The Effect of Gun Prevalence on the Occurrence of School Shootings

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Abstract

This paper studies how gun prevalence, represented by federal firearm background checks, affects the occurrence of school shootings. While precedent literature has estimated adverse effects of school shootings on exposed children, including reductions in mental health, academic achievement, and labor market earnings, few studies have attempted to identify factors that influence school shooting frequency in the first place. The analysis sample is an annual state panel of shootings during 2000-2021, constructed from the proprietary K-12 School Shooting Database as well as from data on background checks, demographic characteristics, economic conditions, and measures of violence and mental health status. Estimates from difference-in-differences regressions that include state and year-by-census region fixed effects and state-specific linear trends indicate a positive relationship between gun prevalence and school shootings, particularly when the dependent variable is specified as a binary indicator of multiple school shootings having occurred. Results are robust to using the annual shooting count or its quartic root, an indicator that a shooting occurred, Poisson regressions of school shooting count models, and quadratic state trends as additional controls. Several types of shootings, including targeted, elementary school, high school, and deadly shootings, increase in frequency and/or likelihood when gun prevalence rises.

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I. INTRODUCTION

Each year, an estimated 3 million children in the United States are exposed to some type of shooting event (Everytown, 2020). Firearms are the leading cause of death for children and teens under 18 in the U.S., with nearly 4,000 children shot and killed annually, a rate which has increased by 87% from 2011 through 2021 (Rabin, 2023). Even at school, children are not safe from this reality. More than 356,000 students have experienced gun violence at school since the Columbine High School shooting in April 1999. Moreover, the number of school shootings has increased rapidly over the last five years, with more shootings in the past three years than there were in total from 2004 to 2020 (Riedman, 2024). Even more startling is that since just 2008, only five states that are among the least populous in the U.S. – Montana, Wyoming, New Hampshire, Vermont, and Rhode Island – have not experienced a school shooting (Matthews, 2023). Although news media outlets only cover the most deadly mass shootings, such as Columbine, Sandy Hook Elementary School in December 2012, and Marjory Stoneman Douglas High School in February 2018, even the less severe events have the potential to result in profound impacts on children (Cabral et al., 2020). So, the question this thesis will consider is, what makes the schools where shootings have occurred different from those where they have not, and does it have anything to do with the gun prevalence in a given state?

Much of the literature surrounding both mass shootings and school shootings focuses on the same general research: the effects of these shooting events on the victims, their family members, and their communities. While Soni and Tekin (2020) find that mass shootings are associated with a decline in both community well-being and mental health, Bharadwaj et al. (2021) find that children exposed to mass shootings obtain lower test scores, receive more psychological diagnoses, and are less likely to graduate high school on time. Research that hones in on the effects of school shootings finds similar outcomes. While Beland and Kim (2016) look into the short-term effects of school shootings on enrollment and standardized test scores, finding declines in both, Levine and Mcknight (2020b) expand this research to look into how school shooting incidents affect test scores, chronic absenteeism, and suicides at all grade levels. They find similar decreases in test scores as well as increases in absenteeism and increases in suicides among male students. Cabral et al. (2020) similarly find increased absenteeism, grade repetition, and decreased high school graduation and college attendance rates. The paper also finds medium-term effects of decreased earnings and rates of employment for previously exposed students from ages 24-26. Rossin-Slater et al. (2019) focus on the mental health consequences of being exposed to such acts of violence, finding that school shootings increase youth antidepressant use.

By contrast, I am aware of only two studies that focus on the inverse: how certain variables may predict school shootings. Yang and Gopalan (2021) look at how a few covariates, measured in the 1997-1998 school year, predict the number of school shootings in their respective districts from 1999 to 2018. They find that district size is the only factor statistically significantly associated with the number of indiscriminate shootings. In contrast, targeted shootings are more often seen in larger districts, districts with less per-pupil revenue, a higher share of black students, or located in higher poverty areas. Additionally, Levine and McKnight (2020a) create static averages from communities where school shootings occurred to show that students of certain races, socioeconomic statuses, and living in rural vs. urban areas are affected disproportionately by certain types of gun violence. I am unaware of any studies delving deeper into the factors behind school shootings. Given the limited funding allocated to firearm injury research in recent decades, it is understandable why such investigations may be lacking.

