The Effect of High School Shootings on Schools and Student Performance

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Abstract

We analyze how fatal shootings in high schools affect schools and students using data from shooting databases, school report cards, and the Common Core of Data. We examine schools' test scores, enrollment, and number of teachers, as well as graduation, attendance, and suspension rates at schools that experienced a shooting, employing a difference-in-differences strategy that uses other high schools in the same district as the comparison group. Our findings suggest that homicidal shootings significantly decrease the enrollment of students in grade 9 (the high-school entrance grade), and test scores in math and English. We find no statistically significant effect for suicidal shootings on all outcome variable of interest. Using student-level data from California, we confirm that shootings affect students that remain enrolled, and the effect is not only through a composition effect.

JEL classification: J13, I29, K4

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1 Introduction

Student violence in high schools may hinder students from learning efficiently. Extreme violent incidents could be a distraction from learning; fear and an unsafe atmosphere could impede students from being open to new opportunities that are essential to learning and, even more problematically, students may avoid attending school. Also, violent incidents could affect the allocation of teaching time. These factors could influence students' cognitive performance and behavioral outcomes.

There has been a steady number of school shootings in U.S. high schools from 1994 to 2009. School shootings may affect all the students attending the school at which they occur, their parents, and the community. These unfortunate incidents are often the subject of national and international headlines. Given their potential negative impact, there is a need for in-depth research on the effect of school shootings on schools and students. The consequences of these incidents have not been analyzed in depth.

We estimate the causal impact of deadly high school shootings using a difference-in-differences strategy, comparing schools that had fatal shootings with other high schools in the same district that did not experience such shootings. Because we compare schools within the same district, our comparison group typically experiences an environment similar to our group of interest (aside from the turmoil generated by the shooting). It is usually hard to separate the effect of school violence on student performance from other disadvantageous neighborhood characteristics because they are positively correlated and, as a result, there is a significant omitted variable bias. Our empirical strategy relies on the assumption that these deadly school shooting incidents are extreme cases that can be interpreted as exogenous in their timing and location. To do this, we merge an existing database on fatal shootings with the high-school-level Common Core of Data (CCD) and school report cards to form a panel of schools.

We aim to estimate the causal impact of high school shootings on school outcomes (enrollment per grade and number of teachers employed), student performance (math and English test scores), and school behavioral outcomes (graduation rates, attendance rates, and number of suspensions per 100 students) using school-level data. More specifically, we address three questions related to the consequences of homicidal and suicidal high school shootings. First, we address whether enrollment patterns change after the shootings, which could be a result of school selection by students and parents or students dropping out of the school system. Second, we examine whether deadly shootings cause longer-term trauma that lowers test scores in the school up to three years after the incident. Third, we look at behavioral variables and study how they are affected.

We find decreases in enrollment in grade 9 (but not in subsequent grades for the first year after a shooting), and in math and English standardized test scores after homicidal school shootings up to three years after a shooting. However, we do not find statistically significant impacts on behavioral outcomes: graduation, suspension, or attendance rates. We find that suicidal shootings have no significant impact on our outcome variables of interest.

This leaves open the question of whether students are affected by shootings or if differences in performance instead reflect a composition effect (for example, students with a high level of achievement might not stay or register at the school after a shooting). To address this question, we use student-level data from California. This data allows us to identify the average treatment effect of shootings, conditional on students taking a test at the same high school before and after a shooting. Using student-level panel data from California high schools, we find that shootings have a negative effect on students' math and English test scores.

The rest of this paper is organized as follows: section 2 describes the theory and related empirical evidence, section 3 provides descriptive statistics, section 4

explains the methodology used, section 5 presents results, and section 6 concludes the paper.

2 Related literature

Multiple studies show that students are negatively affected by violent crimes on several dimensions. Early studies on this topic include Pynoos et al. (1987), McEwen and Sapolsky (1995), and Berman et al. (1996).

Berman et al. (1996) find that students who have been exposed to violent crimes show a greater number of post-traumatic stress disorder (PTSD) symptoms. Among those who were exposed to a violent crime, 44.3 percent were categorized as having "moderate" PTSD symptoms and 18.6 percent as 'severe' PTSD symptoms.[1] Berman et al. find that victims and witnesses exhibit a similar number of PTSD symptoms.

Likewise, Pynoos et al. (1987) find that elementary school students experienced PTSD after a fatal sniper attack on their school playground.[2] The severity of PTSD was worse for all exposure levels if the students knew the victim well. However, they find no difference in severity by age, sex, or ethnicity.

Building on evidence that violent crime causes PTSD, McEwen and Sapolsky (1995) demonstrate that PTSD increases the frequency of declarative errors, but has no effect on tasks that have fewer declarative and more procedural components. Declarative knowledge involves explicit knowledge of a fact, whereas procedural knowledge is implicit knowledge of how to do something.

Several recent studies focus on finding the best course of action by caregivers and authorities after violent crimes (see, for example, Stein et al. (2003), Cohen et al. (2006), and Aycox et al. (2012)).

[1] The categorization is based on the Frederick scoring system of the Post-traumatic Stress Disorder Reaction Index (PTSD-RI).

[2] On Feb 24, 1984, a sniper began firing from a second-story window across the street from an elementary school at children on the school playground. Two children were killed and 13 were injured.

