to which online sports betting may affect a person. First, we examine how legalization affects calls to the National Problem Gambling Hotline, a resource set up to help persons suffering from addiction and problem gambling. This count proxies the number of persons in a state suffering from gambling addiction, i.e. those at risk of financial and health-related harms. Second, we delve into more a distal outcome that has been associated with problem gambling - suicides. Prior work has argued that prolonged gambling addiction can lead people down the path to eventual self-harm (Potenza et al. 2002). In studying the effects of sports betting legalization on these outcomes, we augment the current focus in gambling research that tends to focus on financial and market outcomes with empirical results that demonstrate the social and human costs associated with the industry.

As a start, it is important to note that the relationship between gambling and adverse social outcomes is not new. Extant scholarship has long highlighted the fact that the easy availability of betting infrastructure is associated with elevated levels of problem gambling; and that problem gambling in turn is linked to psychosocial problems, substance use, suicidal ideation, violence, and alcoholism (Chukwuorji et al., 2021; Etuk et al., 2022; Li et al., 2020; Nabifo et al., 2021; Russell et al., 2019; Torrance et al., 2022). However, much of this work has been conducted in the context of physical gambling, where travel to a physical casino or bookkeeper is required. These physical constraints, which are traditionally imposed by the local regulatory structure, in turn raise the question of whether these downstream effects will generalize to an online setting.

On the one hand, it is possible that the negative effects associated with offline gambling are unlikely to manifest online. Physical locations typically include a host of features that are designed to enhance the bettor's hedonic experience (e.g., the use of chips instead of cash, the elimination of clocks, free alcohol,

ambience), and thereby increase the appeal of gambling to individuals with a predisposition to it. The online context lacks these features, suggesting we may not see the same outcomes manifest when online sports betting is legalized. On the other hand, the ubiquity offered by digital platforms might eliminate whatever frictions exist between the bettors and the casino, thereby exacerbating any negative effects. Moreover, the numerous forms of gamification that are possible in the online channel, through parlays and prop bets which readily available online, could conceivably increase the appeal of gambling, even for experienced gamblers who now possess a new gambling channel. In other words, while there are reasons to believe the lack of physical locations and associated perks (food, alcohol, environment) may reduce the attractiveness of gambling, it is also plausible the functionalities and convenience offered by online gambling more than compensate for these losses, thereby leading to an increase in the betting market on the intensive (existing betters bet more) and extensive margin (new users entering the market).

Using data from multiple sources, we examine the relationship between the legalization of sports betting in the US, both online and offline, and social outcomes. First, we examine how the legalization of physical and online sports betting in a state correlates with calls to the National Problem Gambling Hotline from persons suffering from gambling addiction. Subsequently, we study the effect on downstream outcomes in the form of suicides reported in that state. To identify these effects, we exploit the phased state-wide legalization of sports betting across the US using a difference in difference approach (DID). This is feasible because *Murphy* simply eliminated the *federal* prohibition on a state legalizing sports betting, rather than legalizing it nationally. This allowed individual states to enact their own laws regarding gambling legality. To execute the DID, we cast states which legalize physical and digital betting as treatment, and states yet to legalize such activity as control. In empirical extensions, we examine the effect of heterogenous investments in mental health infrastructure on suicide, representing an intervention meant to alleviate the impact of problem gambling. If the interventions are useful and well-resourced, they might mitigate or partly mitigate the effects of legalization on problem gambling and suicides. Data are drawn from the National Council on Problem Gambling (NCPG), the American Gaming Association (AGA), and the Centers for Disease Control and Prevention (CDC). The state-month level panel spans seven years, from January 2017 to December 2022

for fifty states and the District of Columbia. Consistent with prior work, we treat DC as its own jurisdiction.

Results indicate three main findings. First, while our estimations indicate that the legalization of *online* sports books results in a significant rise in calls to the National Problem Gambling Hotline (29% based on the mean), we find no such increase when *physical* sportsbooks are legalized. This underscores the degree to which the rise in sports betting has become a uniquely *digital* phenomenon which can be linked to the appeal of gamification that is inherently associated with mobile and web-based gambling. Second, our results show that the legalization of *online betting* is associated with a 2.75% increase in rates of suicide, with no significant rise observed after the legalization of in-person betting. This again underscores the deleterious effects of the online channel and highlights the degree to which the spike in calls to the National Problem Gambling Hotline is a leading indicator of a far more troubling set of outcomes downstream. Finally, to evaluate institutional interventions which have been created to safeguard against the adverse effects of sports betting, we examine the impact of increased levels of per capita spending on problem gambling services with respect to the effect of online sports betting legalization on downstream consequences in the form of suicides.

Our work has implications for policy makers and the role of technology in sensitive contexts like sports betting. Theoretically, we contribute to the ongoing conversations in Information Systems scholarship regarding both the societal implications of digitization and the implications that emerge from gamification. There has been a growing interest in documenting the societal impact of digitization, where scholars have studied diverse outcomes such as disease outbreaks, access to healthcare, and romantic relationships (Bapna et al., 2016; Greenwood & Agarwal, 2016; Ozer et al., 2022, 2024). While this work has broadly shown that digital platforms and digitization have influenced socially relevant outcomes, the literature has yet to examine the implications of digitized gambling in any material way. This paucity of work is striking given the systematic move towards online betting that has recently emerged and the size of the gambling industry itself. Further, much of the prior work studying the social impacts of digitization tends to be somewhat laudatory of the entry of technology, while our results shines light on the negative effects of digitization. We hope our work serves as a call for greater interest in a market where a sea change in delivery modality is occurring, notably due to the negative implications it can have for society.

We also contribute to the literature on gamification and digital addiction, where the overwhelming majority of scholarship has focused on social media and digital addiction (Allcott et al., 2022; Vaghefi et al., 2023; Venkatesh et al., 2019) or the gamification of the online experience (Broer & Poeppelbuss, 2013; Liu et al., 2017; Teh et al., 2013). Within this stream, scholars have shown the harmful effects of gamification in terms of increased rates of digital addiction (such as to the user's phone). We build on these literatures by not only demonstrating the additional harm that stems from gamifying the user experience in contexts such as sports betting, but the policy initiatives that may be taken to limit their harm.

