The Effect of School Safety Tip Lines

on Youth Suicide Prevention

Tahmeed Hossain

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ABSTRACT

Suicidal deaths of high school-aged youths (14-to-18-year-olds) have almost doubled over the past decade. School safety tip lines, an anonymous reporting method that enables students to submit tips about their suicidal friends and classmates, have emerged as a potential solution to reduce youth suicide. Using data from the CDC's Multiple Causes of Death data for the period 1999-2018, this is the first study to formally investigate the effect of introducing school safety tip lines on youth suicide prevention. My primary identification strategy is a difference-in-differences (DID) method that exploits variation in the timing of the adoption of the safety tip lines across states. I also employ a synthetic control method (SCM) as an alternative identification strategy to compare suicide rates in Colorado and Michigan (early adopters of tip line mobile applications and websites) to non-adopting states before and after the adoption of tip lines. Despite the existence of anecdotal evidence of tip lines saving many high- school students from committing suicides, I find little evidence that tip lines have reduced completed suicides among 14-to-18-year-old youths.

JEL: I18, H75
Keywords: School safety tip line, Youth, Suicide

1 Introduction

18,306 high school-aged youths (14-to-18-years-olds) have committed suicide in the United States from 2007-2018. Suicide rate per 100,000 among this age group has almost doubled over the past decade. Moreover, suicide overtook homicide as the number two leading cause of death for high school-aged youths in 2011. While many interventions to youth suicide prevention have been implemented over the past three decades, reviews of the literature find little evidence that these interventions had any effect in decreasing youth suicide rate (Katz et. al., 2013; Robinson et. al., 2018). As health officials look for ways to prevent youth suicide, school safety tip lines have emerged as a potential program that can help identify suicidal students and reduce suicide rate among high school students (Kingkade, 2020). In this paper, I evaluate the effect of introducing school safety tip line mobile applications and websites on suicide rate of high school-aged youths.

The primary objective of school safety tip lines is to prevent school shootings. However, safety tip lines have received more than twice the number of tips on suicidal youths than on potential shooters or threats to schools in recent years, according to the annual reports of safety tip line programs[1]. This is not surprising given that a high school student (age 14 -18 years) is more likely to die by committing suicide than in a mass shooting in the campus. According to NBC news count, between 2016 and 2018, thirty-eight people of all ages were killed in school shootings in the US. (Chiwaya, DeFrank and Kimelman, 2019). On the other hand, the number of suicides among high school-aged youths (14-to-18-year-olds) in 2018 alone was 2039.

School safety tip lines may represent a viable way of reducing suicide mortality because suicidal students are more likely to talk to their classmates or friends than to adults about their suicidal thoughts (Kalafat and Elias, 1994). A student can anonymously submit a report to the safety tip

[1] Total number of tips on suicidal students and planned attacks on schools was calculated using the data from annual reports of Colorado, Oregon, and Wyoming's safety tip lines of 2017-18, 2018-19 and 2019-20 school years and annual reports of Michigan's safety tip line of 2017, 2018 and 2019.

lines about his suicidal classmate through mobile application, website or just by calling a hotline. As soon as tip line operators receive reports, they send the information to appropriate authority who can help the suicidal student.

While researchers have explored the effects of various school suicide prevention programs, there is no existing evidence on the effect of school safety tip lines. To explore the impact of the safety tip lines on youth suicide, I use restricted-use mortality data from the CDC for the years 1999-2018. I employ a difference-in-differences method that exploits variation in the timing of the launch of the safety tip lines across states as my primary identification strategy. I also use a synthetic control method (SCM) to compare youth suicides in Colorado and Michigan (early introducers of tip line apps/websites) to other states prior to and following the introduction of tip line apps/websites.

My result provides no evidence that the tip lines had any effect on the suicide rate of high school-aged youths. The result is consistent across all specifications of the difference-in- differences method, with and without controls, and in both linear and log transformed models. An event study analysis shows statistically insignificant effects in all the post-treatment years. My alternative strategy, Synthetic Control Method, also confirms this result. Hence, the results are robust, and not dependent on the use of a particular identification strategy.

2 Background

2.1 History of School Safety Tip Lines

Colorado was the first state to launch a school safety tip line, safe2tell, which allows students to anonymously report suspicious activities or concerns about classmates via a mobile application, website, or hotline number. Two students at Columbine High School in Colorado killed 12 students and a teacher on April 20, 1999. The two perpetrators committed suicide at the end. At that time, it was the deadliest school shooting to occur in USA. As officials in Colorado began looking for ways to prevent school shootings, Susan Payne, a 28 -year law enforcement veteran based in Colorado, came up with the idea of a local hotline where young people could anonymously call before an incident happened (McCrimmon, 2009). However, getting students to come forward with information was not easy as they were afraid of retaliatory attacks on themselves, and being called a traitor. It was critical to provide them with a safe and confidential way of reporting concerns. The Columbine Review Commission, which was established to present reports about the Columbine shooting, also identified anonymity as a vital element of any school safety program. Finally, on the recommendation of the Columbine Review Commission, Susan Payne's idea of a school safety tip line was adopted. On September 14, 2004, Safe2tell, a 24/7 hotline went live. Dispatchers of the Colorado State Patrol was the main answering point. In 2007, Colorado introduced web reporting as a medium of tip line. Mobile application was added to the program in 2015.

Several other states such as Wyoming, Oregon, Utah and Nevada also implemented safety tip line programs in the following years as a result of the Sandy Hook Shooting. The Sandy Hook shooting and recent high school shooting incidents in Parkland, Florida (February 14, 2018) and Santa Fe, Texas (May 18, 2018) have resulted in more states coming forward to either build their own versions of safety tip lines, or to encourage/endorse the use of private, nationwide youth violence prevention programs and apps such as "Say Something"[2]. 12 states are now operating school safety tip lines (listed in table 1).

[2] Say Something is a youth violence prevention program established by Sandy Hook Promise (SHP), a not-for-profit organization. Several family members of the victims of the Sandy Hook School shooting founded the SHP. Anyone in the US can report safety concerns via either website or mobile app.

Table 1: School safety tip lines

State	Effective Year
Colorado	2004
Michigan	2014
Utah	2016
Wyoming	2016
Oregon	2017
Florida	2018
Nevada	2018
Maryland	2018
Pennsylvania	2019
Missouri	2019
Ohio	2019
Kentucky	2019

Notes: Colorado introduced web reporting in 2007. Between 2004 and 2006, it was only a hotline. There is confusion regarding the effective year of Missouri's school safety tip line. Different sources show different effective years for Missouri. According to the website of Missouri's tip line, it was launched in 2019.

2.2 How School Safety Tip Lines Work

The operating procedure of school safety tip lines in different adopting states is similar. As soon as a student or someone else submits a report to the school safety tip line either by calling a hotline number or by using mobile application and/or website, an analyst or an operator fields initial information for the report. Tip lines ensure anonymity as no caller id is displayed, and submission of a name is not required. The information is then investigated by analysts.

Depending on the type and urgency of the reports, the analysts send the information to appropriate authorities including local law enforcement agency, school and state-level officials. If immediate action is necessary, typically local law enforcement agency will intervene. Tips are also generally forwarded to school officials who can notify parents or provide counsel to students or take other necessary actions. State level officials generally oversee that concerned authorities

are taking proper actions following a submitted tip. The intervening parties have to submit reports about how they addressed a tip and what the outcome was. Although initial purpose of school safety tip lines was preventing school shooting, tip lines also receive reports on bullying, drug use, sexual abuse, suicidal behavior, suspicious activities, and other categories. Almost all the safety tip lines are established and funded by state legislatures. Typically, different public offices such as Office of the Attorney General, Department of Education, Department of Public Safety, Department of Law, State Police jointly oversee the operation of safety tip lines.