Recent papers study the effects of school violence. Poutvaara and Ropponen (2010) analyze the immediate effect of a school shooting in September 2008 at a school in Finland in the middle of a national exam period that lasts 2-3 weeks. They find that the shooting decreased average test scores for boys but not for girls. Since a fatal shooting can be considered exogenous to other determinants of educational outcomes, Poutvaara and Ropponen's estimates can be interpreted as causal.[3]

Other papers that study the effect of neighborhood violence on student performance include Grogger (1997) and Sharkey (2010). Both of these papers show that students are negatively affected by violence in their neighborhood. Grogger (1997) studies how local violence, defined as a combination of school violence and neighborhood violence, negatively affects educational attainment. Sharkey (2010) identifies the negative effect of exposure to a local homicide on the cognitive performance of children. He finds that a sample of African-American children between five and 17 years old had lower scores on educational assessments when they were exposed to a homicide in the Census block group less than a week before the assessment. Finally, Carrell and Hoekstra (2010) find that children who suffer from domestic violence significantly decrease the reading and math test scores of their peers and increase the amount of misbehavior in the classroom.

Our paper aims to improve the understanding of how extreme violence in schools affects enrollment, student performance, the number of teachers in a school, and student behavior, based on a sample of deadly shootings that occurred between 1994 and 2009. We also analyze student performance using nationwide aggregated school-level data up to three years after the shooting, and student-level data from California. Moreover, we hypothesize that homicidal shootings cause more severe

[3] Anderson et al. (2001) categorize school shootings from 1994 to 1999 by type of incident, weapon use, whether it occurred in a rural or urban area, and time of day. Chandler et al. (2011) build a predictive model of shootings, which helps determine which students should be included in a highly targeted and resource-intensive mentorship program in Chicago. Chandler et al. (2010) find that shootings are very hard to predict.

effects on students compared to suicidal shootings, and confirm this by analyzing homicidal and suicidal shootings separately. This suggests that the traumatic impact of homicidal shootings plays a key role in explaining our results.

3 Data and Descriptive Statistics

3.1 Shooting Data

Our main data source of shooting incidents is the Report on School Associated Violent Deaths from the National School Safety Center (2010). The report uses newspaper articles to track shootings from 1994 to 2009.[4] Additional school shooting data is from Washington Ceasefire and the National School Safety and Security Services, which we verified with information from newspaper clippings.

We use the National School Safety Center's definition of a deadly school shooting, which is any homicidal or suicidal gun-related death in the United States that occurred on the property of a functioning public, private or parochial secondary school; on the way to or from regular sessions at such a school; while a person was attending or was on the way to or from a school-sponsored event; or as an obvious direct result of school incidents, functions or activities, whether on or off a school bus, school vehicle or school property.

As shown in Figure I, we document 157 shootings in high schools between 1994 and 2009 that resulted in one or more deaths. These shooting schools contained approximately 245,391 enrolled students, who may have suffered negative direct or indirect consequences from the event. We do not detect any trend in the annual number of deadly shootings. Among the 157 shootings that occurred in high schools, 104 were categorized as homicidal and 53 were suicidal incidents. Among the 104 homicidal shootings, 27 involved multiple deaths (ranging from 2 to 15 people).[5]

[4] We use the year of the fall semester to indicate the school year. For instance, we refer to the 2001-02 school year as 2001.

[5] When a person shot someone else and then committed suicide, we categorized the incident as a

3.2 School-Level Data

Data on school characteristics is from the Common Core of Data (CCD) from the National Center for Education Statistics (NCES) from 1990 to 2009. The data set provides a complete listing of all public elementary and secondary schools in the U.S. and provides basic information and descriptive statistics on schools, their students, and their teachers. We use CCD data for enrollment per grade (grades 9 to 12) and number of teachers.[6]

We define our comparison group as other high schools in the same district. Schools in the same district have many similar unobservable characteristics. As Figure II reveals, enrollment in other schools in the same district is not negatively affected by shootings. Thus, we do not double count the movement of students from shooting schools to comparison schools. Our estimates can be viewed as a lower bound of the true effect of school shootings on student outcomes because the comparison schools are influenced due to their physical proximity, albeit at a different magnitude. Figure II shows a decrease in entrance grade 9 enrollment after a shooting takes place.

Table I shows that schools that experience shootings are larger than average, both in terms of the number of total enrolled students and in full-time equivalent teachers (FTEs). This size difference is present in all grades and is noticeably larger in grade 9, the entrance grade for most high schools and before students are permitted to drop out of school.

School performance data is from each state's Department of Education website. A student's ability in math and English is tested at least once during high school using a standardized test. Information is extracted from each school's report card and from data files posted by each state's Department of Education. We focus on data

homicidal shooting. We classify accidental gun-related deaths in the homicidal category.

[6]There is no information on teacher turnover at the school level in the CCD.

from 2002 to 2010 due to availability. The *No Child Left Behind Act* passed in 2001 requires all schools receiving federal funding to administer a state-wide standardized test; in most states, these results are posted online. Most states only publish the proportion of a school's students who fall into various categories of achievement, such as "minimum," "basic," "proficient" and "advanced" performance, rather than the actual mean scores of the schools. We use the proportion of students achieving a proficient or advanced level on math and English state-wide standardized tests for each school, which we refer to as the "proficiency rate," as the outcome variable.