Our work further has implications for practice, particularly for policy makers. From a policy perspective, there is a clear tradeoff between the tax benefits that accrue from legalized gambling and the negative societal and health implications of gambling (Henriksson, 2001). While our research cannot speak to the optimal balance between the two, we can estimate the extent to which legalizing online sports betting imposes a significant cost to society. We believe policy makers should craft suitable policies while being informed of the cost of these digital innovations, their revenue benefits notwithstanding. Moreover, if legislators are comfortable with the ubiquity of online betting in all its diverse forms, they should also be aware of the importance of investing in mental health infrastructure given the documented effect on adverse health outcomes, viz. suicides.

Finally, our work has implications for the operators of online sports books (e.g., DraftKings, Fan Duel, BetMGM). While these sites clearly cater to an unmet market need, as evidenced by their popularity, their negative impact on mental health should be kept in mind. Unmanaged outcomes at scale could, and likely will, lead to regulatory action that will handicap or even ban online betting models. Our work helps inform these stakeholders about the costs associated with legalization of online betting within the US, even as the eventual impact of nation-wide legalization of gambling has yet to manifest. In this sense, our work can be viewed as an early warning of the adverse effects that are likely to manifest, in higher magnitudes, as more states legalize online sports betting.

Related Literature

Before conducting our empirical analysis, we briefly review two distinct, but related, literature streams to theoretically ground our work - extant work on the legalization of sports betting and current understanding of

the implications of digitization of sports betting. We conclude by arguing that the legalization of online sports betting is likely to have deleterious downstream effects before conducting our empirical investigation.

Legalization of Sports Betting

One of the key arguments in favor of legalizing sports betting has been the potential for economic development. Insofar as legalized sports betting can contribute to the economy through the establishment of regulated betting markets, which in turn generate tax revenues and promote job creation (Humphreys, 2021; Petrotta, 2023; Sichel, 2020), the economic benefits are apparent. This economic argument is further supported by the potential to redirect funds from illegal betting markets to legitimate and regulated channels, thereby reducing the scope of unlawful gambling and generating tax revenues for the state. Yet, these economic benefits must be, and frequently are, juxtaposed against well-established concerns related to gambling-related problems such as addiction, overdoses, suicides, and the integrity of sports (Cason et al., 2020; Harris, 2020). Easier access to betting may lead to a rise in gambling addiction, with detrimental effects on individuals and their families (Chukwuorji et al., 2021). This concern is particularly pronounced in the face of the increasing digitization of the gambling process, which can facilitate more frequent and impulsive betting behaviors (Abbasi & Awais, 2022; Chóliz et al., 2021).

Thus, from a policy perspective, this tradeoff requires in context empirical evidence regarding whether the associated economic benefits from legalizing sports betting are worth the potential toll that may be imposed on individuals that are prone to gambling addiction. However, given the recency of the *Murphy* decision, the regulatory landscape surrounding the legalized sports betting industry, whether offline or online, in the US is still emerging. Effective regulation is critical to balance the economic benefits with the need to protect vulnerable populations, and the lack of empirical work on the topic remains an obstacle. While states and individual sports leagues (e.g., MLB, the NCAA) may apply restrictions such as age and betting limits, or provide resources for gambling addiction prevention and treatment, these have been introduced in a largely haphazard manner. Concurrently, the rapid digitization of sports betting through the web and smartphone

apps has eased access to betting markets.[5] The rapid growth of these activities where it is deemed legal has raised calls for regulators to acknowledge how "digital" gambling has potentially changed the landscape. We discuss this next.

Sports Betting Digitization

Historically, gambling has been primarily housed within physical venues like casinos and betting parlors, and participation was restricted by physical and temporal boundaries. The digitization of sports betting has altered this landscape considerably. More specifically, the transition from traditional, location-based, betting to online platforms has significantly reduced the transaction costs associated with needing to be at specific physical locations, thereby providing increased accessibility and fundamentally changing the nature of gambling and betting behaviors (Chóliz et al., 2021; Hing et al., 2017). This shift has made gambling more accessible to a broader demographic and introduced new modalities, channels, and interactive elements that have reshaped the gambling experience (Parke & Griffiths, 2012; Sirola et al., 2018; Ukhov et al., 2021).

Some discussion of these differences bears note. Unlike traditional gambling venues, online betting platforms and applications are accessible to a wider, and more diverse, audience, which transcends geographical and socio-economic barriers by eliminating the need to physically travel to a gaming venue. In turn, this eliminates both the costs of travel and the potential cost of lodging. Perhaps unsurprisingly, early evidence indicates that this increased accessibility has contributed to a rise in the prevalence of gambling, making it a more commonly observed activity across various segments of the population, in comparison to the previous regime of purely offline gambling (see Montiel et al., 2021 for a review).[6] Moreover, research indicates that the increased accessibility of online sports betting has increased gambling frequency and the risk of developing gambling disorders (Chóliz et al., 2021).

Digitization has also introduced new betting options that are easier to incorporate into mobile applications and websites. Real-time or live betting has become popular, and allows bettors to engage with

[5] See "Gambling is easier than ever. That's not the case for finding gambling addiction help" at NPR: npr.org/2023/12/27/1221890943/gambling-is-easier-than-ever-thats-not-the-case-for-finding-gambling-addiction-h

[6] See "The Sports Gambling Gold Rush Is Absolutely Off the Charts" at bloomberg.com/graphics/2021-opinion-online-sports-betting-future-of-american-gambling

sports events dynamically, thereby adding an interactive dimension to the betting experience. Further, the expansion of betting options, including complex bets on specific outcomes such as *proposition bets*, further gamifies the betting experience on attractive smartphone apps, with appeal to a wide range of users (from experienced bettors to novices). For experienced bettors, proposition bets serve as new and innovative challenges, thereby helping retain their interest. In contrast, the opportunity for enormous payouts that are built into the design of proposition helps attract new bettors. Interestingly, for both sets of customers, online platforms and mobile apps offer detailed analytics, historical data, and personalized betting recommendations that end up drawing in even more demand for these services because they create an illusion of control for such complex betting (Koehler et al., 1994; Lopez-Gonzalez et al., 2018; Parke & Griffiths, 2012).