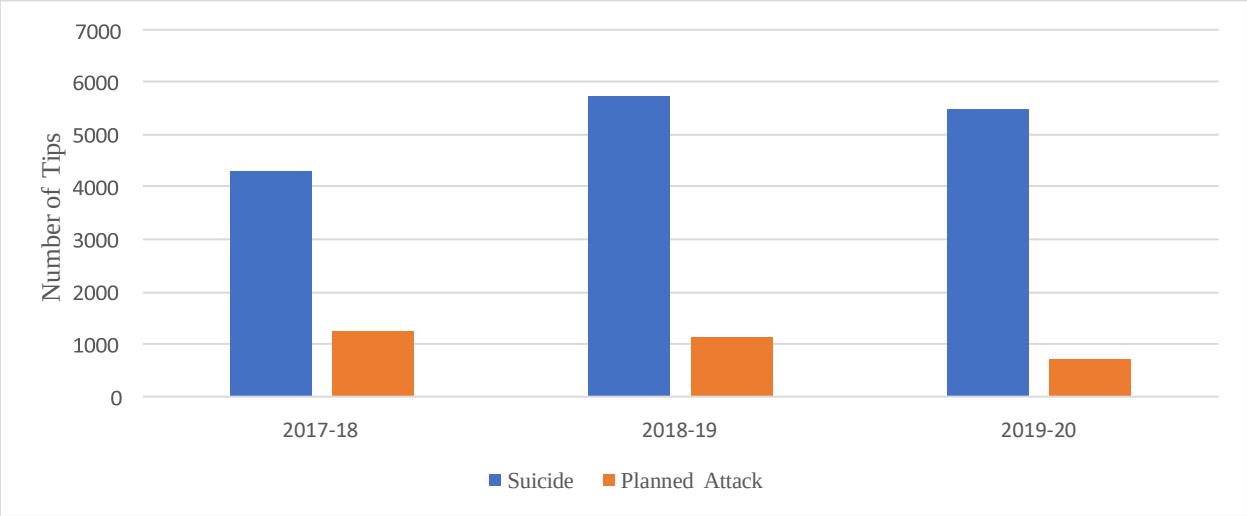
An important reason why safety tip lines have been successful in encouraging students to come forward and report safety concerns is the use of the websites and mobile applications. The use of mobile applications and websites also distinguishes school safety tip lines from simple hotline numbers and 911. With the popularity of internet and mobile apps, especially among teens, it is not unreasonable to assume that high school students will be more comfortable in reporting tips via website and mobile apps than by calling to a number and talking to an operator. Annual reports from different states' support this assumption. The number of tips received via mobile applications and websites far outnumber the tips received via phone calls, making it evident that students feel comfortable in using websites and mobile apps[3].

[3] For example, in the 2018-19 school year, safe2tell Colorado received 31% of the tips via mobile app and 46% via web, as opposed to 23% by phone calls (Safe2tell annual report, 2018-19 school year). In the 2019-20 school year, although percentage of tips received via phone call increased to 30%, it still lagged web (45%). Mobile apps received 25% of tips (Safe2tell annual report, 2019-20 school year). The same scenario is seen in Oregon, where during the school years between 2017 and 2020, SafeOregon received a total of 3680 tips from the website and 831 tips from the mobile app (SafeOregon annual report, 2017, 2018, 2019). On the other hand, calls contributed to only 416 tips. In Pennsylvania, mobile app contributed to about 83% of total reports in the 2018-19 school year. In other states where apps and websites are being utilized, only a fraction of tips come from calls.

2.3 School Safety Tip Lines and Youth Suicide

States initiated tip line programs to prevent attacks on schools. However, reports about self-harm or suicidal students have far outnumbered reports about potential shooters or threats to school. For example, safe2tell received 499 reports of planned school attacks in 2018 -19 school year, compared to 3668 reports of suicide threats in the same school year. The situation is similar in other states such as Wyoming, Oregon, and Michigan. Figure 1 shows the comparison between reports of suicidal students and planned attacks on schools in these four states for the school years 2017-18, 2018-19 and 2019-20[4].

Figure 1: Comparison between number of tips on suicide and number of tips on planned attacks on school



The large number of reports about suicidal students is not surprising in light of the high rates of teen suicides. From 2007, the number of suicides has been continuously rising. The number nearly doubled between 2007 and 2018, from 1124 to 2039. Moreover, a large number of youths are struggling with suicide ideation, often resulting in suicide attempts. School safety tip line programs in different states have emerged as potential solutions in curbing youth suicide.

[4] Statistics of SafeUt, Utah's tip line, could not be collected. Other states that have launched tip lines in or after 2018 have not published statistics yet

For example, in November, 2017, two police officers in Hermiston, Oregon saved a teenager at his home from committing suicide after they received a report from SafeOregon, Oregon's school safety tip line (Kingkade, 2020). One of the teenager's classmates had submitted a report that the teenager was suicidal. The officers went to the teenager's home and found the teen in his bedroom with a belt wrapped firmly around his neck. The teenager was not breathing. One of the officers quickly removed the belt and performed CPR on him. The teen was then immediately taken to a hospital. He eventually recovered and received mental health service later (Kingkade, 2020). A tip from SafeOregon saved another student, who talked about wanting to shoot herself on the head. She later received mental health counsel (Kingkade, 2020). The tip lines have led to many interventions like these two examples and have prevented multiple youth suicides, according to the annual reports of safety tip line programs.

There seems to be a consensus among the implementers of safety tip line programs in different states that safety tip line is an effective tool of preventing youth suicide. Particularly, the use of websites and mobile applications seem to have encouraged high school students to report about suicidal students (and potential threats to schools) without any fear of retaliation or worry about being wrong. But has there really been a significant impact of the safety tip line on youth suicide prevention? In this paper, I aim to provide empirical evidence of the causal effects of the school safety tip lines on suicide prevention of high school students.

3 Data

County-level suicide data of high school-aged youths (14–18 years) comes from Centers for Disease Control and Prevention's (CDC) restricted-use Multiple Causes of Death data for the period 1999-2018. I measure suicide mortality based on International Classification of Diseases, Tenth Revision codes (ICD-10), with specific reference to intentional self-harm. To calculate suicide rate per 100000 population, I collect population data from National Cancer Institute's SEER data. Although presence of tip lines varies at the state level, I analyze the outcome variable at the county level to account for variation in factors such as underlying county's age distribution, community characteristics, school quality, income level, and other county characteristics—either through county fixed effects or control variables.

Data for control variables used in the main regression, such as percent male, percent white, percent under 19-year-old, are also obtained from the SEER data. Data for county unemployment rates and per capita income are collected from Bureau of Labor Statistics' Local Area Unemployment Statistics and Bureau of Economic Analysis' Local Area Personal Income data, respectively. I also collect data on Child Access Prevention (CAP) laws from the Giffords Law Center that varies at the state level[5].

In table 2, I present descriptive statistics for the data used in my analysis[6]. Table 2 indicates an average of 10.22 annual suicide deaths per 100,000 youths aged 14 -18 years. It also indicates relatively high youth suicide rates for males and whites.

[5] CAP laws mandate that minors do not have unsupervised access to guns by enforcing liability on adults (Giffords Law Center to Prevent Gun Violence, 2018). Studies show that risk of suicide is higher among youths whose guardians keep their guns loaded and/or unlocked (Grossman et al., 2005; Miller and Hemenway, 1999)

[6] The sample contains data of U.S. counties within 49 states and District of Columbia. Missouri is excluded from the sample as a potential treated state due to confusion about the effective year of Missouri's school safety tip line.

Table 2: Summary statistics

	(Mean)	(std. dev.)
Youth Suicide (Per 100000)	10.22	42.38
White	10.24	45.74
Black	5.407	196.9
Other Races	10.26	358.7
Male	15.85	71.48
Female	4.194	36.06
Percent White	86.49	15.85
Percent Male	49.83	2.019
Percent Under 19	25.14	3.514
CAP law	0.503	0.500
Log Per Capita Income	10.37	0.297
Unemployment Rate	6.181	2.700
County-year observations	50,874	

Notes: The sample contains data of U.S. counties within 49 states (excluding Missouri) and District of Columbia.

In Table 3, I show the means before (Column A) and after (Column B) the implementation of school safety tip lines[7]. These averages indicate increases in suicide outcomes of males, females, and whites from column A to Column B. This is not surprising as youth suicide rate had been consistently rising in almost all the states in the US from 2007 -2018. And almost all school safety tip line programs were launched during that period.