These tests vary from state to state but are identical within a state for any given year.[7] As Table I shows, the mean proficiency rate is not statistically different between "shooting schools" and comparison schools. Figures III and IV display the average proficiency rate for the years before and the years after any shooting incidents for shooting schools and comparison schools, which show a decline in the math and English proficiency rates in the years following a homicidal shooting for schools that experienced a shooting.

In addition, we collected school-level graduation rates, average daily attendance rates, and numbers of suspensions per 100 students for all schools in the districts that experienced shootings in all available states.[8]

[7]We examine the relationship between 36 high school shootings and the proportion of students achieving a proficient- or advanced-level result on English tests in 14 states. We also examine the relationship between 34 high school shootings and the proportion of students achieving a proficient- or advanced-level result on math tests in 13 states. Not all states have both test results posted on their Department of Education websites, which is the reason why the sample size is different for math and English tests. English test results are from Alabama, California, Florida, Louisiana, Michigan, Minnesota, Nevada, North Carolina, South Carolina, Tennessee, Utah, Washington and Wisconsin. Math test results are from Alabama, California, Florida, Louisiana, Michigan, Nevada, North Carolina, South Carolina, Tennessee, Utah, Washington, and Wisconsin.

[8]We have information on graduation rates and attendance rates for shooting-affected school districts for ten shootings in five states (Nevada, North Carolina, South Carolina, Tennessee, and Utah) and information on numbers of suspensions per 100 students for seven shootings in three states (Nevada, North Carolina, and Tennessee).

3.3 Student-Level Data

We use student-level data from California. The data is provided by the California Department of Education (CDE) for 2007 to 2010. During that period, seven deadly high school shootings occurred in seven school districts. The seven affected school districts have 195 high schools within their boundaries and a large number of students. The data contains test results on the California Standards Tests (CST). The CSTs, which are part of the California Standardized Testing and Reporting (STAR) program, are taken by students from grades 2 through 11 in many subjects, but we use only math and English results from grades 9 through 11. We have measures of the proficiency level in math and English for students in the seven districts. The possible levels of math and English proficiency for students in the seven districts are: far below basic (1), below basic (2), basic (3), proficient (4), and advanced (5). We also have information on the sex of the students, which allows us to determine whether shootings affect males and females differently.

4 Methodology

We use a difference-in-differences (DD) strategy to analyze the effect of deadly homicidal high school shootings. The comparison group consists of all other high schools in the same district. We estimate

$$Y_{it} = \beta_0 + \beta_1 After_{it} + \beta_2 After_{it} * Shooting_i + \mu_i + \gamma_t + \epsilon_{it} \qquad (1)$$

where Y_{it} is one of several different outcome variables for school i in year t; $Shooting_i$ is a dummy variable that takes a value of 1 if there was ever a shooting in school i and 0 otherwise; and $After_{it}$ is an indicator for the period after the shootings.[9] The coefficient of the interaction variable ($After_{it} * Shooting_i$) is of

[9]The "after" period is defined differently for the enrollment analysis and the proficiency rate analysis. For the enrollment analysis, the "after" period starts the school year following the shooting,

primary interest, as it captures the casual effect of school shootings on various outcomes. The outcomes of interest are: enrollment per grade (9 to 12), number of teachers, proficiency rate (in math and English), and behavioral variables (graduation, suspension and attendance rates). We include school fixed effects, μ_i for school i, to control for any time-invariant school-level factors that may be correlated with shootings and the outcome variables. We also include year fixed effects to control for any policy changes or trends from 1994 to 2009.[10] We use clustered standard errors at the district level. We use a three-year window around the shooting year.[11]

To identify whether negative effects of school shootings result from students being directly affected by shootings or from a composition effect (e.g. students with a high level of achievement might not stay or register at a school after a shooting), we use student-level data and condition on having a test result before and after a shooting at the same school.[12] We use a similar empirical strategy for student-level data as for school-level data, so that we can exploit the panel aspect of the data at the student level. We estimate conditional logit models with student-level fixed

since enrollment data is typically generated very early in the school year (usually in September or October). For proficiency rate analysis, the "after" period starts the same year as the shooting, since the tests are usually administered towards the end of a school year.

[10]We tested different specifications of the model, such as using district and year fixed effects (controlling for enrollment three years prior), which lead to similar results. Results of this specification can be provided upon request.

[11]The nature of difference-in-differences estimation requires us to check whether the schools and districts have multiple shootings over the sample period. Multiple shootings in one school or district could bias our estimates because the "before" and "after" periods of the shootings could overlap with those of another shooting in the same school or district. High school shootings occur only once in most school districts over the 16 school years; 103 school districts had one shooting, 12 school districts had two shootings, and six school districts had three or more shootings. In our analysis, additional to all initial shootings in a district, we include subsequent shootings in a district if they are six or more years apart. We view shootings six or more years apart as distinct because almost all students who experience a shooting leave their school within three years, which could be interpreted as the school returning to its pre-shooting environment. Another rationale for a three-year window around the year of shootings is that using the entire sample for the difference-in-differences estimator will contain noise in years far from the shooting incidents. This leads us to use a three-year window sample for all analysis.