Finally, the digitization of sports betting creates a social dimension of gambling through the integration of social media elements, which prior work suggests increases the appeal and engagement of gambling activities, especially among younger users (Mathner et al., 2019). Gambling activity can be shared, discussed, and even conducted in tandem through these applications. Incorporating social elements into betting again represents a material shift from the traditionally individualistic nature of gambling. Thus, and perhaps unsurprisingly, surveys show that such design elements have increased interest in sports betting even among teenagers, despite age restrictions.[7] The entry of new segments like teenagers and college students into online betting is a significant sign of the online channel influencing the extensive margin of the industry as these newer segments are more likely to enjoy both the social aspects of gambling and the gamified elements provided by platforms and apps.

Taken in sum, the digitization of sports betting represents a significant shift in the means and venues by which people bet. While it may be argued that digitization of sports betting democratizes access and enhances the user experience, there are also reasons to expect that these changes will increase the risk of problem gambling, indicating a need for rigorous research into these consequences. We discuss these reasons next.

[7] See the publication "NCAA releases sports wagering survey data" for the NCAA's April 2023 survey at ncaa.org/news/2023/5/24/media-center-ncaa-releases-sports-wagering-survey-data.aspx

Digitization, Gamification, and Problem Gambling

Above and beyond the increased access to gambling which digitization affords, the body of work reviewed above suggests that digitization and gamification will likely intensify problem gambling through two psychological mechanisms: *intermittent reinforcement* and *sensory enhancement*. The critical design change that causes these psychological mechanisms to activate is the introduction of gamified elements. This is troubling in the sports betting context because of the addictive impact gamification can have on behavior. As in other contexts, gamification employs design features like rewards, challenges, and leaderboards to increase user engagement (Abbasi & Awais, 2022; Cugelman, 2013). While gamification has been used positively in some contexts (e.g. managing personal health (Alsawaier, 2018; Bayuk & Altobello, 2019; Bitrián et al., 2021; Hydari et al., 2018)), these elements are worrisome in the context of gambling because they are known to trigger psychological reactions which mimic addiction (Andrade et al., 2016; Baptista & Oliveira, 2019; Diefenbach & Müssig, 2019). This is colloquially as "*gamblification*" (Macey & Hamari, 2022) in the gambling literature.

More specifically, the first reason gamification will likely increase gambling addiction is through intermittent reinforcement. Intermittent reinforcement refers to the psychological rewards associated with performing certain acts where the schedule of rewards is neither guaranteed nor predictable (Luo et al., 2015; Richter & Raban, 2012). These activities tend to foster compulsive behavior that is also addictive in nature. Gambling possesses this dynamic, because wins are largely stochastic and therefore prone to inducing addiction in predisposed persons. Gamification intensifies this effect because gamified contexts tend to highlight the unpredictability of wins, which encourages continued participation and risk-taking (Torrance et al., 2022; Ukhov et al., 2021). Thus, from a structural perspective, digitized gambling and gamification both incorporate and highlight activities that are characterized by intermittent reinforcement, which are addictive.

The second reason the gamification of betting apps is likely to intensify gambling addiction is through social reinforcement, i.e. social feedback from others in the form of praise or attention. While this form of social feedback occurs in offline contexts as well (i.e. casinos), the effect is likely particularly acute in the digital context (Phang et al., 2015; Sundararajan et al., 2013; Tsai & Bagozzi, 2014). As is well known, most sports betting apps integrate social media elements into their design. In turn, this allows users to share wins and compete with friends through digital leaderboards, limited time competitions, and traditional sharing

on social media. As a result, the gamified elements tend to amplify the "highs" that individuals experience when gambling, and the socialized aspects of the applications amplify their addictive potential by introducing elements of competition and social validation. The end result is that users to place bets not only for potential financial gain but also for social recognition (Campanella, 2023; Kim & Um, 2016; Lindell, 2017).

Finally, beyond psychological reasons, the design of sports betting apps bears specific note. Put simply, the design of gamified betting platforms and smartphone apps intentionally incorporates sensory cues which enhance the gambling experience. These sensory enhancements increase arousal and excitement, similar to the environment of a casino, further contributing to the addictive nature of these platforms (Torrance et al., 2022; Ukhov et al., 2021). Research has shown that the immersion created by these sensory elements can extend periods of engagement, which in turn increases the likelihood of problem gambling developing (Suh et al., 2018); much as they have in the video game context (Zastrow, 2017). Moreover, the ease of access and convenience offered by *mobile* sports betting apps only exacerbates the issue because the mobile channel allows people to bet anywhere and at any time, thereby removing any physical and temporal barriers that might otherwise limit the gambler. This constant availability can lead to increased frequency of betting and a greater risk of addiction, as users can engage in gambling activities without the constraints typically associated with traditional gambling venues (Oksanen et al., 2022; Tobon et al., 2020).

In light of this, there is a *prima facie* case that the recent legalization of sports betting, online or offline, will likely spark negative downstream effects in the form of gambling addiction and the behaviors that are associated with it. However, the problem is likely intensified online. In lieu of formal hypotheses, we allow our empirical analysis to guide us in quantifying any such effect.

Data and Analysis

To examine the effect legalized sports betting, we leverage its phased legalization across the US following the PASPA ruling. The data on suicide are drawn from the Centers for Disease Control and Prevention's (CDC) Detailed Mortality Dataset. Data on the legislative changes within each state are collected in collaboration with the American Gaming Association (AGA). Data on calls to the Hotline are collected from the National Council on Problem Gambling (NCPG), which operates the National 1-800-GAMBLER network. The NCPG is the oldest organization servicing gambling issues in the US. The network serves as a single national

access point for those seeking help with a gambling problem. As discussed above, we leverage a difference in differences design, casting legalization of gambling (of both physical and online) as treatment. Our outcomes of interest are the number of calls to the Hotline and the number of suicides per state reported by the CDC. Our dataset runs from January 2017 (the year before the *Murphy* decision) to December 2022 for all 50 states and the District of Columbia. The unit of analysis is the state-month. The individual variables we measure are described below.