[7] If a tip line is not in effect for any portion of the year, y, in a specific county, c, the mortality observation is included in column A of table 2 for c and y. Column B includes mortality observations of treatment years and post-treatment years of a county.

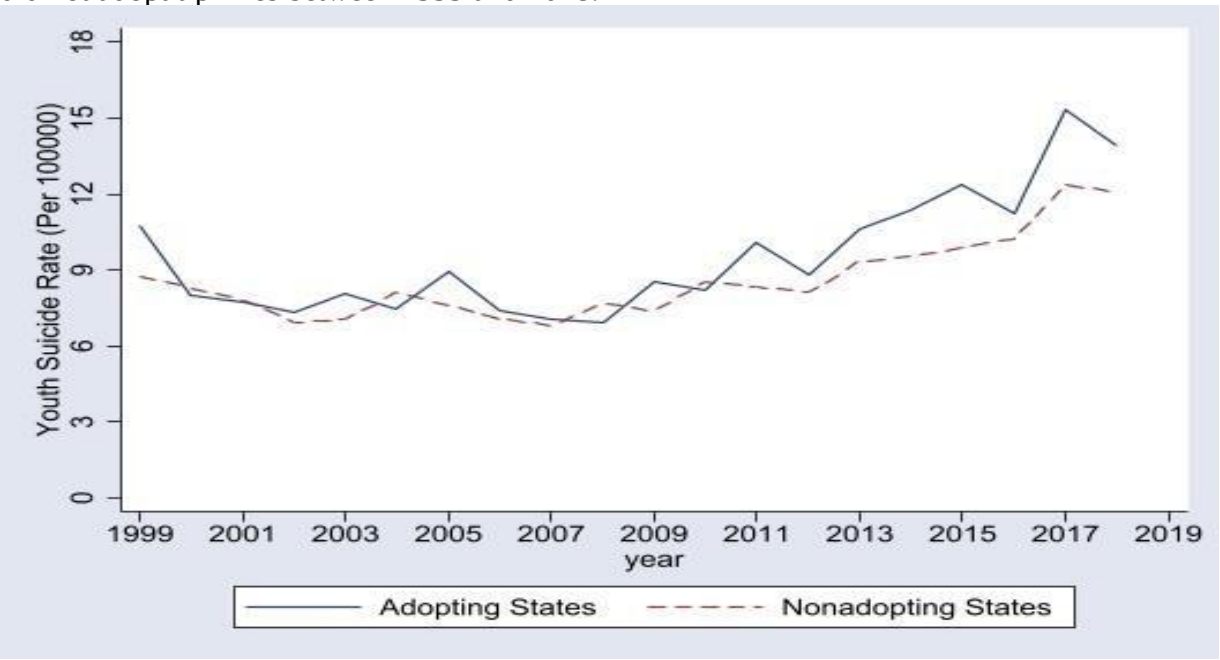
Table 3: Comparison of mortality rates between pre-treatment and post-treatment periods

	(1) Tip Line = 0	(2) Tip Line = 1
Youth Suicide (Per 100000)	10.089	14.895
	(42.420)	(40.626)
White	10.094	15.606
	(45.794)	(43.379)
Black	5.434	4.439
	(199.347)	(57.617)
Other Races	10.362	6.718
	(363.435)	(64.863)
Male	15.674	22.054
	(71.518)	(69.704)
Female	4.103	7.493
	(35.822)	(43.820)

Notes: The sample contains data of U.S. counties within 49 states (excluding Missouri) and District of Columbia.

Figure 2 shows a time series of the average youth suicide rates for the tip line adopting states, compared to states that did not adopt tip lines during 1999-2018 period. From the figure, it seems that average suicide rate has a slightly decreasing trend for both groups from 1999 to 2007. Also, two groups have similar average rates of youth suicide during this period. However, from 2008 to 2018, both groups have increasing trend in the suicide rates, and the rate of increase is higher in tip line adopting states relative to the non-adopting states. As a result, the average rate of suicide is higher in treated states than in control states during this period.

Figure 2: Time series of average youth suicide rate for the treated states, compared to states that did not adopt tip lines between 1999 and 2018.



4 EMPIRICAL STRATEGY

I employ a difference-in-differences method as my preferred approach to estimate the causal impact of school safety tip lines on youth suicide rate. As an alternative identification strategy, I use Synthetic Control Method formulated by Abadie and Gardeazabal (2003).

4.1 Difference-in-differences Model

As my primary identification strategy, I exploit the variation in the timing of launching safety tip line mobile applications and websites across states. To explore the effect of school safety tip line programs on youth suicide, I estimate a difference-in-differences regression that takes the following form:

$$\mathbf{Y_{cst} = \beta_0 + \beta_1\ tip\ line_{st} + \beta_2\ X_{ct} + \beta_3\ Z_{st} + v_c + w_t + u_s t + \varepsilon_{cst},}$$

where Y_{cst} represents suicide rate of 14-to-18-year-olds per 100000 residents of the same age group in county c of state s and year t. The independent variable of interest, tip $line_{st}$, is equal to 1 if tip line mobile application and/or website was in effect in state s and year t, and equal to 0 otherwise[8] [9].

Although I use a linear model with suicide rate as the outcome in my main specification, I also show results of alternative specifications including Poisson and log models that adjust for zero outcomes. In the Poisson model, the count of youth suicides is the outcome variable. I show that the results are similar across all specifications.

[8] Colorado launched safety tip line in 2004 with phone call as the only method of reporting tips. Colorado introduced website in 2007. Because this study is mainly concerned with the effect of tip line mobile applications and websites, I treat 2007 as the first year of treatment for Colorado. Data from Safe2Tell Colorado's annual reports also indicate that the tip line was not immediately fully utilized as it received just over 100 tips during each of 2004-05 and 2005-06 school years. In 2006-07, number of tips increased to 453. However, the main result remains similar even if I select 2004 as the treatment year.

[9] Tip $line_{st}$ is equal to fractional values during the year the tip line was implemented. For example, Florida launched tip line in October, 2018. Hence, in 2018, tip $line_{st}$ is equal to $8/12$ or 0.25 in Florida.

The vectors v_c and w_t represent county and year fixed effects, respectively. County fixed effects control for time invariant attributes of a county that may be related to youth suicide. Year fixed effects control for shocks that are common to all counties during a year. ε_{cst} represent unobserved factors. I also include state specific linear time trends ($u_s t$), permitting each state to follow a separate trend. Linear time trends account for state specific factors that evolve steadily over time, such as attitude towards mental health, LGBT community, gun control.

I include several county-level control variables for demographic measures such as race, age, gender (% white, % under 19, % male) and economic conditions including the unemployment rate and per capita income in the vector X to test the robustness of my result. Z_{st} represents a gun control law (Child Access Prevention Law) that varies at the state level. I weight the regressions by county populations to improve efficiency and use standard errors clustered at the state level, allowing yearly observations to be correlated within states.

4.2 Synthetic Control Method

As an alternative strategy, I use the synthetic control method (SCM) to estimate the impact of tip lines on youth suicide prevention. SCM is a data-driven process that generates a synthetic control group in comparative case studies for estimating treatment effects. To construct the synthetic control group for the treated unit, SCM uses a weighted average of the control groups that closely matches the treatment group during the pre-treatment period. SCM has similarity to the difference-in-differences method, as both methods exploit differences in treatment group and control group across the event of interest. However, SCM assigns different weights (including zero) to different untreated units, as opposed to the difference-in-differences method that assigns equal weight for all untreated units.