[12]Similar results are found if we restrict the sample to two observations per student, one before and one after a shooting (balanced panel).

effects. The primary outcome variables of interest are whether a student is proficient in English and math (i.e., whether the student achieves level 4 or 5 in California).

We also investigate the possibility that shootings have heterogeneous effects in two ways. First, we investigate whether shootings affect students in various parts of the test-score distribution differently. To study the most affected part of the distribution, we change the outcome variables in the same regression to the probability of being in level 2 to 5, level 3 to 5, and level 5 to identify which part of the distribution is generating the lower level of test results in schools that experienced a shooting. Second, we study whether boys are affected differently than girls.

5 Results

We analyze the effect of deadly homicidal high school shootings in Tables II, III and IV. In Table V, we present regressions for suicidal shootings.

5.1 Enrollment per Grade and Number of Teachers

Table II reveals that homicidal shooting schools experienced a decline in grade 9 enrollment relative to other schools in the same district.[13] Table II shows that a shooting reduces enrollment in grade 9 by 28 students on average, which represents a 5.8 percent decline in grade 9 enrollment for the average school experiencing a shooting. This decrease in grade 9 enrollment represents a large change in school selection by students entering high school. One possible explanation for the large decline in grade 9 enrollment is that middle school students and their parents try to avoid the school that had the shooting.[14]

[13] We use a subset of high schools for the enrollment analysis, which is high schools where the lowest grade is grade 9 and highest grade is grade 12, to ensure a clear interpretation of the coefficient. Among the 157 high school shootings, 136 occurred in high schools that have grades 9 through 12 over the sample period. Results are robust to the inclusion of all high schools.

[14] Smith et al. (2012), for example, find that parents and students change enrollment decisions in response to negative news about schools.

Enrollment in other grades and the number of teachers employed do not show a statistically significant change after a shooting.[15] The fact that enrollment for grades 10, 11, and 12 does not significantly change the following year after a shooting suggests that continuing students in schools experiencing a shooting have established connections that raise the cost of transferring to another school. It is also likely to be administratively difficult for continuing students to transfer.

Table A.1 in Appendix A presents a regression for enrollment in grades 10 and 11, excluding either the first year or the first two years after a shooting. It shows that a decrease in enrollment for the entrance grade (grade 9) immediately following a shooting is followed by a decrease in the number of student enrolled in grade 10 (after one year) and grade 11 (after two years).

5.2 Math and English Proficiency Rates and Behavioral Outcomes

Columns 1 and 2 of Table III show that the proficiency rate decreases after homicidal shooting incidents relative to comparison schools. Table III indicates that the proficiency rate in math is reduced by 4.9 percentage points, which means that the proficiency rate in math decreased by 9.3 percent for the average school experiencing a shooting. For English tests, the effect of shootings is of a slightly smaller magnitude, 3.9 percentage points lower than the comparison schools. This means that in the average school experiencing a shooting, 6.2 percent fewer students achieve a "proficient" or "advanced" level on their English tests.

Columns 3 to 5 of Table III show the causal effect of deadly shootings on graduation rates, average daily attendance rates, and the number of suspensions per 100 students. We do not find any statistically significant results for all three

[15] We do not have information on teacher turnover in the data. It is possible that some teachers leave after a shooting and are replaced by younger teachers. An alternative approach would be to use the student to teacher ratio as an outcome variable. The coefficient for the student to teacher ratio is positive but not significant. Results are available upon request.

outcomes.

5.3 Effects of Suicidal Shootings

Table IV presents results for the impact of suicidal shootings on outcome variables: enrollment per grade (9 to 12), number of teachers, and the proficiency rate in math and English.[16] Table IV shows that suicidal shootings have no significant impact on any outcome of interest.[17] This suggests that the traumatic effect of homicidal shootings is an important factor to take into account.

5.4 Student-Level Effects

Using California student-level data, Table V shows 4.2 and 10.2 percentage point decreases in the probability of achieving a proficient-level result (i.e. achievement level 4 or 5 in California) in math and English, respectively. These results suggest that the decrease in test scores is not solely due to fewer high-achieving students attending schools where shootings occurred.[18] This suggests that students' academic achievement worsens.

Table VI identifies the effect of shootings on the probability of reaching various achievement levels. It shows that shootings have heterogeneous effects on the math test results. For math tests, the negative effects are concentrated on students who are at the high achievement part of the distribution. The effect of shootings on the probability of reaching achievement level 5 in math tests is large, 10.4 percentage points, which is as large as English test results. The magnitude of the effect of shootings decreases as the achievement level of interest goes down, almost disappearing when looking at the probability of achieving level 3 or higher. However, the negative effect is consistent throughout the distribution for English test results.

[16] We do not have enough observations to study behavioral outcomes for suicidal shootings.

[17] The sample size is smaller and standard errors are bigger.

[18] The results are similar when we restrict the sample to students who stay I'm the same school district as well as to those who do not repeat a grade.

Lastly, when we analyze the effects of shooting by gender, we find that male and female students are both similarly affected by shootings with respect to their English test results (see Table VII). Shootings negatively affect math test results for females, but not for males. This shows that female students are driving the negative effects on math test results.

5.5 Robustness

We do several tests to ensure that our results are robust and valid.