This paper seeks to fill this gap in the literature by identifying how state-level gun prevalence, as represented by federal firearm background checks, affects the occurrence of school shootings within the state. Federal firearm background checks serve as a proxy for assessing gun prevalence at the state level due to the absence of accurate state-level data on actual gun ownership, a topic elaborated on in Section II. I find a positive relationship between gun prevalence and the aggregated school shootings data, as well as additional positive responses among the following disaggregated categories: targeted, elementary school, high school, non-deadly, and deadly shootings. This research contributes to several specific literatures related to gun violence by identifying variations in the occurrence of school shootings resulting from differences in the prevalence of guns in various states and years. This analysis presents the first causal estimates of gun prevalence as it increases the occurrence of school shootings and, in doing so, contributes broadly to both the school/mass shootings literature and the literature on the effects of gun prevalence on various forms of social harm.

The rest of the paper will proceed as follows. Section II of this paper reviews literature discussing the aftermath of mass shootings, the causes and impacts of school shootings, and the measurement of gun prevalence. Section III reviews theories of gun control and what puts a school at heightened risk of a shooting. Section IV describes the data used in this paper's study, how it was handled, and important descriptive statistics. Section V outlines the empirical strategy. Section VI presents the main results of the analysis along with several robustness checks and subsample results. Section VII concludes and discusses future research possibilities. An appendix includes additional tables.

II. LITERATURE REVIEW

A. Mass Shootings

There is a vast body of literature surrounding mass shootings that defines such events as 3-4 or more killings within a single incident. According to data from the violence project, which uses one of the most conservative definitions from the FBI of at least four killings during one event, 31 mass shootings occurred between 2017 and 2021, a number which is more than any 5-year period since 1966. Mass shootings are getting deadlier, too, with 295 people killed in 2017-2021. This number is up 33% from the previous five years and is higher than any other similar period since the sixties (Valeeva & Ruderman, 2022). Simultaneously, James Alan Fox, who manages the Mass Killings Database, points out that mass shootings have become increasingly perceived as an epidemic in the U.S. due to the "pervasive attention, particularly visual attention" to live video footage and news reporting available at our fingertips (Ali, 2023).

Research shows that mass shootings have detrimental consequences for direct victims and their family members. Soni and Tekin (2020) leverage the variation in the timing of mass shootings across U.S. counties between 2008 and 2017, along with the Gallup-Healthways survey, in a difference-in-differences design to assess the effects that these shootings have on general mental health and community well-being. The study finds that mass shootings are associated with a 27 percentage point decline in the likelihood of having "excellent community well-being" and a 13 percentage point decline in the likelihood of having "excellent mental health" in the month following the incident within the county the shooting occurred, with more substantial effects in parents of school-age children. Bharadwaj et al. (2021) studied a specific mass shooting that took place on July 22, 2011, in Utøya, Norway, to understand how mass shootings affect survivors, primarily teenagers, and their families. Using a difference-in-differences design, the paper finds that survivors obtained lower test scores in middle school and were less likely to finish the last year of high school on time. Additionally, regardless of age at exposure, survivors were found to increase their utilization of health care services, with more general practitioner visits (60% increase relative to control mean) and psychological diagnoses (400% increase relative to control mean). Parents were shown to have an increase in the number of mental health diagnoses, and siblings also had lower test scores overall. Both studies imply that mass shootings severely impact the livelihood of both children and adults.

B. Impacts of School Shootings

A comparatively more extensive amount of research has studied the effects of shootings that specifically occur on school grounds. Levine and McKnight (2020b) use a triple difference estimation strategy to examine the academic consequences of the Sandy Hook school shooting in Newtown, CT, hypothesizing that if shootings have a causal impact, students in affected birth years would experience differential outcomes relative to those of previous and subsequent years of students. The paper finds that following the incident, average 3rd and 4th grade test scores at Sandy Hook fell by 26% and 6% in Math and English and Language Arts (ELA), respectively. Additionally, test scores in other Newtown Elementary Schools fell even more dramatically, with a 35% and 18% drop in Math and ELA, respectively (Levine & McKnight, 2020b). Yang and Gopalan (2021) employ a difference-in-differences analysis to find that student enrollment declined significantly when compared with schools in non-shooting districts. This is similar to the finding of a 5.8% decline in 9th grade enrollment following school shootings by Beland and Kim (2016). Similarly, in the case study of Sandy Hook, Levine and McKnight (2020b) show that in the first full year following the mass shooting, the rate of chronic absenteeism increased by over 4 percentage points from the previous year's rate of 2.2%.