Following Abadie, Diamond, and Hainmueller (2010) and Cavallo (2013), let S_{it}^{N} be the suicide rate of 14- to 18-year-olds per 100000 in state i at time t if there is no safety tip line, for state $i =$

$1, \ldots, j + 1$, and time periods $t = 1, \ldots, T$. Let, S_{it}^{I} be the youth suicide rate per 100000 in state i at time t if state i introduces safety tip line. If T_0 is the number of years before the launch of safety tip line, with $1 \leq T_0 < T$, then for $t \in \{1, \ldots, T_0\}$ and all $i \in \{1, \ldots, N\}$, we have that $S_{it}^{I} = S_{it}^{N}$

Let $\alpha_{it} = S_{it}^{N} - S_{it}^{I}$ be the impact of the tip line for state i at time t if tip line is in effect in state i in periods $T_0 + 1, T_0 + 2, \ldots, T$ (where $1 \leq T_0 < T$). Rearranging,

$$S_{it}^{I} = S_{it}^{N} + \alpha_{it}$$

Next, let D_{it} be a dummy variable that is equal to 1 if state i launches safety tip line at time t and is equal to 0 otherwise. The observed youth suicide rate for state i at time t is

$$S_{it}^{I} = S_{it}^{N} + \alpha_{it} D_{it}$$

If the tip line is in effect only in the first state (say, Colorado) and only after period T_0, we have that $D_{it} = 1$ if i = 1 and $t > T_0$.

Let the first state (say, Colorado) be the treated state. Hence, parameters of interest are $(\alpha_{1,T0+1}, \ldots, \alpha_{1,T})$, the lead specific causal effect of the school safety tip line on youth suicide. For $t > T_0$,

$$\alpha_{1t} = S_{1t}^{I} - S_{1t}^{N} = S_{1t} - S_{1t}^{N}$$

Because Y_{1t} is observed, we only need an estimate of Y_{1t}^{N} to estimate the effect of the tip line. The unknown Y_{1t}^{N} is approximated with a weighted average of untreated states. Hence, the effect of the tip line is:

$$\hat{\alpha_{1t}} = S_{1t} - \sum_{j=2}^{j+1} W_j^{*} S_{jt}$$

The weighting vector W* in SCM is chosen such that it minimizes some distance, $|X_1 - X_0 W|$, as follows:

$$||X_1 - X_0 W|| = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$$

where X_1 is the vector of pre-treatment linear combinations of suicides and predictors of suicide not affected by the safety tip line for the treated state and X_0 is a vector with the same variables for the control states.V is a positive definite and diagonal matrix. V minimizes the root mean squared prediction error (RMSPE) of the outcome variable for the pre-treatment period. The predictors of suicide that are not affected by the safety tip lines are the percentage of the population that are less than age 19, male, white, and county unemployment rate and per capita.

I evaluate the effect of school safety tip line using SCM for two states, Colorado and Michigan, separately. Therefore, I construct two separate synthetic control groups for the two treated states to show the outcome of intervention in each of the two states. I exclude other treated states as these states introduced safety tip lines in or after 2016. Because my sample period ends in 2018, there is either too few or zero post-intervention periods for these excluded states. I also discard Missouri as a potential treated state due to lack of available information.

Because eight states launched statewide safety tip line programs during the 1999–2018 period, those states (and Missouri) are excluded from the donor pool of control states. My donor pool includes the remaining 41 states and District of Columbia.

5 RESULTS

Following Cheng and Hoekstra (2013), I begin my analysis by presenting the raw data of the tip line adopting and non-adopting states in a set of figures to check if the parallel trends assumption holds for the two groups. Figure 3 shows youth suicide rates over time for treated states and control states, by year of treatment. For example, Figure 3A shows the youth suicide rate for Colorado, which launched safety tip line website in 2007, compared to states that did not launch tip line websites and mobile applications between 1999 and 2018. We can make few observations from figure 3. The first is that suicide rate has a rising trend in both control and adopting states after 2007. The trend is flat or slightly decreasing between years 1999 and 2006.

Second, except for the three states introducing tip lines in 2018 (Nevada, Maryland, and Florida), suicide rate in tip line adopting states increased more or decreased less than in nontreated states before the treatment takes place. While the trend is not clear for Colorado in the pre-treatment period, if we look at the line of best fit for both Colorado (treated state) and the control states in pre-treatment periods (1999-2006) in figure 4, we see that suicide rate had a slightly decreasing trend for both groups. But the rate of decrease was larger for non-adopting states relative to Colorado. On the other hand, the rate of increase was larger in Michigan, Utah, Wyoming, and Oregon compared to control states in the pre-adoption periods. Hence, the two groups of states have diverging trends, that is, the slope of the trend lines differ for the two groups. This violates the parallel trends assumption of the difference in difference model. I relax this parallel trend assumption by including the state specific linear time trends, which moves the underlying assumption from parallel trends to parallel growth (More and Reggio, 2012). Now the trend lines do not need to have the same slope. The two groups just need to have linearly increasing or similar non-linear trends, which is a less stringent assumption than the parallel trend assumption (More and Reggio, 2012).

Third observation from figure 3 is that suicide rate increased in the post treatment periods for both the groups, with slightly greater increase in adopting states. Post treatment trend seems to have followed from the pre-treatment trend. It does not look like there is any significant effect of the tip line.

Figure 3: Suicide rates before and after the introduction of tip lines, by year of introduction

Figure 3A: Colorado (adoption of tip line in 2007) vs control states

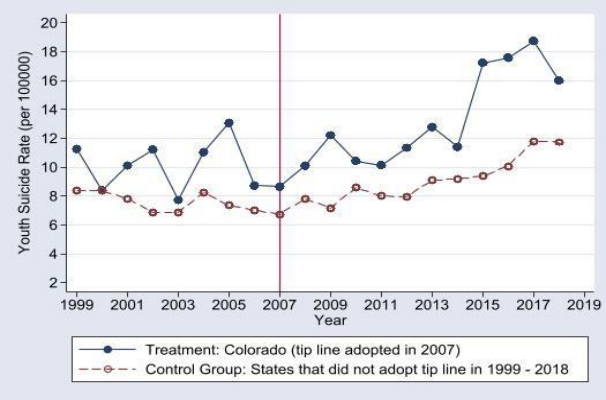


Figure 3B: Michigan (adoption of tip line in 2014) vs control states

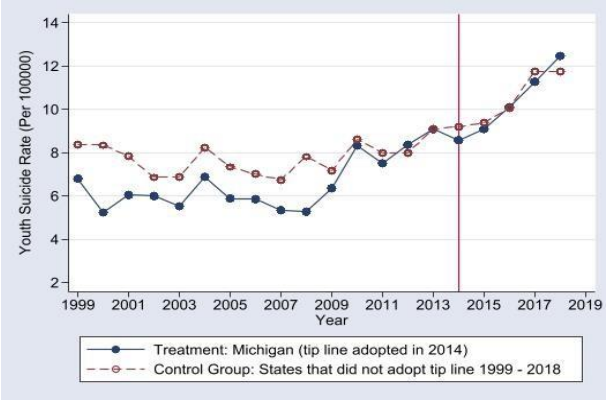


Figure 3C: Utah and Wyoming (adoption of tip line in 2016) vs control states

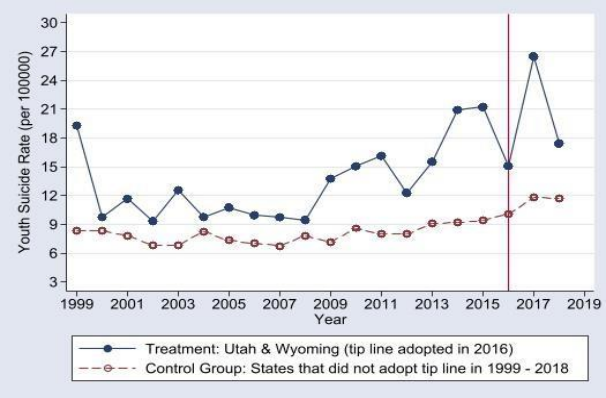


Figure 3D: Oregon (adoption of tip line in 2017) vs control states

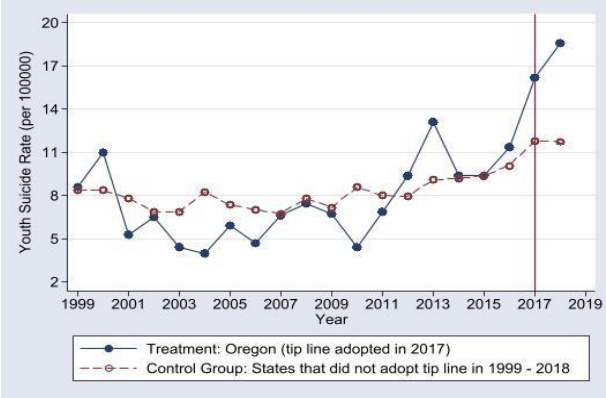


Figure 3E: Nevada, Florida and Maryland (adoption of tip line in 2018) vs control states