Dependent Variables

Hotline Calls: The first dependent variable is the number of calls to the National Hotline per month. This variable is an indicator (and historically a strong predictor) of problem gambling. Bettors who are struggling with uncontrollable behavior can call the Hotline to seek help. As it is unlikely that all persons experiencing trouble with problem gambling will call the Hotline, the counts of individual callers per month is likely to underestimate of the actual population that is at risk of problem gambling. This suggests that our analysis may underestimate the actual effects of legalization within the state. This variable is operationalized as the count of calls observed at state-month level.

Number of Suicides: Our second dependent variable capturing the downstream effects of legalization is the number of suicides reported per state by month. Data on suicides are drawn from CDC's Detailed Mortality database. Again, this is operationalized as a state-month count.

Independent Variables

Legalization of in-person sports betting (sportsbooks): The first independent variable of interest is the legalization of sports betting in *physical* (offline) sportsbooks at the state level. This legalization requires physical presence in a sportsbook to place bets. This variable is dichotomous and captures whether a state *i* legalized in-person sports betting in month *t* (1 if legalized, 0 otherwise).

Legalization of online sports betting (mobile phones, web): The second independent variable of interest is the legalization of *online* sports betting at the state level. In this case, services are provided either via the web or smartphone application offered by licensed betting companies. The variable is dichotomous and captures whether a state *i* legalized online sports betting in month *t* (1 if legalized, 0 otherwise).

Control Variables

To complete the difference in difference design we include state and year-month fixed effects. We also

control for median age, education (percentage of those with a Bachelor's degree or above), employment rate, median household income, poverty rate (among those in the state whose poverty level is determined), vehicle and home ownership rates, and population. The data for the controls are drawn from the American Community Survey of the U.S. Census. Descriptive statistics and pairwise correlations are in Table 1.

Estimation Procedure

We use a difference in differences (DID) approach to identify the effects of sports betting legalization on the relevant outcomes. DIDs have been widely used in prior work in leveraging the phased nature of policy changes at the state level (Burtch et al., 2018; Callaway & Sant'Anna, 2021; Goodman-Bacon, 2021; Ozer et al., 2024; Wang & Overby, 2022). The goal is to simulate an experimental design using observational data. States where physical or online (or both) sports betting is legalized are cast as treatment while states where sports betting is not yet legal are cast as control. State fixed effects are included to control for time invariant state level heterogeneity and year-month fixed effects are included to account for general trends. Formally:

$$Y_{it} = \beta_1 I_{it} + \beta_2 O_{it} + S_i + T_t + \gamma' X_{it} + \varepsilon_{it}$$

where Y_{it} is the outcome {number of hotline calls, suicides} in state *i* in month *t*, I_{it} is a dummy equal to 1 if in-person sports betting at sportsbooks is available in state *i* in month *t*, 0 otherwise. O_{it} is a dummy equal to 1 if online sports betting is available in state *i* in month *t*, 0 otherwise. S_i are state and T_t are month fixed effects. X_{it} is the vector of controls. ε_{it} is the error term, clustered on the state. As the main dependent variables, number of calls, are interval-scaled and relatively large counts, we use an OLS estimator as our base specification to ease interpretation. In cases where we have small counts, such as in the case of suicides, we use the Poisson QMLE, a specification that has been used frequently in prior work to estimate similar models. Results are in Table 2.

Before discussing any results, it is important to acknowledge and test the various assumptions that DIDs are subject to. The most important of these is parallel pre-treatment trends in the dependent variable (Angrist and Pischke, 2009). Briefly, DID models presume that trends in the movement of the dependent variable are similar for treated and untreated locations prior to treatment (Bertrand et al., 2004). The absence of parallel pre-treatment trends would suggest that any observed post-treatment differences should be

ascribed to an unmeasured event and weakens the argument that changes in the dependent variable are a result of the treatment, i.e. legalization. To test this assumption, we leverage the widely used variant of the leads and lags model proposed by Autor (2003). Results are in Table 3. We discuss these results next.

Results

Results of the baseline estimations are in Table 2 and indicate a nuanced relationship. In Column 1 we see that the legalization of *in-person* (offline) betting is positively associated with the number of calls to the National Hotline, as may be expected when a new channel or market is made available for gambling within a state. While directionally consistent with prior theory, the estimate is beyond the traditional thresholds of statistical significance (p-value = 0.102). In Column 2, we include the indicator for the legalization of *online* betting. Interestingly, results show a significant rise in the number of calls to the National Hotline following the legalization of online sports betting, i.e., permitting bettors to place wagers through the web or smartphone apps. Economically, the coefficients indicate approximately 127 more people, per state month, seek help after the legalization of online sports betting, a 29% increase over the baseline.

In Column 3, we consider the effect of legalization on suicides in a state. Results indicate a pattern that is similar to those in Column 2 – the legalization of online betting is correlated with an increase in suicides per state, but there is no associated increase emerging from the legalization of in-person betting. The estimates indicate that the number of suicides increases by approximately 2 per state per month (2.75% based on the mean) when online betting is legalized. Across both outcomes results show that the legalization of online sports betting, with its gamified elements and reduction in transaction costs, is more damaging relative to the legalization of in-person sports betting.

Pretreatment Trends

As discussed above, the DID approach relies on the assumption that the trends in the dependent variable are parallel across the treatment and control groups once the estimates are conditioned upon controls (Bertrand et al., 2004). To assess the validity of the parallel trends assumption, we first estimate the popular variant of the Autor (2003) leads and lags model, done by interacting a series of relative time indicators with the treatment. In doing so, we capture the effect pre- and post-treatment by modeling the effect semi-parametrically. Our expectation is to obtain a significant effect post treatment, with no pre-treatment

differences between the control and treatment groups.

Results are in Table 3 and Figure 1 for the number of Hotline calls (Figure 2 for suicides). In these estimations t_{-1} serves as the omitted period to avoid the dummy variable trap. Relative time indicators prior to, and later than, twelve months from treatment are included in the estimation, but the point estimates are omitted in the interest of space. As can be seen in both tabular and graphed results, in the months prior to legalization, the relative time indicators are insignificant and center around zero. This suggests no demonstrable differences across the treatment and control groups prior to legalization. Further, following the legalization of online sports betting, the estimated coefficients are positive and significant, consistent with the baseline results above. These effects corroborate the earlier estimations showing that the legalization of online sports betting is associated with a significant increase in the Hotline calls and the number of suicides and are consistent with the main model in terms of direction and magnitude.