Other studies examine the consequences of such events through the lens of mental health and well-being. Rossin-Slater et al. (2019) do so through the use of antidepressant prescription data, finding that exposure to fatal school shootings increases the number of antidepressant prescriptions written to children by providers within a 0-5 mile radius of a school by approximately 21% more than the number written by providers located 10-15 miles away. However, these effects were significantly smaller in areas with a higher density of behavioral-focused rather than pharmacological mental health interventions, which might signify that children in these areas are either less affected by school shootings or more likely to rely on behavioral treatments. Furthermore, the study found no effects of fatal school shootings on antidepressant use among adults, though it did not separate parents from the general adult population.

Other studies recognize that the impacts of such events can persist far past a few years after their occurrence. Levine & McKnight (2020b) extend their study to look at the impact of 103 high school shootings that led to a fatality on one of the most extreme measures of mental health, subsequent mortality. They find that subsequent suicides and accidental deaths appear to increase for boys but not significantly for girls. Deb and Gangaram (2021) estimate the effects of less extreme indicators of well-being, namely risky behaviors and labor market outcomes. Using the Behavioral Risk Factors Surveillance System (BRFSS) surveys, the paper finds that students exposed to school shootings experience declines in health, engage in more risky behaviors (e.g., cigarette smoking, alcohol consumption, and/or inactivity), and have worse educational and labor market outcomes as young adults. However, the effects on employment status for men are insignificant. Cabral et al. (2022) leverages linked schooling and labor market data in Texas from 1992 to 2018 and finds that students who are exposed to a school shooting in 10th and 11th grade are 2.9 percentage points less likely to graduate and 5.5 percentage points less likely to enroll in a 4-year college; students exposed in grades 9-11 are also 4.4 percentage points less likely to be employed and are seen to have on average 13.5% lower annual earnings at ages 24-26.

While many papers point to psychological trauma as the cause for the decreased academic performance and labor market outcomes of exposed students after a school shooting, Yang and Gopalan (2021) look for other potential reasons behind this decline. Using difference-in-differences analyses, the paper finds that school shootings increase per-student spending by $248, with most of these spending increases going toward non-instructional functions (i.e., student support services such as school counseling and infrastructure projects aimed at heightened security). Levine and Mcknight (2020b) studied school spending on support services at the district level, focusing on six indiscriminate shootings occurring after 1998, and found similar outcomes, namely that spending on support services per student per year increased an average of 27% in the year following a shooting and remained elevated for at least three years afterward. Furthermore, Cabral et al. (2022) discover that despite school shootings being found to increase the number of leadership staff at affected schools, there is a decrease in retention among teachers and support staff in the years following a shooting, which is a potential factor causing lower graduation rates among students. Despite this, Yang and Gopalan (2021) also find that the funding for these functions does not crowd out instructional spending. Thus, declines in academic performance post-shooting cannot be attributed to changes in instructional resources in addition to trauma. In summary, it is possible that instructional composition changes after a shooting, but it is not due to a change in spending.

Separately, Deb and Gangaram (2021) look at migration patterns and find no evidence of the migration of students in response to school shootings. This finding is supported by numerous other papers, and it is somewhat expected, given the majority of the American population does not have the privilege or circumstances to be able to move away from an area after a traumatic event has occurred (Levine & McKnight, 2020b; Cabral et al., 2022). However, for the proportion of the population that can afford to migrate after the occurrence of an adverse event, Yang and Gopalan (2021) do find that school shootings contribute to changing student compositions and enrollment through the exit of higher income families, often to different districts altogether, which changes socioeconomic diversity. This migration could also be a consequence of the effects school shootings have on parents, with Nabors (2023) finding that a mental health index of mothers is 0.1 standard deviations lower following exposure to a school shooting. No matter the severity or the cause, school shootings can have long-lasting consequences.