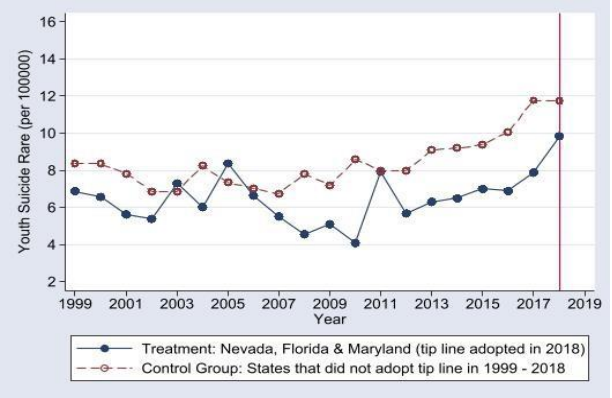
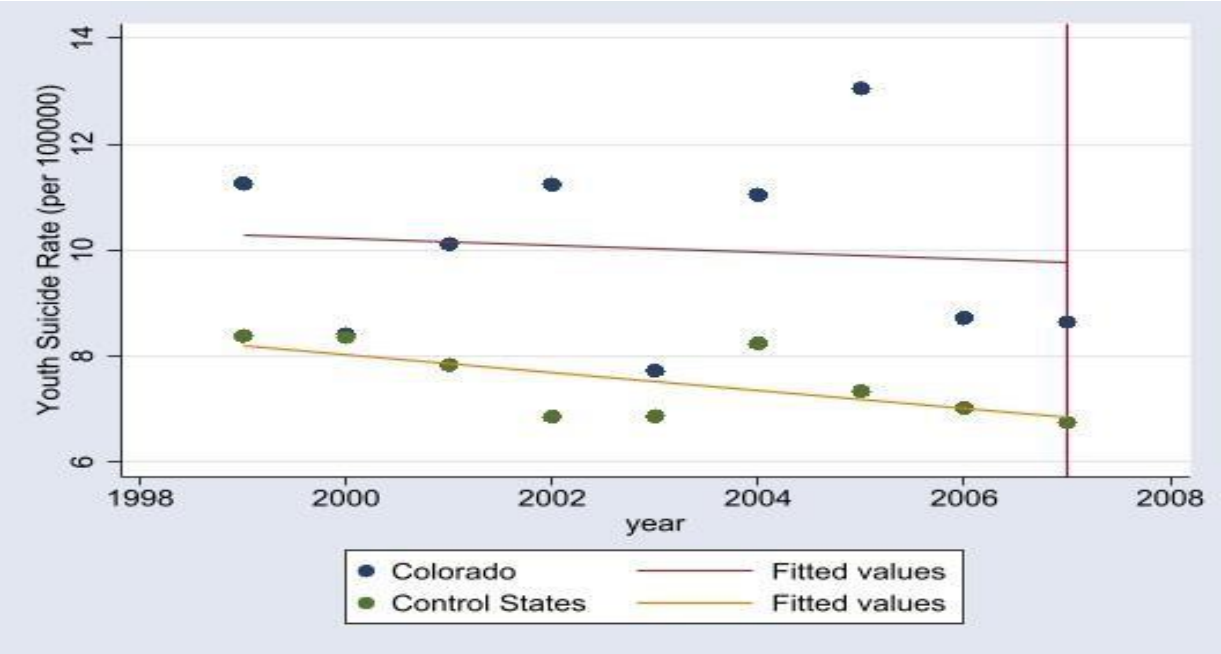


Figure 4: Line of best fit for pre-treatment period, Colorado vs control States



Consistent with the post-treatment trends in figure 3, the baseline results of my difference-in-differences regressions presented in table 4 suggest no clear effect on youth suicide rate following the adoption of school safety tip lines. Column 1 represents a model that accounts for county and year fixed effects but does not include any control variable. In columns (2) through (4), I add county-level time-varying demographic and economic covariates, and state- level CAP law. The estimates remain similar and insignificant for all the specifications. As my estimates are not precisely estimated zeroes, I cannot definitively rule out effects of any meaningful magnitude. My 95% confidence interval is between -1.22 and 2.80 in the main specification (Column 4). Hence, the true effects may be negative, zero or positive. However, since my point estimates are positive and moderately large (0.786 percentage point or 7.69%), it is likely that tip lines did not have a large negative effect on youth suicide.

Table 4: Difference-in-differences results: youth suicide rate

	(1) Youth Suicide Rate	(2) Youth Suicide Rate	(3) Youth Suicide Rate	(4) Youth Suicide Rate
Safety tip line	0.724	0.724	0.785	0.786
	(0.809)	(0.810)	(0.806)	(0.806)
County-year Observations	50,874	50,874	50,874	50,874
Number of counties	2,968	2,968	2,968	2,968
Demographic Controls	No	YES	YES	YES
Economic Controls	No	No	YES	YES
CAP Law	No	No	No	YES
County FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
State Specific Time Trend	YES	YES	YES	YES

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.
Notes: The outcome variable is annual county suicide rates of 14-to-18-year-olds per 100000 obtained from the CDC's Multiple Causes of Death data (1999-2018). Controls include county level unemployment rate, log of per capita income, the share of county population that is male, white, under the age of 19 and an indicator for the presence of CAP laws. Standard errors in the parentheses are corrected for clustering at the state level.

I also present my results using an event study analysis. I replace school safety tip line program with a dummy variable that is equal to 1 the year in which a tip line was launched, 5 leads of this indicator (lead2, lead3, lead4, lead5 and lead5+), and 5 lags (lag1, lag2, lag3, lag4, lag5 and lag5+). The omitted category is one year prior to the adoption of the program. That is, each estimate of coefficient represents the change in youth suicide rate in tip line adopting states relative to non-adopting states during year y, as estimated from the year immediately before adoption. The outcome is youth suicide rate and controls include county fixed effects, year fixed effects, state specific liner time trends, demographic and economic controls, and presence of Child Access Prevention (CAP) laws. The results are presented in table 5 and figure 5. We can see from the figure and the table that the pre-adoption coefficients are statistically indistinguishable from zero, thereby satisfying the parallel growth assumptions. The post- treatment coefficients, while

positive, are insignificant with large standard errors. There is no evidence of any effect of the school safety tip lines on youth suicide rate.

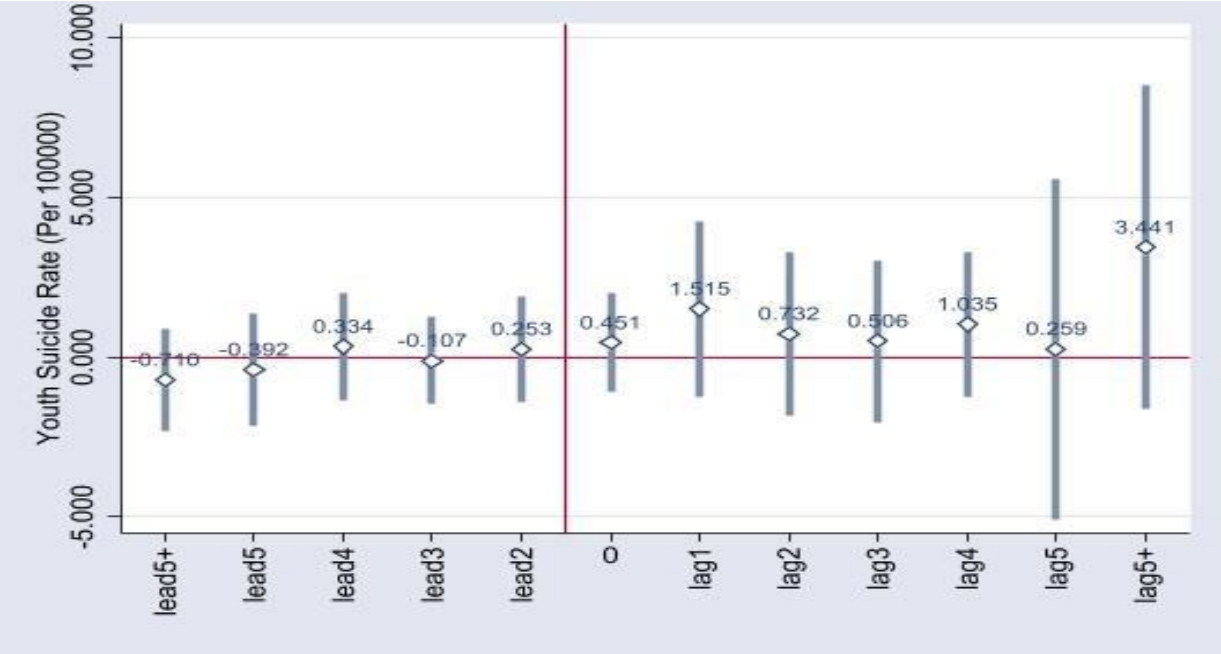
Table 5: Leads and lags of school safety tip lines