Robustness Checks

In this section, we report on a series of tests carried out to show that the baseline results discussed above are robust and remain consistent across different specifications.

Placebo and Falsification Tests

We first probe our baseline specification by conducting placebo testing. Specifically, we replicate the Danaher and Smith (2014) model in which we shift the panel and treatment forward in time (i.e., move it earlier in time) and drop the posttreatment observations. Intuitively, this allows us to examine if the treatment and control groups are significantly different prior to treatment (Hydari et al., 2018). To do so, we artificially move the treatment three and six months prior to the actual treatment time. Results are consistent preponing the treatment by nine and twelve months. Results in Table 4 indicate that the pseudo-treatment effects are not statistically significant, providing further evidence that the treatment and control groups do not differ significantly prior to the treatment, and that the likelihood of a spurious treatment effect are limited.

In a second falsification test, we use the deaths due to cardiovascular diseases (including heart attacks and strokes per CDC's ICD-10 code of I00-I99: deaths due to the diseases of the circulatory system) as a pseudo-outcome. This is to capture whether treatment has any effect on outcomes that should be unrelated to the treatment. Arguably, there should be no effect of legalization on this outcome, as there is no obvious

relationship between gambling addiction and diseases of the circulatory system. Results are in Table 5 and, as expected, we observe no significant effect of the legalization, whether in-person or online, on these deaths. This is reassuring, suggesting that our main effect relates to suicides, not just any causes of death that may be occurring coincidentally following the treatments.

Variations of the DID Estimator

Although a two-way fixed effect estimation remains popular in the literature, recent work in econometrics has raised the potential that staggered treatment designs may yield biased estimates. This is because the coefficient is a weighted average of the various different treatment effects stemming from states legalizing sports betting at different times (Goodman-Bacon, 2021). In short, because the calculation of the overall treatment effect is a weighted comparison of those groups who are treated earlier versus later, treated versus never treated, and so forth, the estimation of the average treatment effect may be biased due to disproportional or nonsensical assignment of weights. To safeguard against potential this issue, we estimate a Goodman-Bacon decomposition (Goodman-Bacon, 2021) which allows the full effect to "decomposed" into specific contrasts across the matched and control samples (i.e., later treated vs. earlier control, later treated vs. earlier treated, treated vs. never treated). Results of this analysis are in Table 6 and remain consistent, showing a positive and significant effect on both outcomes.[8]

In this same vein, it is worth noting that the Goodman-Bacon decomposition is not the only proposed method to resolve the inverse weighting problem. Thus, as an additional robustness check, we leverage two of the two-stage difference-in-difference estimators proposed by recent research (Borusyak et al., 2021; Gardner, 2022). These models resolve the potential issue with conventional TWFE diff-in-diff models by removing potential biases stemming from treatment effect heterogeneity (Borusyak et al., 2021; De Chaisemartin & d'Haultfoeuille, 2020; Sun & Abraham, 2021). These estimations are in Table 7. Our inference remains consistent, with the effects of online legalization being positive and significant on both the number of calls and suicides.

[8] This robustness test does not allow us to control for in-person sports betting while testing for the effect of online sports betting. What is important is that our results are directionally consistent without any deflated/inflated weights.

Further, we also estimate the effects of the legalization of sports betting using cohort by time interactions in a two-stage doubly robust estimator (Callaway & Sant'Anna, 2021). This estimation method tests any biases that may be associated with the TWFE regressions when there are multiple periods or variations in treatment timing. The idea behind this specification is to estimate each of the *cohort X time* interactions relative to a valid control group (by default, the never-treated states) and uncover the individual average treatment effects. The model then aggregates the individual average treatment effects into a single average treatment effect (173.10 and 3.09, for Hotline calls and suicides respectively). Results of this analysis are in Table 8 and corroborate our previous findings. The average treatment effects are positive and significant, showing a marked increase in number of calls to the gambling Hotline and number of suicides.

Finally, we use a recent method developed to test the robustness of staggered interventions using imputations of the average treatment effect (Borusyak et al., 2021). The method uses *untreated* observations to predict the counterfactual outcome on treated observations, estimates an average treatment effect, and provides the appropriate standard errors. Results in Table 9 show both the pretreatment estimations and average treatment effect. As can be seen, a significant effect for both outcomes emerge. Figures 3 and 4 show these effects visually, contrasting the average posttreatment effect vis-à-vis the pretreatment trends (or lack thereof). Across these multiple robustness and placebo tests, our results remain consistent, providing clear evidence of the impact of legalization of online sports betting on adverse outcomes for individuals.

Discussion

The *Murphy* decision, and the lifting of the federal prohibitions on sports betting, has been largely viewed as a watershed event because of the markets it precipitated. Although the holding in *Murphy* is relatively recent, its effects have been pronounced. As of 2023, the market for sports betting in the US has already reached $10 billion, with more than $100 billion in wagers being placed. And while the potential tax revenues are considerable, and may yield material social good if properly invested, little is known about the potential downsides of legalizing sports betting online. Our work thus provides an early, but compelling, set of results speaking to the potential deleterious effects of permitting these markets to operate. Building on prior scholarship which examined the functions enabled by the online environment in other contexts (e.g., video games, healthcare apps), we find that the legalization of online betting is linked not only to a significant

increase in calls to the National Problem Gambling Hotline, but an increase in suicides at the state level. Moreover, we find that this effect is a uniquely digital phenomenon, with no concomitant spikes being observed with the legalization of in-person betting. Finally, our results suggest that investing in state-level health infrastructure can ameliorate these punitive effects to some extent.