C. Causes of School Shootings

While the impacts of school shootings have been extensively studied, what causes these events is less known. However, a small amount of literature looks to see if there are any recognizable patterns related to the schools in which shootings typically occur. Wike and Fraser (2009) do so by recognizing risk factors at the individual student and school levels. The paper outlines that at the individual student level, many risk factors include alienation from school, rejection and victimization by peers, leakage of plans, and access to guns, the last point being interesting given that the median age of a school shooter is only 16 years old (Cox, 2023). This is below the legal age required to buy guns and speaks to the extent to which school shooters acquire guns from family members, a point which is elaborated upon in greater detail in Section III. Additionally, several of these risk factors have known predictors in the literature. Poor social problem-solving skills, for example, are indicative of peer relational problems, and low school involvement is known to be associated with peer alienation. Some school-level risk factors include heavy social stratification, poor security and response systems, and cultural norms supporting social aggression in response to conflict (Wike & Fraser, 2009).

Levine and Mcknight (2020a) group school shootings into five different categories – indiscriminate shootings, suicides, personal attacks, crime-related events, and other shootings – and notice that there can be significant variation in the results of different studies depending on how strict the qualifications are for a school shooting to be included in a study. This is because school shootings falling into different categories affect very different populations and is noteworthy given that it is not completely agreed upon in the literature exactly what type of gun event on school grounds constitutes a school shooting (i.e., whether or not accidental firings and/or shootings targeted towards adults, for example, can be classified as school shootings). More specifically, Levine and McKnight (2020a) find that while White students are more likely to be exposed to indiscriminate shootings and suicides, Black and Hispanic students are disproportionately exposed to targeted and crime-related shootings. Furthermore, when looking at exposure in terms of socioeconomic status (SES), higher SES students are more likely to be exposed to indiscriminate shootings and suicides. In comparison, lower SES students are more likely to be exposed to targeted attacks and crime-related shootings. Failure to pay attention to a certain sub-sector of school shootings can generate misleading conclusions about their effects and the appropriate policy responses. Additionally, the paper clearly states the importance of considering the category in which each school shooting belongs and how analyses of aggregated data are misleading. Because of this, I have not only divided up the dependent variable into various sub-categories in this paper, but I have also included several controls that cover demographic and economic concerns.

D. Gun Prevalence

A separate area of guns and gun violence literature discusses and tests the best ways to measure gun prevalence. Although the General Social Survey (GSS) is seen as the "gold standard" for national surveys on gun ownership, the survey has significant limitations, including that it is subject to response bias, only administered every two years, and samples insufficient respondents to provide meaningful state-level information. Given these limitations, research on gun ownership and prevalence has been forced to rely on various proxies.

One proxy utilized by many studies is the fraction of suicides committed by a firearm (Azrael et al., 2004; Siegel et al., 2013; Cook & Ludwig, 2006). Cook and Ludwig discuss the use of this proxy, referred to as FSS (from "FS/S"), in estimating the effects of household gun prevalence on homicide rates. To first validate FSS as a proxy for gun prevalence, panel regressions of GSS-based estimates of gun prevalence are run against two possible proxies, the FSS and the subscription rate to *Gun and Ammo* magazine, used by Duggan (2001). While Duggan's proxy was not significantly related with the GSS estimates, the FSS coefficients were found to be significantly positive in every regression. Despite this, the authors discuss the possible measurement error when using FSS as a proxy. Beyond the correlation between FSS and the "true" gun prevalence in an area being imperfect, FSS reliability depends crucially on the number of suicides used to compute it. In low-population areas with relatively few suicides, measurement error is higher, biasing the coefficient of FSS towards zero. However, state-level estimates are shown to be much larger and, therefore, likely less biased by measurement error. Furthermore, the authors found no significant effects of FSS on outcomes that logically have little relationship with gun prevalence, such as the fatality rate from motor vehicle accidents.