First, we conduct a randomization of the shooting incidents. We randomize the shootings within the school districts for the year the shooting took place and re-run baseline regressions for our main outcome variables: the proficiency rate in math and English, as well as enrollment in grade 9. The rationale behind this randomization is to provide confidence that our significant results are not caused by a factor other than the shootings. We do 1,000 replications and find that it is unlikely that the results are random. Appendix B presents histograms of t values (Figure A.1) and coefficients by intervals for our main variable of interest (Figure A.2). Results from this randomization and these figures give confidence to our results.

Second, our results are robust to alternate specifications, such as using district fixed effects instead of school fixed effects. Results are also robust to alternate error clustering, such as clustering at the state level or using a block bootstrap specification at the state level.

Third, we check that our results are not driven by extreme shooting incidents where multiple people die (the effect on students could arguably be higher in these cases). Restricting the sample to school shootings where only one person dies leads to a similar conclusion for the proficiency rates on English and math tests as well as enrollment in grade 9.

5.6 Discussion

The negative effect of shootings on student achievement on math and English tests could be an important factor in determining wages and employment for these students in the long-run. If students attending schools that experienced a shooting have lower test scores, they might be accepted into less selective colleges, which could lead to lower earnings later in life (Hoekstra, 2009). Moreover, several studies document the links between student performance and labor market outcomes at adulthood. Neal and Johnson (1996) find that scores from tests administered between the ages of 14 and 21 are highly significant predictors of wages at age 26 to 29. Murnane, Willett, and Levy (1995) show that test scores from one's senior year of high school are related to wages at age 24. Currie and Thomas (2001) find that a one standard deviation increase in test scores at age 16 translates into a higher wage rate and higher probability of being employed at age 33. Thus, even though we are looking at the short-run impact, school shootings are likely to have long-run negative effects on students too. Future research should try to answer this question.

6 Conclusion

We analyze the causal effect of deadly shooting incidents in high schools on these schools and their students. We find that enrollment declines in grade 9 (the high school entrance grade) in schools that experience homicidal shootings. Furthermore, math and English standardized test proficiency rates drop significantly in schools that experience a shooting. However, we do not find a detrimental effect of shootings on suspension, graduation, or average daily attendance rates. We find that there is no significant impact for suicidal shootings. To settle whether students are directly affected by shootings or if it is rather a composition effect, we use student-level data from California. We find that students are directly affected by shootings. There is a

decrease in probability of being at proficiency level 4 or 5 (a high achievement level) for math and English tests.

Our estimates indicate that schools and students, on average, are highly affected when there is a homicidal shooting. These results indicate that policymakers should consider providing extra support to all students in schools where a shooting occurs. It also suggests that more effort should be invested in preventive measures such as gun control (Duggan, 2001) and more resources should be made available to students (Carrell and Hoekstra, 2011), especially in the aftermath of shootings. More research should be done regarding the negative effect of high school shootings, such as on the long-term effects of high school shootings on students.

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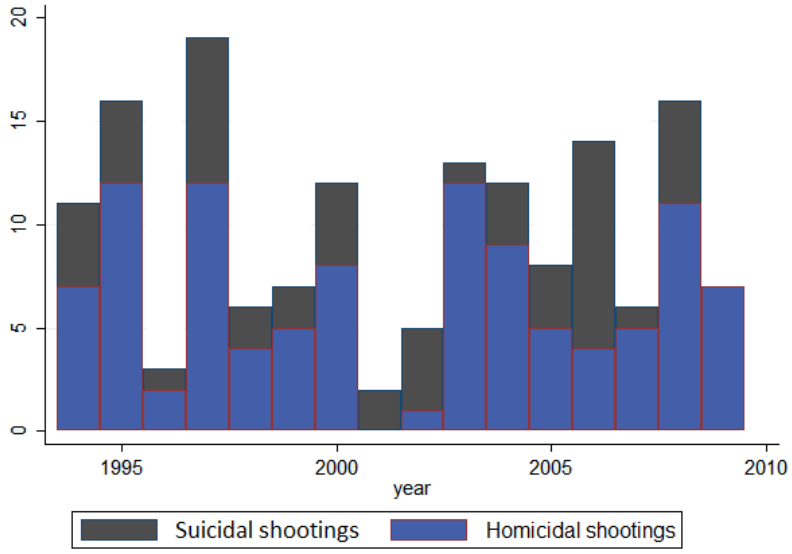

Figure I: Number of Shootings By Type of Shooting
Source: Report on School Associated Violent Deaths from the National School Safety Center (2010), Washington Ceasefire, and the National School Safety and Security Services.