	(1) Youth Suicide Rate
5+ years prior to Tip line	-0.710
	(0.821)
5 years prior to Tip line	-0.392
	(0.896)
4 years prior to Tip line	0.334
	(0.847)
3 years prior to Tip line	-0.107
	(0.695)
2 years prior to Tip line	0.253
	(0.844)
Year of Tip line	0.451
	(0.788)
1 year after Tip line	1.515
	(1.397)
2 year after Tip line	0.732
	(1.316)
3 year after Tip line	0.506
	(1.298)
4 year after Tip line	1.035
	(1.155)
5 year after Tip line	0.259
	(2.717)
5+ year after Tip line	3.441
	(2.589)
County-year observations	50,874
Number of counties	2,968
Demographic Controls	YES
Economic Controls	YES
CAP Law	YES
County FE	YES
Year FE	YES
State Specific Time Trend	YES

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: The outcome variable is annual county suicide rates of 14-to-18-year-olds per 100000 obtained from the CDC's Multiple Causes of Death data (1999-2018). Controls include county level unemployment rate, log of per capita income, the share of county population that is male, white, under the age of 19 and an indicator for the presence of CAP laws. Standard errors in the parentheses are corrected for clustering at the state level. The omitted category is one year prior to the adoption of the program.

Figure 5: Pre- and post-treatment trends in suicide rates of 14-to-18-year-olds per 100000



Notes: The outcome variable is annual county suicide rates of 14-to-18-year-olds per 100000 obtained from the CDC's Multiple Causes of Death data (1999-2018). Controls include county level unemployment rate, log of per capita income, the share of county population that is male, white, under the age of 19 and indicator for the presence of CAP laws. Standard errors in the parentheses are corrected for clustering at the state level. The omitted category is one year prior to the adoption of the program.

As robustness checks for my difference-in-difference results, I apply natural log and inverse hyperbolic sine (IHS) transformation to the dependent variable, youth suicide rate[10]. An advantage of the natural log and inverse hyperbolic sine (IHS) transformation is that both diminish the influence of outliers. Also, ln(y+1) and IHS transformed dependent variables are defined when the original variable is zero, thus allowing for zero values[11]. I also estimate a Poisson regression, with the dependent variable as the count of suicides of 14-to-18-year-olds in county *c* and year *t*. The natural logarithm of the county population of 14-to-18-year-olds is used as an offset variable in the Poisson regression. Accounting for the full set of control variables, fixed effects and state

[10] Youth suicide rate's histogram shows skewness to the right, indicating that natural log and IHS transformation may improve efficiency in the estimation.

[11] Since ln(y) is undefined when y=0, dependent variable is transformed as ln(y+1)

specific linear time trend, columns 1, 2, and 3 of table 6 report the results. All three specifications show no significant effect for youth suicide rate.

Table 6: Difference-in-differences results: robustness checks with transformed dependent variables and Poisson regression

	(1) Natural Log Rate	(2) Inverse Hyperbolic Sine	(3) Poisson
Safety Tip Line	0.0197	0.0143	0.00823
	(0.0792)	(0.0936)	(0.0742)
County-year observations	50,874	50,874	44,647
Number of counties	2,968	2,968	2,444
Demographic Controls	YES	YES	YES
Economic Controls	YES	YES	YES
CAP Law	YES	YES	YES
County FE	YES	YES	YES
Year FE	YES	YES	YES
State Specific Time Trend	YES	YES	YES

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.
Notes: In columns (1) and (2), the outcome variable is annual county suicide rates of 14-to-18-year-olds per 100000 obtained from the CDC's Multiple Causes of Death data (1999-2018). In column (3), the outcome variable is annual counts of suicide of 14-to-18-year-olds in a county. Controls include county level unemployment rate, log of per capita income, the share of county population that is male, white, under the age of 19 and an indicator for the presence of CAP laws. Standard errors in the parentheses are corrected for clustering at the state level.

Although tip line programs may have some spillover effects on other age groups, such effects should be very low. Therefore, finding effects on suicide rate of other age groups might invalidate my research specification. To that end, I replace youth suicide rates with adult suicide rates in columns (1) and (2) of Table 7. Specifically, I consider the suicides rate of 18+ year-olds in column (2). I restrict the age range between 19- and 23-year-olds in column (1). I find estimated coefficients to be statistically insignificant across both specifications. Additionally, an event study analysis (Figure 6) shows zero difference in adult suicide rate between adopting and non-adopting states in both pre-treatment and post-treatment periods.

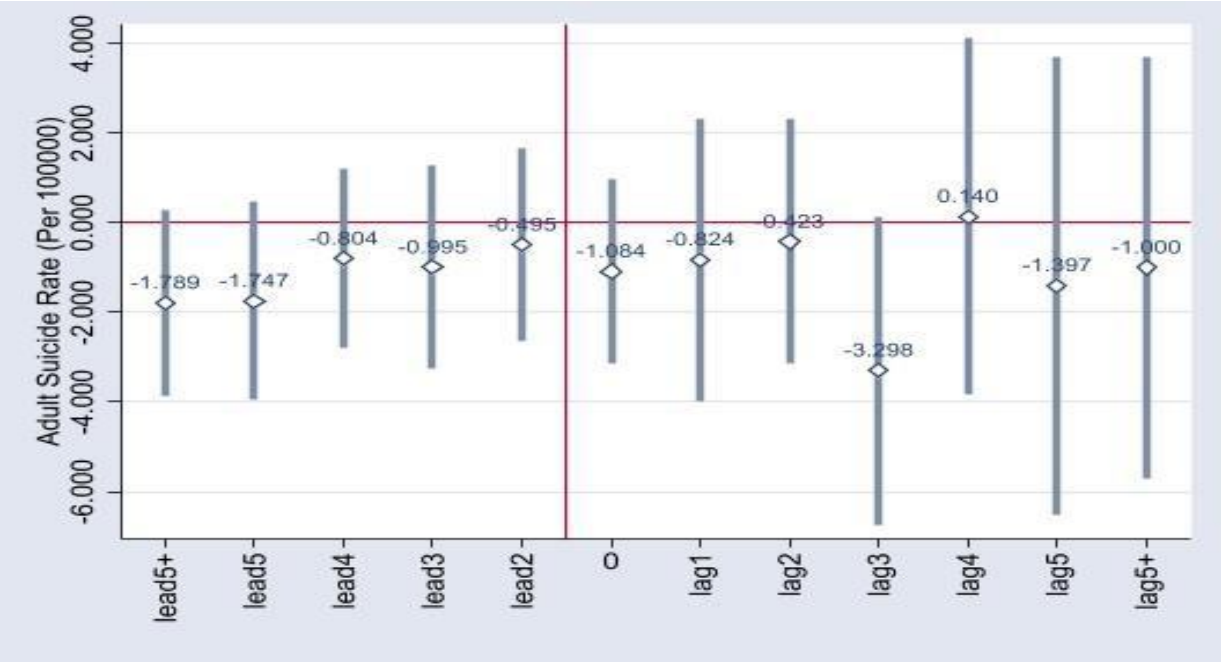
Table 7: Difference-in-differences results: adult suicide rate

	(1) Adult Suicide Rate (19- to 23-year-olds)	(2) Adult Suicide Rate (19+ year-olds)
Tip Line	-0.649	0.205
	(0.932)	(0.333)
County-year observations	50,874	50,874
Number of counties	2,968	2,968
Demographic Controls	YES	YES
Economic Controls	YES	YES
CAP Law	YES	YES
County FE	YES	YES
Year FE	YES	YES
State Specific Time Trend	YES	YES

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: The outcome variable is annual county suicide rates of 19-to-23-year-olds per 100000 (column 1) and 19+ year-olds per 100000 (column 2) obtained from the CDC's Multiple Causes of Death data (1999-2018). Controls include county level unemployment rate, log of per capita income, the share of county population that is male, white, age between 19 and 23 (column 1) and over the age of 19 (column 2) and an indicator for the presence of CAP laws. Standard errors in the parentheses are corrected for clustering at the state level.