Johnson and Robinson (2023) also explore the effect of gun prevalence on homicide rates but use a different proxy: gun dealer density, as measured by the number of gun dealers per 100 square miles in a county and surrounding "halo regions." Including "halo regions" accounts for individuals "shopping around" for firearms. Using data on Federal Firearm Licensees (FFL), or federally-licensed gun dealers, from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), the authors built a measure of gun density based on the number of FFLs relative to the size of a county and its surrounding areas. They find that a 10% increase in FFLs per 100 square miles increases homicides by approximately 4.43%, a result that presents elasticity estimates of gun density on gun homicides similar to other researchers and helps verify its usefulness as a proxy (Duggan, 2001; Cook & Ludwig, 2006; Chalak et al., 2022). This proxy is cited as superior to FSS because of its freedom from large measurement errors at the county level. Additionally, they cite a specific example of north-central Colorado, a region where many mass shootings have occurred (e.g., Boulder, Aurora, Columbine, etc.), yet FSS is low. While using FSS as a proxy shows low gun availability, the authors' gun density measure suggests that this area has the highest concentration of guns in the western United States. Additionally, the authors note how the FFL proxy also captures the presence of firearms that would not have been required to undergo a federal background check by recording the purchases of other items at the shop, such as firearm components, accessories, and ammunition. Despite this discussion, the authors do not show an estimate of the relationship between "true" gun ownership rates – usually thought of for econometric purposes as the GSS reported gun ownership rates – and the FFL proxy.

Lang (2013) examines the effect of guns on suicide by using firearm background check data from the National Instant Criminal Background Check System (NICS) as a proxy for gun prevalence. After establishing a statistically significant relationship between federal firearm background checks and GSS gun ownership rates, Lang regresses the change in a state's suicide rate on the change in guns per capita as proxied by the NICS data. Additional regressions are run separating non-firearm vs. firearm suicide rates as the dependent variable, as well as youth suicide rates. Using this empirical strategy, the paper finds that increasing the number of firearms in a state is associated with an increase in the firearm suicide rate, while non-firearm suicide rates are insignificantly related to changes in the stock of guns. The paper discusses the measurement error inherent in using the NICS data, including potential non-compliance by FFLs, transfers of guns across state lines, and the lack of ability to measure gun purchases exempt from background checks. Despite these drawbacks, the author believes background checks to be the best proxy in measuring the change in state-level suicide rates and firearms, especially given the obvious conflict in using the popular proxy of FSS in his research. This line of thought is on par with many other researchers who also found NICS to be the best proxy for gun prevalence (Lang, 2016; Depetris-Chauvin, 2015; Koenig & Schindler, 2020). In my research, I have chosen to use federal firearm background checks to represent gun prevalence, given that it has the best ability to capture the actual number of guns circulating as opposed to simply the number of people who own them. However, no studies appear to bridge the gap between the school shooting and gun prevalence literatures, which is the aim of this thesis.

III. THEORETICAL FRAMEWORK

A. Pro- vs. Anti-Gun

Whenever a mass shooting occurs, whether it be school-related or not, the news is met first with shock and then with calls for gun control. However, the effectiveness of gun control is widely debated. While some theories believe that more guns inevitably lead to more gun violence, others advocate for the Second Amendment in their belief that gun access allows law-abiding citizens to defend themselves against criminals better. In particular, Alper et al. (2016) found that among state and federal prisoners who possessed a gun during their offense, 90% did not purchase it from a retail source, which includes a gun store, pawn shop, flea market, or gun show. Instead, more than half of these prisoners had either stolen the firearm, found it at the scene of the crime, or obtained it off the street or from the underground market. Furthermore, only 1 out of 5 federal prisoners obtained a firearm with the intent to use it for crime, suggesting that the purchase of a gun with malicious intent is fairly rare. Given all this, the paper argues that criminals who go through illegal avenues to obtain firearms will circumvent background checks while doing so, making the cost of expanded background checks far outweigh the benefits. Another study argues the ineffectiveness of gun control by looking at a law implemented in California in 1991 that both mandated a background check for all firearm purchases and prohibited gun purchases for persons convicted within the past ten years of violent crimes classified as misdemeanors. The paper did not find these two policies to affect any change in firearm suicide or homicide rates in any way, providing support to pro-gun advocates (Carniglia et al., 2019).