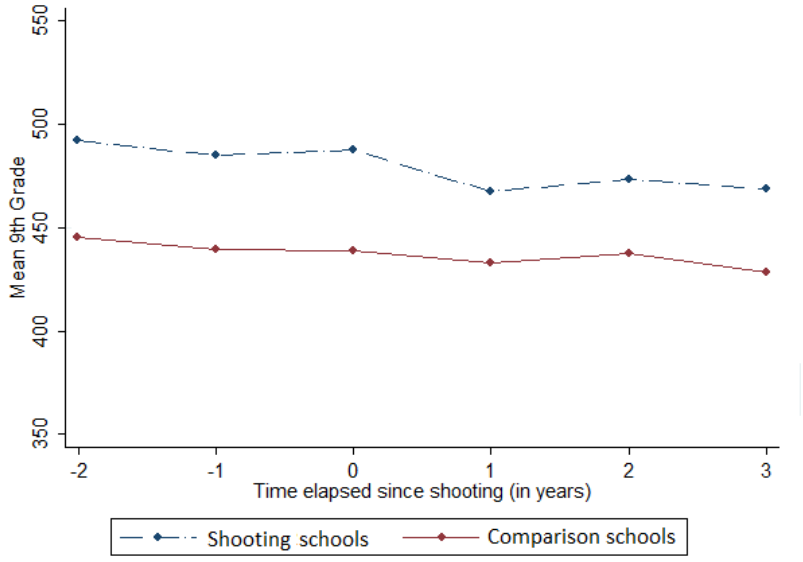

Figure II: The Effect of Shootings on Entrance Grade 9 Enrollment
Source: Common Core of Data (CCD) from the National Center for Education Statistics (NCES).

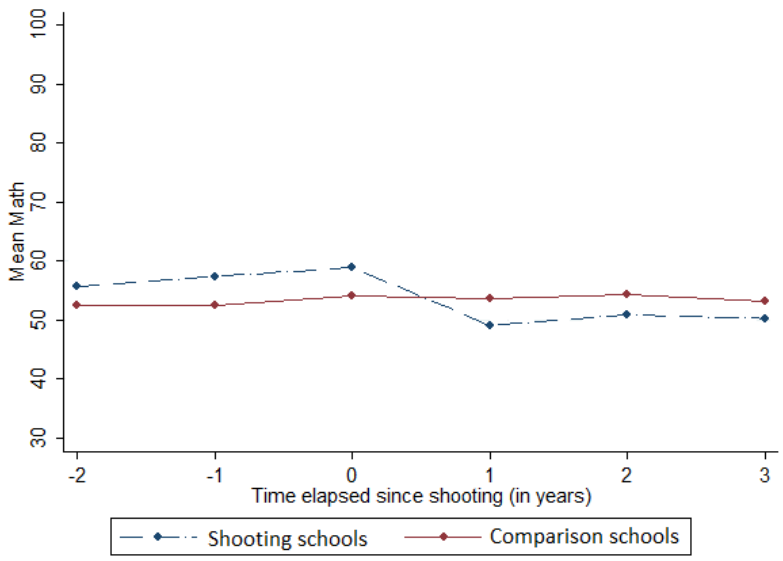

Figure III: The Effect of Shootings on Math Proficiency Rate
Source: Information was extracted from each school's report card and from data files posted by each state's Department of Education.

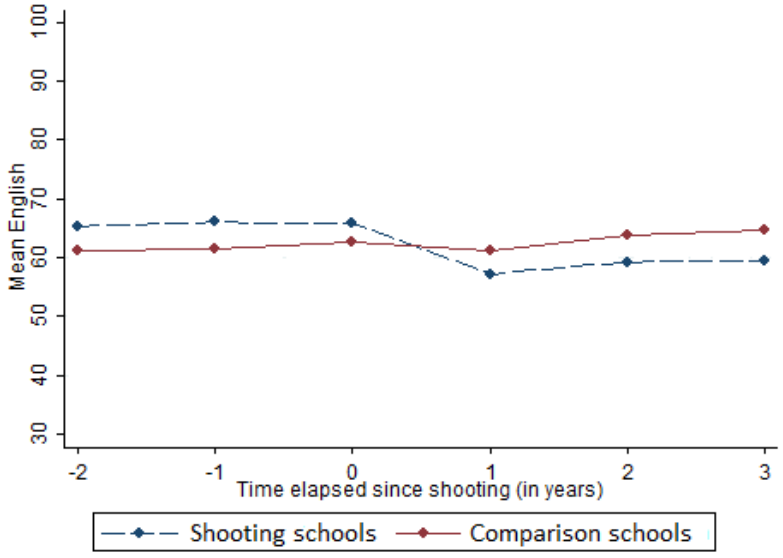

Figure IV: The Effect of Shootings on English Proficiency Rate
Source: Information was extracted from each school's report card and from data files posted by each state's Department of Education.

Table I: Summary Statistics - High Schools before the shooting

	All Shooting Schools		Comparison Schools	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Enrollment in				
Grade 9	486	283	436	344
Grade 10	426	238	378	289
Grade 11	352	196	314	240
Grade 12	298	171	262	202
Total Students	1587	835	1408	1044
FTE Teachers	80	37	73	47
English	65.4	23.0	60.5	27.9
Math	57.8	24.3	52.9	28.6
Graduation Rate	71.5	13.6	72.3	17.8
Attendance Rate	92.8	3.5	91.3	3.9
Suspension Rate	19.6	17.7	18.3	18.0

Note: Table I presents descriptive statistics for key variables for shooting schools and our comparison schools for the three years before the shooting. Enrollment and teacher variables are from the Common Core of Data. Test results and behavioral variables are from school report cards. Only high schools with grades 9 to 12 are included in the enrollment and teacher sample. All high schools are included in the test results and behavioral sample. Math and English variables are the proficiency rate from standardized tests. FTE Teachers are full time equivalent teachers. Suspension rate is number of suspensions per 100 students. The comparison schools are all other schools in the shooting district. Using a t-test or Wilcoxson test, we find that shooting schools are statistically different in terms of students (grade 9 to 12 and total students) and number of teachers but not for proficiency in English and math, as well as graduation, attendance, and suspension rates.