Figure 6: Pre- and post-treatment trends in suicide rates of 19-to-23-year-olds per 100000



Notes: The outcome variable is annual county suicide rates of 19-to-23-year-olds per 100000 obtained from the CDC's Multiple Causes of Death data (1999-2018). Controls include county level unemployment rate, log of per capita income, the share of county population that is male, white, age between 19 and 23 years and indicator for the presence of CAP laws. Standard errors in the parentheses are corrected for clustering at the state level. The omitted category is one year prior to the adoption of the program.

We saw in table 2 that suicide rate varies across race and gender, with white and male youths having higher rates of suicides. To that end, I explore potential heterogenous effects of the tip lines across race and gender in table 8. Columns (1) and (2) present the impact of tip lines for white and black youths, respectively. I consider suicide rates of male and female youths in columns (3) and (4), respectively. The results suggest that tip lines did not have any impact on the suicide rates across any of the demographic groups.

Table 8: Heterogeneity

VARIABLES	(1) White Youth Suicide Rate	(2) Black Youth Suicide Rate	(3) Male Youth Suicide Rate	(4) Female Youth Suicide Rate
Tip Line	1.380	-1.602	1.930	-0.398
	(0.887)	(2.048)	(1.249)	(0.880)
County-year observations	50,874	49,974	50,874	50,874
Number of counties	2,968	2,949	2,968	2,968
Demographic Controls	YES	YES	YES	YES
Economic Controls	YES	YES	YES	YES
CAP Law	YES	YES	YES	YES
County FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
State Specific Time Trend	YES	YES	YES	YES

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.
Notes: The outcome variable is annual county suicide rates of 14-to-18-year-old white, black, male and female youths per 100000 obtained from the CDC's Multiple Causes of Death data (1999-2018). Controls include county level unemployment rate, log of per capita income, the share of county population that is male, white, under the age of 19 and an indicator for the presence of CAP laws. Standard errors in the parentheses are corrected for clustering at the state level.

Figure 7 show results from my Synthetic Control Method analysis for Colorado (Panel A) and Michigan (Panel B). The solid line shows youth suicide rate for Colorado in Panel A and the same outcome for Michigan in Panel B. In both graphs, the dashed line represents the counterfactual of the respective states, i.e., synthetic Colorado in Panel A and synthetic Michigan in Panel B[12]. We can see that both synthetic Colorado and synthetic Michigan closely matches actual Colorado and actual Michigan prior to the adoption of school safety tip lines. Panel A shows that there is no

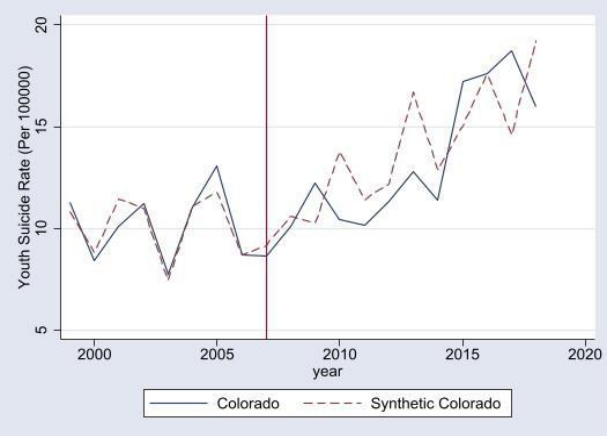
[12] Synthetic Colorado consists of Delaware (0.182), Hawaii (0.001), Idaho (0.345), Montana (0.373), North Dakota (0.023). Synthetic Michigan consists of Alabama (0.042), Delaware (0.101). District of Columbia (0.012), Illinois (0.108), Kansas (0.017), Massachusetts (0.099), Montana (0.033), New Jersey (0.203), New York (0.05), North Carolina (0.079), North Dakota (0.074), Oklahoma (0.182)

distinct difference between the suicide rates of actual Colorado and synthetic Colorado in the post-adoption period. Although we see no distinct difference between the two lines, and no immediate impact of the tip line, SCM suggests an average decrease in youth suicide rate of 0.56 or 4.1% each year in Colorado. However, the effect is statistically insignificant, which I will discuss shortly. This finding is consistent with the results from the difference-in-differences method.

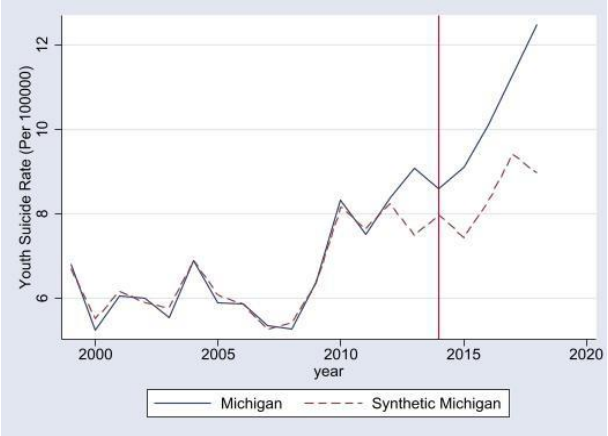
Panel B shows a surprising result for Michigan. It seems that suicide rate has increased in Michigan after the adoption of school safety tip line, compared to the counterfactual. If we look closely at the figure, however, it shows that the solid line seems to diverge from the dashed line even before the treatment takes place, as the suicide rate in Michigan rapidly increases from 2013. There was already a difference in the suicide rate between Michigan and synthetic Michigan in 2013 and 2014, and that difference seems to persist in the post-treatment years. In any case, result from the SCM suggests an average increase in suicide rates of 1.89 or 20.11% each year. However, the effect is not significant at 5% level, and is barely significant at 10% level (p value 0.093). This suggests that tip line did not have any effect on the prevention of youth suicide rate in Michigan.

Figure 7: Synthetic control results: youth suicide rate

Panel A: Colorado



Panel B: Michigan

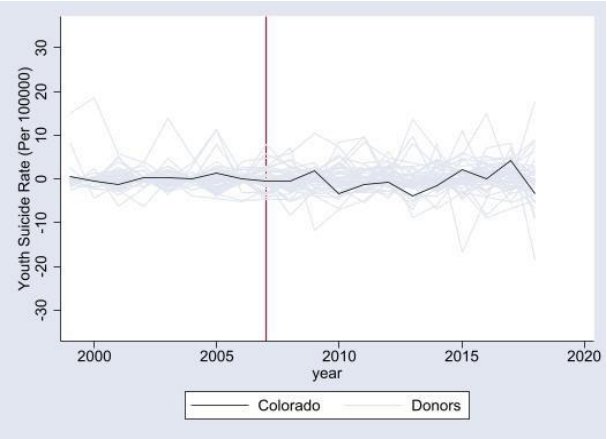


To determine the significance of the result from SCM, and to calculate the p value, I follow the inferential technique proposed by Abadie, Diamond, and Hainmueller (2010). First, I iteratively apply the SCM for the same treatment period to each of the 41 control states and District of Columbia. This results in a graph that shows a distribution of placebo effects. I then compute the Root Mean Squared Prediction Error (RMSPE) for each placebo for both pre-adoption and post-adoption periods. After computing the ratio of post-treatment RMSPE to pre-treatment RMSPE for each state, I sort the ratios from highest to lowest. Finally, p value is calculated as rank/total. Intuitively, since the pre-treatment Colorado (Michigan) closely matches the synthetic Colorado (synthetic Michigan), the pre-treatment RMSPE should be a small value. On the other hand, a large deviation in the post-treatment period would have resulted in a large post-treatment RMSPE. A high post to pre ratio therefore means low probability of SCM result being a matter of chance. However, because we do not see large post-adoption difference between the two lines in graph 7, I do not expect a large post-treatment RMSPE, and a large ratio for both Colorado and Michigan, compared to other control states on which SCM is applied.