It is worth noting that our work is triggered by the change in state level regulatory regimes and their ability to not only create industries but affect their structure and size. Prior research in economics has attested to the significant impact that changing regulation has on the birth and growth of new industry sectors (Roth, 2018). Indeed, markets frequently emerge due to such changes, the market for recreational cannabis, for example (Auriol et al., 2023). In other cases, regulation has led to the creation or easing of markets in areas that are considered not wholesome. As regulations change, and new markets come into being, there is a need to understand the ex-post *implications* (viz., costs and benefits) of the new regulatory regime. Even in cases where the benefits appear noteworthy, scholarship has uncovered hidden costs that are borne by certain players, and could be ameliorated. The rise of the sharing economy, e.g., car-sharing and home-sharing, represents some examples where scholars have tried to identify the hidden costs associated with their entry into specific jurisdictions (Dhanorkar & Burtch, 2022; Ozer et al., 2024). Our work follows in this stream by investigating the potential "human" costs imposed by the recent legalization of sports betting in certain states in the US.

Our work has implications for IS scholarship and technology policy. For information systems researchers, there is considerable body of work which has studied the deleterious effects of technology addiction (e.g., Venkatesh et al., 2019; Zastrow, 2017), as well as research showing how mobile apps, social media and games have the capacity to induce stress (Allcott et al., 2022; Vanman et al., 2018), particularly for those who are predisposed to these problems. However, the notion that elements of gamification and social interactions can be interactively used to enhance gambling addiction remains relatively underexplored. Further, while a growing body of scholarship has examined the downstream effects of emerging digital platforms, be they beneficial (Greenwood & Wattal, 2017; Ozer et al., 2024; Park et al., 2021) or harmful (Chan & Ghose, 2014; Chan et al., 2016), it is striking that many of these contexts are not always strictly in

accordance with local law.[9] We push the bounds of this work, not only by considering a new context (i.e. gambling), but by considering how platforms can fill nascent markets once they become permissible.

Regarding technology policy, we hope our work provides an early reckoning of how the legalization of sports betting may negatively affect society, and how these effects may be mitigated. The fact that the adverse effects of gambling only manifest under certain conditions (i.e., through online and mobile betting) shows a clear scoping condition. Namely, the expansion of gambling access by itself does not appear to trigger the same negative outcomes as online legalization. These findings have direct implications. To the extent that any changes to an established regulatory framework requires legislators to balance positive (viz. tax revenues) and negative (viz. harm to the public) outcomes, it is critical that policymakers be aware of these relationships. While legislators might be comfortable with the balance between the two (the collection of tax revenue through other means having the potential to be politically unpopular), these tradeoffs should be informed with empirical evidence of the kind that we provide here. Further, it is critical that policymakers be aware of the conditions under which the observed outcomes intensify and abate when crafting policy.

Finally, our results with respect to suicides suggest that adequate resources should be allocated to ensure that gambling addiction does not spiral into more harmful outcomes for affected persons. The potential for addiction in gamified sports betting thus speaks to the role of mental health professionals and addiction specialists. There is an urgent need for increased awareness and understanding of gambling addiction in the digital age, particularly as it relates to gamified betting. This includes training for healthcare providers on how to recognize and treat digital gambling addiction and the development of treatment and prevention programs tailored to the digital setting. Going further, public education and awareness campaigns can play a crucial role in mitigating the risks associated with gamified sports betting. By educating the public about the addictive potential of gamified betting and promoting responsible gambling practices, states where these activities are newly legalized can help reduce the incidence of gambling addiction. This includes providing information on the signs of addiction, resources for help, and strategies for responsible gambling.

[9] See, for example, theguardian.com/news/2022/jul/15/the-uber-files-australia-launched-operated-illegally-document-leak for Uber and wvtf.org/news/2024-01-25/local-governments-claim-airbnb-is-violating-state-law for Airbnb.

In conclusion, this work represents an early analysis of the effects of legalizing online sports betting and should therefore be viewed as the proverbial "canary in the coal mine." It is important therefore to recognize that this work is subject to limitations which offer ripe opportunities for future scholarship. First and foremost, it is important to emphasize that legalization, and the manner of legalization, is not assigned at random. This is critical to recognize, not only to ensure future scholars replicate and refine the understanding of gambling markets, but to ensure our results are interpreted cautiously. Second, while we can observe our outcomes directly, the connection between digital sports betting and a specific suicide cannot be made. Instead, we are compelled to infer this relationship using the tools available to us. This again offers opportunities for future scholarship, in the form of both secondary statistical investigations and qualitative field studies. Third, we cannot identify the specific elements of gamification that are used by each platform, or which design elements result in the observed changes. To the extent that gamification, and the betting modalities employed by online platforms, are clearly important, future scholarship is needed to fully understand the means by which online betting directly leads to the identified outcomes. Thus, while we might speculate that prop bets and parlays, as specific forms of particularly addictive betting, need to be better regulated, future work is evidently needed to identify how to effectively do so.

Fourth, we only consider variations at the state level, using hand-collected data as well as data shared by the NCPG. Clearly, even data collection on new forms of online gambling is at a nascent stage and as more data is made available, future research will be able to corroborate our results. Finally, we look at two broad outcomes – Hotline calls and suicides. This is not to suggest that gambling addiction does not affect other outcomes. Indeed, bankruptcy is an outcome long associated with problem gambling (Hollenbeck et al., 2024) as is divorce (Syvertsen et al., 2023). However, the links to *online* gambling still remain to be established for other outcomes. These represent important and impactful areas of research that remain to be explored. We believe that our work is indicative of this need to fully explore how online gambling as a new industry can be managed well by balancing the costs and benefits.