Table II: The Effect of Homicidal Shootings on Enrollment

	Enrollment in Grade					# of
	9	10	11	12	Total	Teachers
After	-3.48	-6.46	-8.08**	0.92	-14.27	0.57
	(7.03)	(4.51)	(4.09)	(2.62)	(12.61)	(1.25)
After*Shooting School	-28.41***	-8.84	6.96	-3.71	-37.79	-1.78
	(10.92)	(8.37)	(9.30)	(6.69)	(23.97)	(1.28)
Observations	5,385	5,386	5,394	5,392	5,397	5,222
R-squared	0.842	0.890	0.875	0.850	0.941	0.901

Note: Table II presents difference-in-differences regression estimates for the number of student in grades 9 to 12 and the number of teachers. The coefficient of interest is After*Shooting School. We use clustered standard errors at the district level. Coefficients for school and year fixed effects are not shown. *** p<0.01, ** p<0.05, * p<0.1.
Source: Common Core of Data (CCD) from the National Center for Education Statistics (NCES).

Table III: The Effect of Homicidal Shootings on Test Results and Behavioral Variables

	Fraction proficient in			Rate of	
	Math	English	Graduation	Attendance	Suspension
After	-3.48	-3.52**	0.81	-1.29***	1.02
	(2.31)	(1.58)	(1.34)	(0.46)	(1.34)
After*Shooting School	-4.92***	-3.93***	0.40	0.62	-2.28
	(1.18)	(1.07)	(1.19)	(0.39)	(1.55)
Observations	1,412	1,425	566	501	462
R-squared	0.606	0.668	0.254	0.366	0.669

Note: Table III presents difference-in-difference regression estimates for math and English proficiency rate, graduation, attendance and suspension rates. The coefficient of interest is After*Shooting School. We use clustered standard errors at the district level. Coefficients for school and year fixed effects are not shown. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Test results and other variables are extracted from each school's report card and from data files posted by each state's Department of Education.

Table IV: The Effect of Suicidal Shootings

	Enrollment in Grade			
	9	10	11	12
After	-2.04	-8.50	-1.16	2.02
	(10.31)	(6.99)	(5.02)	(3.51)
After*Shooting School	22.70	-2.69	3.77	0.88
	(17.61)	(14.03)	(14.41)	(8.52)

	Total Number of		Fraction Proficient in	
	Students	Teachers	Math	English
After	-13.25	0.48	-3.39	0.64
	(17.19)	(0.78)	(10.18)	(7.08)
After*Shooting School	26.59	0.09	7.50	-5.59
	(39.16)	(1.49)	(10.59)	(6.29)

Note: Table IV investigates the effect of suicidal shootings. We run regressions for enrollment per grade, number of teachers, proficiency in math and English and behavioral outcomes for suicidal shootings. The coefficient of interest is After*Shooting School. We use clustered standard errors at the district level. Coefficients for school and year fixed effects are not shown. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Source: Enrollment data are from the Common Core of Data (CCD) from the National Center for Education Statistics (NCES). Test results and other variables are extracted from each school's school report card and from data files posted by each state's Department of Education.

Table V: The Effect of Shootings using California Student Level Data - 2007-2011

	Probability of proficiency level in	
	Math(Level 4 or 5)	English (Level 4 or 5)
After	-0.079***	-0.015
	(0.010)	(0.009)
After*Shooting School	-0.042**	-0.102***
	(0.017)	(0.017)
Observations	246,864	270,114
Number of Students	120,924	125,949

Note: Table V investigates the impact of shootings on students using student-level data from the California Department of Education. Using conditional fixed effects logit models with student-level fixed effects, we study the probability of students achieving level 4 or 5 in math and English. The sample is restricted to students who took tests both before and after a shooting. The level of math and English proficiency for students in the 7 districts are: far below basic (1), below basic (2), basic (3), proficient (4), and advanced (5).To correct for autocorrelation, we cluster errors at the district level. Estimates for student and year fixed effects are not shown. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Student-level data from California provided by the California Department of Education (CDE).

Table VI: The Effect of Shootings on Cumulative Level of Achievement

	Probability of Student Reaching Achievement Level			
	2, 3, 4, or 5	3, 4 or 5	4 or 5	5
Math Test	0.005	-0.012	-0.042**	-0.104***
	(0.015)	(0.012)	(0.017)	(0.039)
English Test	-0.106***	-0.116***	-0.102***	-0.104***
	(0.020)	(0.017)	(0.017)	(0.019)

Note: Table VI investigates the distributional impact of shootings on students using student-level data from the California Department of Education. Using conditional fixed effects logit models with student-level fixed effects, we study the probability of students achieving various levels on math and English tests after a shooting. The sample is restricted to students who took tests both before and after a shooting. The level of math and English proficiency for students in the 7 districts are: far below basic (1), below basic (2), basic (3), proficient (4), and advanced (5). Column 1 estimates the probability of reaching achievement level 2, 3, 4, or 5 after the shooting. As we move right from column 1, the remaining columns restrict the outcome to higher levels of achievement. The coefficient of interest is After*Shooting School for math and English tests. Estimates for student and year fixed effects are not shown. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Student-level data from California provided by the California Department of Education (CDE).