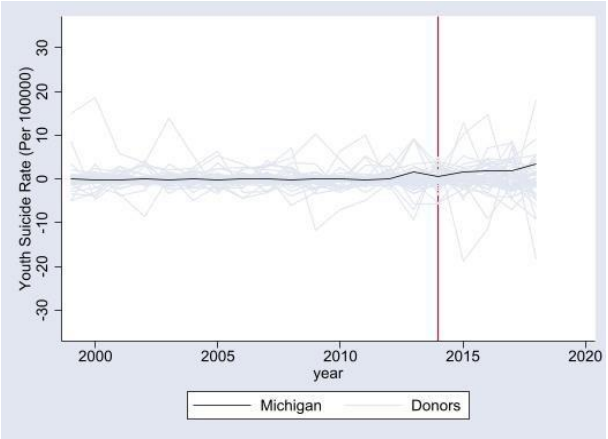
The results of these placebo exercises are shown in figure 8. Clearly, suicide rates in both Colorado and Michigan do not belong to the tails of the distribution of placebo states, that is, the two states are not outliers in the distribution. P-values for Colorado and Michigan are 0.139 and 0.093, respectively, which confirm that the effects of the tip lines are insignificant at the 5% level.

Figure 8: Synthetic control placebo results: youth suicide rate

Panel A: Colorado



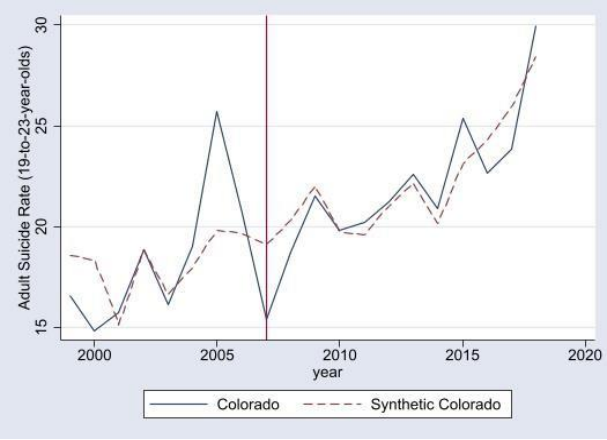
Panel B: Michigan



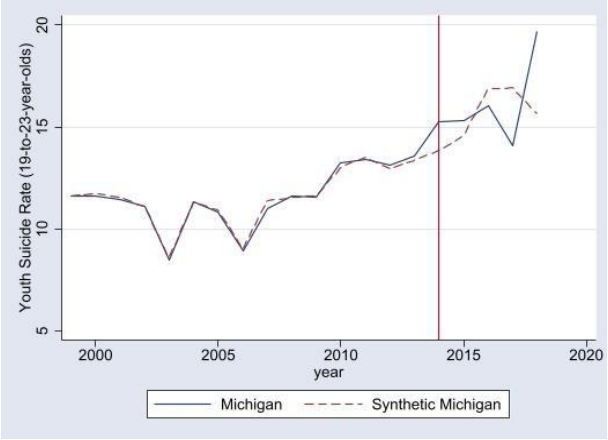
As a falsification test, I apply the SCM to the suicide rate of 19-to-23-year-olds. The results are shown in figure 9. It is clear from Panel B of figure 9 that tip line does not cause any distinct difference in the suicide rate in Michigan, compared to its counterfactual. On the other hand, panel A shows that the pre-treatment match between Colorado and its counterfactual is not credible. A good match is not found by the algorithm as the suicide rate in Colorado sharply rises from 2004 to 2005. None of the combination of the donor states can replicate this sharp increase. As such, synthetic control method may not be well suited to identify the effect of the tip line on suicide. In any case, we do not see any significant post-treatment difference between Colorado and synthetic Colorado.

Figure 9: Synthetic control results: adult (19-to-23-year-olds) suicide rate

Panel A: Colorado



Panel B: Michigan



6 CONCLUSION

The rapid rise in suicidal behavior and suicide deaths among high school students in recent years poses one of the biggest challenges that the American public health sector is currently facing. School safety tip lines, which enable students to anonymously report suspicious activities and suicidal behaviors of their classmates and friends, have emerged as a potential medium to prevent students from committing suicide. The tip lines in different implementing states have led to multiple interventions that saved the lives of suicidal high school students.

Using data from the Center for Disease Control's (CDC) Multiple Causes of Death data for the period 1999-2018, I examine whether the tip lines have made any significant difference in the rate of youth suicide in the tip line adopting states, compared to non-adopting states.

My results suggest that school safety tip lines had no effect on the suicide rate of high- school aged youths (14-to-18-year-olds). My results are robust across both the difference-in- differences and synthetic control methods. Additionally, the zero effects are apparent in graphical analysis of raw data. Although there is anecdotal evidence of tip lines being used to save several suicidal students, it seems tip lines did not make enough difference to produce statistically significant results. Also, except for Colorado, there are either very few or zero post- treatment periods for other treated states during my sample period (1999-2018). This may have also contributed to insignificant results. As more states start implementing tip lines, and as data of more post-treatment years becomes available, the effect of tip lines may become evident in the prevention of youth suicide.

Because safety tip lines tend to be adopted in the wake of school shootings, the assignment of interventions may not be random. Even though youth suicide was not a primary focus for the initial adoption of the tip lines, it is likely that models in this paper suffer from slight endogeneity issues. There is possibility that tip line implementing states have passed other gun-related

legislations immediately before or after the adoption of tip lines[13]. These laws, in turn, may change the way tip lines affect youth suicide, and may have biased the results in this paper. The direction of this bias is ambiguous. A body of research shows a positive association between firearm availability and suicides (Knopov et al., 2019; Rodríguez Andrés and Hempstead, 2011; Briggs and Tabarrok, 2014; Phillips, 2013). Restrictive gun laws may, therefore, reduce youth suicides by making guns less accessible to youths. On the other hand, possibility or discussion of the passage of restrictive gun laws leads to large spike in firearms sales in the US (Levine and McKnight, 2020). This may result in higher rates of youth suicide.

Finally, there is little evidence in the literature that previous and ongoing school-based suicide prevention programs have been successful in reducing suicide morality, although most programs have shown generally positive results in terms of increasing knowledge and improving attitudes towards suicide. Katz et. al., (2013), after conducting a systematic review of the literature of school-based suicide prevention programs in USA, hypothesize that a single program may not be enough to effectively prevent suicide among school students. They suggest using a combination of programs. Indeed, future research can evaluate two or more programs in combination to see whether these programs complement each other. For example, peer leadership training program such as Sources of Strength, and a school safety tip line program share the same idea about preventing suicide- classmates and friends are more likely to identify suicidal students. They differ in methods of reporting. As a result, peer leadership training program may complement school safety tip line, and potentially increase the effectiveness of tip lines. Students will be more successful in identifying suicidal students if they are properly trained to recognize symptoms of suicide, as found in peer leadership training program. This may result in more actionable tips being reported by trained students. Ideally, the synergy between the two programs will lead to

[13] For example, after the Columbine School shooting, state of Colorado passed gun laws related to the sale of firearms at gun shows, concealed carry, and "straw purchases" (Schwartz, 2012).

more suicides being prevented.

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