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Table 1: Descriptive Statistics and Pairwise Correlations

Variable	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Hotline Calls	437	758										
(2) Sportsbook (Binary)	0.237	0.425	-0.005									
(3) Online (Binary)	0.185	0.389	0.032	0.739								
(4) Median Age (Years)	38.5	2.38	-0.158	0.185	0.167							
(5) Education (%)	0.324	0.0662	0.028	0.052	0.095	-0.018						
(6) Employment (%)	0.639	0.037	-0.053	-0.148	-0.07	-0.362	0.626					
(7) Household Income ($)	81,805	17,221	0.143	0.138	0.171	-0.116	0.879	0.649				
(8) Poverty (%)	0.13	0.0285	0.104	0.014	-0.04	-0.105	-0.525	-0.747	-0.606			
(9) Vehicle Ownership (%)	0.922	0.0531	-0.128	-0.125	-0.104	0.078	-0.57	-0.168	-0.524	-0.111		
(10) Home Ownership (%)	0.66	0.0545	-0.38	-0.007	-0.026	0.374	-0.469	-0.253	-0.536	-0.104	0.721	
(11) Population	6,399,306	7,230,336	0.79	-0.101	-0.083	-0.071	0.048	-0.108	0.111	0.093	-0.115	-0.31

Table 2: OLS Fixed Effects Models on the Number of Calls to the Hotline and Number of Suicides

	Number of calls to the National Hotline		**# of Suicides**
In-person bets	101.2 (61.90)	32.50 (63.44)	-1.230 (0.96)
Online bets		127.4* (50.35)	2.135* (1.030)
Controls (Median age, Education, Employment, Household Income, Poverty rate, Vehicle Ownership, Home Ownership, Population)	Included	Included	Included
State FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
# of states	51	51	51
# of months	72	72	72
Observations	3,672	3,672	3,672
Squared cor.	0.8262	0.8274	0.9820
Pseudo R2	0.1091	0.1096	0.3496
Note:			*p<0.05, **p<0.01, ***p<0.001

Table 3: Results of the Leads/Lags (Relative Time) Model for Hotline Calls and Suicides

Relative time	Help calls	Suicides
t_{-12}	-23.239916 (49.660723)	-3.79458297 (3.024995)
t_{-11}	7.853020 (64.620503)	-0.95809190 (3.343165)
t_{-10}	17.579855 (58.053955)	-2.75661461 (2.986595)
t_{-9}	-6.873135 (40.866089)	0.92930847 (3.725873)
t_{-8}	-43.879912 (49.025105)	0.73732433 (2.210169)
t_{-7}	-10.825490 (42.211025)	-0.18065643 (2.885110)
t_{-6}	3.406782 (36.793011)	-3.90504009 (3.041218)
t_{-5}	13.266827 (34.146967)	0.61703571 (2.526127)
t_{-4}	21.807231 (37.701330)	-4.11271484 (2.542910)
t_{-3}	4.819353 (31.850946)	-0.83778599 (2.904301)
t_{-2}	31.381111 (32.012201)	2.87686149 (2.558523)
t_{-1}	Omitted	Omitted
t_0	27.569848 (19.960311)	7.01356995** (2.612055)
t_1	635.692022 (539.341893)	4.16406870 (2.584719)
t_2	310.033191† (156.306359)	4.02288700 (3.228611)
t_3	154.215410* (71.753383)	9.66714364** (3.092833)
t_4	146.893588* (70.694350)	6.75274146† (3.822082)
t_5	118.253623* (58.859812)	8.48358958* (3.715832)
t_6	119.743538* (53.068639)	6.30828071† (3.305351)
t_7	172.628287* (77.118910)	10.24761778† (5.232090)
t_8	228.024832* (101.151608)	10.74604797** (3.506450)
t_9	277.720653* (116.280609)	8.97669801* (3.738027)
t_{10}	176.460260** (63.278614)	12.85533045** (4.256516)
t_{11}	171.249546** (63.236113)	7.93076483* (3.811037)
t_{12}	140.518393** (48.614173)	7.81446013† (4.239690)
Control variables	Included	Included
Observations	3,672	3,672
Number of states	51	51
State fixed effects	Yes	Yes
Month fixed effects	Yes	Yes
Note:	*†p<0.1;*p<0.05; **p<0.01; ***p<0.001*	

Table 4: OLS Models on the Number of Calls and Suicides using Placebo Treatments

	Treatment 3 months before		**Treatment 6 months before**	
	Number of calls to the National Hotline	# of Suicides	Number of calls to the National Hotline	# of Suicides
In-person bets	-40.54 (41.09)	-0.370 (2.05)	-0.370 (2.05)	-0.290 (2.654)
Online bets	20.81 (44.10)	2.344 (2.318)	-10.74 (33.50)	-1.085 (2.680)
Controls (Population, Education, Median age, Employment, Household Income, Poverty rate, Home Ownership, Vehicle Ownership)	Included	Included	Included	Included
State FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
# of states	50	50	50	50
# of months	72	72	72	72
Observations	2,535	2,535	2,442	2,442
Squared cor.	0.9098	0.9844	0.9106	0.9846
Pseudo R2	0.1488	0.3550	0.1490	0.3549
Note:	**p<0.05, **p<0.01, ***p<0.001*			

Table 5: OLS Fixed Effects Models on the Number of Deaths by Cardiovascular Diseases

	# of Cardio Deaths
In-person bets	-11.63 (18.60)
Online bets	-13.44 (21.10)
Controls (Population, Education, Median age, Employment, Household Income, Poverty rate, Home Ownership, Vehicle Ownership)	Included
State FE	Yes
Month FE	Yes
# of states	51
# of months	72
Observations	3,060
Squared cor.	0.9876
Pseudo R2	0.2502
Note:	**p<0.05, **p<0.01, ***p<0.001*

Table 6: Goodman-Bacon Decomposition

	Number of hotline calls		Number of suicides	
	Weight	**Avg. diff-in-diff**	**Weight**	**Avg. diff-in-diff**
Earlier Treated vs. Later Treated	0.19955	125.12	0.18939	0.92618
Later Treated vs. Always Treated	0.02821	64.85	0.02778	-0.89828
Later Treated vs. Earlier Treated	0.06688	216.40	0.08834	1.54582
Treated vs. Never Treated	0.70535	119.15	0.69449	-0.22500
State fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes
Weighted sum of the decomposition	125.31		0.1308	

Table 7: Two-stage Estimation of the Average Treatment Effect

	Number of Hotline Calls	**Number of Suicides**
Online bets	69.95* (32.48)	3.870* (1.497)
Control variables (incl. in-person bets)	Included	Included
State fixed effects	Yes	Yes
Month fixed effects	Yes	Yes
R-squared	0.0073	0.0213
Note:		*$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$*

Table 8: Doubly Robust Estimation of the Cohort Effects and Average Treatment Effect