Table VII: The Effect of Shootings by Gender using Student-Level Data

Male Students	Probability of achieving	
	Math (Level 4 or 5)	English (Level 4 or 5)
After	-0.062***	-0.010
	(0.014)	(0.013)
After*Shooting School	-0.030	-0.094***
	(0.023)	(0.024)
Observations	125,649	138,731
Number of Students	62,238	65,190
Female Students	**Probability of achieving**	
	Math (Level 4 or 5)	English (Level 4 or 5)
After	-0.098***	-0.020
	(0.015)	(0.013)
After*Shooting School	-0.054**	-0.110***
	(0.024)	(0.024)
Observations	121,215	131,383
Number of Students	58,755	60,841

Note: Table VII investigates the impact of shootings on students by gender using student-level data from the California Department of Education. Using conditional fixed effects logit models with student-level fixed effects, we study the probability of students reaching level 4 or 5 on math and English tests. The sample is restricted to students who took tests both before and after a shooting. Estimates for student and year fixed effects are not shown. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Student-level data from California provided by the California Department of Education (CDE).

Appendix

Appendix A - Randomization:

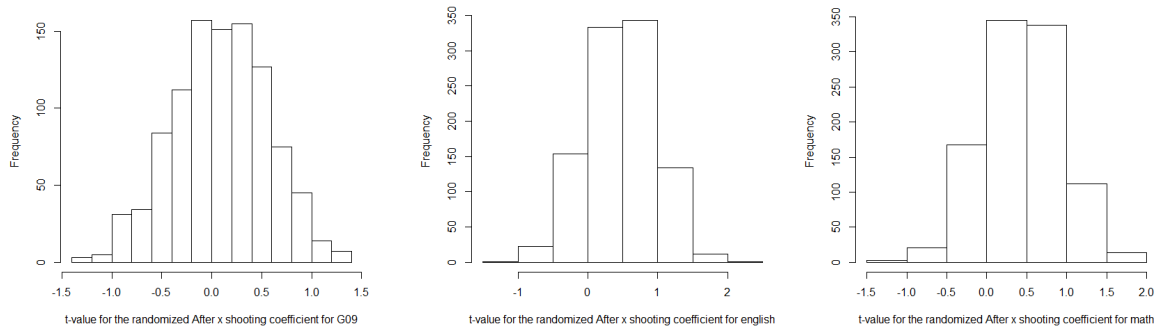

Figure A.1: Distribution of T-values from Randomization for Enrollment in Grade 9, English, and Math.

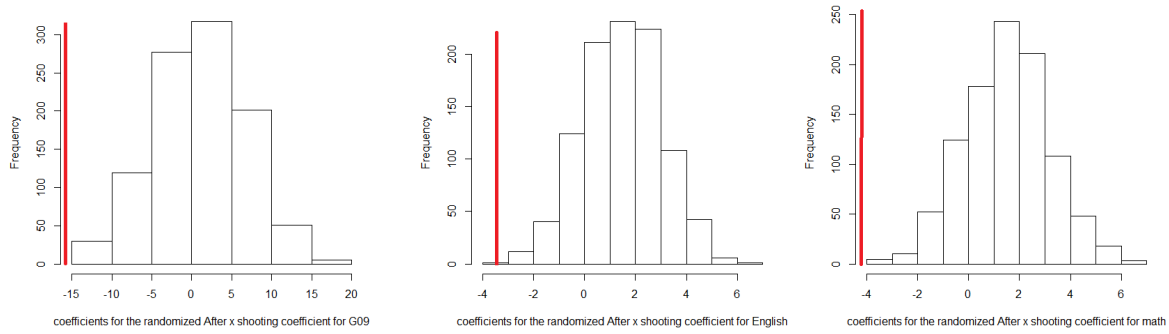

Figure A.2: Distribution of Coefficients from Randomization for Enrollment in Grade 9, English, and Math. Verticical line represents estimates from our main specification.

Table A.1: The Effect of Shootings on enrollment for future years

VARIABLES	Grade10	Grade11	Total	Total
After	1.201	-2.881	3.982	-9.118
	(6.251)	(9.900)	(24.09)	(34.38)
After*Shooting School	-41.40*	-35.92*	-130.2*	-196.0**
	(22.28)	(21.81)	(75.40)	(83.04)
EXCLUDED 1^{st} Yr	Y	Y	Y	Y
EXCLUDED 2^{nd} Yr		Y		Y
Observations	5,173	4,335	5,192	4,345
R-squared	0.437	0.438	0.462	0.468

Note: Table A.1 presents difference-in-differences regression estimates for the number of students in grades 10 and 11, and the total number of students, by excluding the first year or the first two years after a shooting. The coefficient of interest is After*Shooting School. We use clustered standard errors at the district level. Coefficients for school and year fixed effects are not shown. *** p<0.01, ** p<0.05, * p<0.1.
Source: Common Core of Data (CCD) from the National Center for Education Statistics (NCES).