	Number of Hotline Calls	**Number of Suicides**
Average treatment effect:	173.10* (47.57)	3.09* (1.01)
Month 31 cohort	-55.8422 (27.0472)	-3.5644 (3.5860)
Month 35 cohort	0.9135 (16.2998)	-2.2273 (6.1326)
Month 40 cohort	101.3275* (31.6612)	20.5455* (2.8304)
Month 43 cohort	48.9460 (42.5930)	7.0237 (3.3634)
Month 44 cohort	61.8829 (43.7407)	-1.4545* (0.1348)
Month 45 cohort	79.3572* (24.0249)	6.8775 (4.6054)
Month 47 cohort	45.4785* (6.9017)	5.1858 (3.3436)
Month 50 cohort	51.9889* (16.6775)	0.1304 (2.4179)
Month 52 cohort	121.8808* (54.7990)	9.4881 (5.4756)
Month 53 cohort	974.3230* (104.3332)	-2.9545 (NA)
Month 58 cohort	163.4380* (40.1830)	-0.3992 (1.5532)
Month 60 cohort	127.7882 (65.5136)	-6.6858 (3.6669)
Month 68 cohort	144.0594 (81.5390)	8.3788 (3.9707)
Month 69 cohort	55.1220 (48.0707)	13.1299* (2.0703)
Month 72 cohort	839.7954 (513.0586)	9.0065 (5.5467)
Month 74 cohort	96.7495* (14.7296)	-2.1818 (3.4273)
Month 80 cohort	130.6271* (29.2722)	5.0889 (5.5277)
Month 82 cohort	8.2456 (76.6166)	-7.7143 (3.6208)
Month 84 cohort	74.3600* (27.3771)	-3.8333 (3.0201)
Control variables (incl. in-person bets)	Included	Included
State fixed effects	Yes	Yes
Month fixed effects	Yes	Yes
Note:	** denotes that the confidence band does not cover 0.*	

Table 9: Test of Pre-trends and Average Treatment Effect using the Imputation Method

	Number of Hotline Calls	Number of Suicides
Average treatment effect:	112.47**	2.25**
	(26.62)	(0.87)
t_{-5}	-26.591	1.016
	(28.562)	(1.644)
t_{-4}	-19.109	-3.104
	(36.563)	(2.074)
t_{-3}	-17.555	0.184
	(40.447)	(2.045)
t_{-2}	-2.741	2.488
	(32.050)	(1.664)
t_{-1}	-27.586	-1.241
	(37.157)	(2.082)
Control variables (including in-person bets)	Included	Included
State fixed effects	Yes	Yes
Month fixed effects	Yes	Yes
Note:	*$^{\dagger}p<0.1; ^{*}p<0.05; ^{**}p<0.01; ^{***}p<0.001$*	

Figure 1: Leads/Lags Model for Hotline Calls

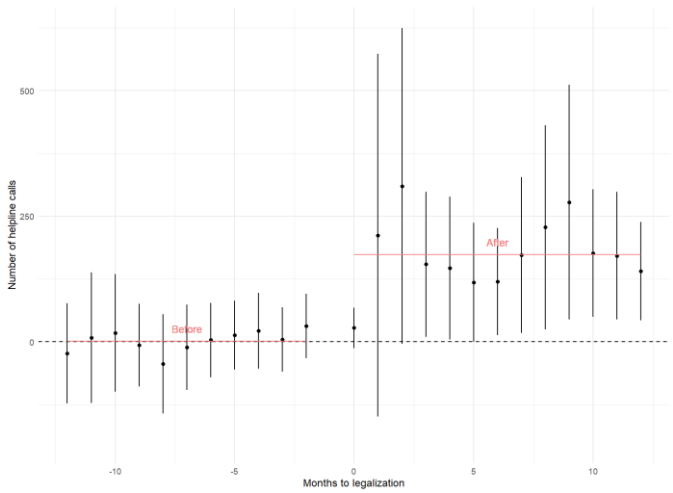


Figure 2: Leads/Lags Model for Suicides

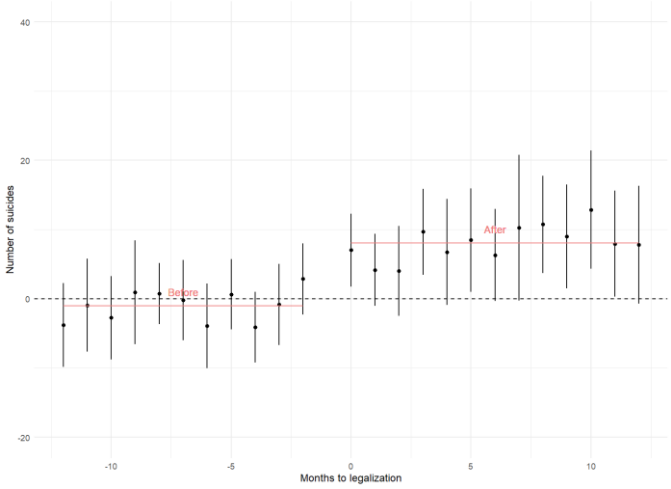


Figure 3: Imputation Test for Pretreatment Trends for Hotline calls

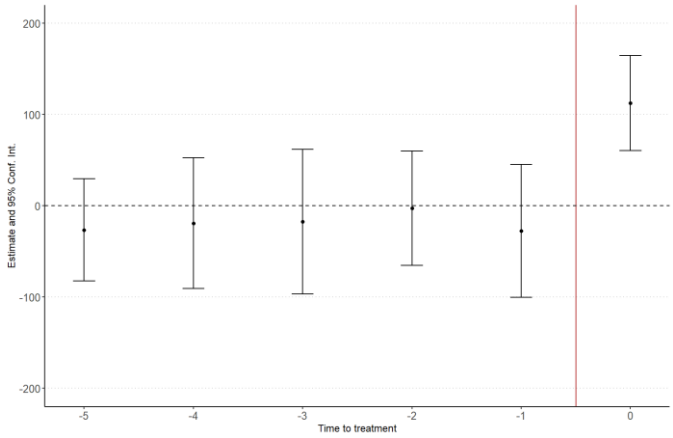


Figure 4: Imputation Test for Pretreatment Trends for Suicides