Another line of pro-gun work frequently cited is a long series of studies by John Lott, an advocate of the deterrence argument that the prospect of a criminal encountering a victim who may be armed will deter some attacks in the first place. His 1997 study of concealed handgun laws finds that if all states had adopted RTC laws in 1992, there would be around 1,500 fewer murders annually (Lott, 1997). Additionally, Lott and Landes (2000) show that gun permit holders are rarely involved in committing a gun-related crime, especially murder, and argue that there are numerous instances of public shootings when firearms were used to inhibit or stop the attacker. Examples cited include the Luby's Cafeteria shooting in 1991 and the high school shooting spree in Pearl, Miss., in 1997. Additionally, Lott and Landes (2000) find that right-to-carry laws reduce the number of people killed or wounded from multiple victim shootings (shootings with two or more victims) as many attackers are either deterred from attacking or, when they do occur, they are stopped by armed citizens. Moreover, in one of his most recent studies, co-authored with Wang (2020), he finds that although the percentage of adults with concealed handgun permits has been growing exponentially over time, from 2.7 million permit holders in 1999 to 19.48 million in 2020, this increase has had a negative relationship with murder and violent crime rates, which have fallen by 29% over the same period. Additionally, the paper goes on to argue that concealed carry permit holders are more law-abiding than even police, citing 103 crimes per hundred thousand officers between 2005 and 2007 and only 1,268 concealed handgun permits revoked in total between June 2019 and July 2020, with over 2 million permit holders in the state.

Despite all of Lott's findings, many studies have found evidence contradicting his arguments. Lott and Mustard (1997) used the varied implementation of right-to-carry (RTC) laws to argue that these laws could reduce crime. However, this study and many others are limited in scope and have several fundamental methodological flaws and sample selection concerns. More recent studies using more years of data (Donohue et al., 2019) and other models have provided the literature with clearer ideas of the impact of RTC laws. It has always been the consensus that RTC laws do not decrease violent crime, and recent literature suggests they may significantly increase violent crime. More specifically, RTC laws are thought to increase crime through two mechanisms: decreasing criminals' perceived probability of being discovered and increasing the supply and demand for guns used in a crime (Donohue et al., 2022). The theory regarding the former is that RTC laws cause police to be both busier processing more complaints and more likely to shy away from engaging in dangerous situations due to the increased risk posed by guns; both factors cause the police force to have fewer resources to fight crime. Regarding the latter, RTC laws are associated with more widespread carrying, thus facilitating gun theft, which allows for more guns to be traded illegally by criminals in the underground market (Cook, 2018). There is evidence that increased legal carrying of firearms leads to more gun theft, particularly from vehicles (Elinson & McWhirter, 2022). Billings (2023) uses data from Mecklenburg County, North Carolina, to match concealed carry permit holders to non-concealed carry permit holders with similar demographic characteristics and finds that concealed carry permit holders are 68% more likely to be crime victims, with the largest increase due to the increased likelihood of having a gun stolen. From the demand side, since RTC laws increase lawful gun carrying of law-abiding citizens, the opportunity cost for criminals to carry a gun also becomes lower, as police become less proactive about searching for illegal firearms, and thus increases the criminal demand for guns (Donohue et al., 2022). So, while Alper et al. (2016) may find that the majority of criminals do not obtain their weapons through legal means and instead resort to stealing, they are stealing the weapons from citizens who purchased their guns legally, exposing a pitfall in the paper's argument. These stolen guns likely, at one point, triggered a federal firearms background check, providing support for the use of NICS as a proxy for gun prevalence.

Much research has also been done to show how Child-Access-Prevention Laws (CAP), which impose criminal liability on gun owners who allow children unsupervised access to firearms, decrease the rate at which children under 18 carry guns, which in turn reduces child gun exposure and decreases the rates of school violence by peers (Anderson & Sabia, 2018; Anderson et al., 2021). Roughly 7% of U.S. children are estimated to live in homes with an unlocked and loaded firearm, making the likelihood of childhood gun exposure and accidental firing fairly high (Azrael et al., 2018; Shaffer, 2000). However, through the implementation of CAP laws, there is estimated to be both a roughly 18% decrease in the rate at which high-school students under 18 report carrying a gun in the past month as well as a similar decrease in the rate at which students report being threatened or injured with a weapon on school property (Anderson & Sabia, 2018). Additionally, CAP laws are associated with a 17% reduction in the expected number of firearm-related homicides committed by juveniles, providing mounting evidence that rebuts earlier claims that found no statistically significant evidence that CAP laws reduce violent crime and prompted the NRA to previously claim that CAP laws are unnecessary and ineffective (Anderson et al., 2021).

B. Theories of School Shooting Risk Factors and Consequences

Still, other theories focus less on the impact of gun control on juvenile crime and school violence and hypothesize potential risk factors related to school shootings. In particular, the "Safe School Initiative," which was commissioned by the U.S. Secret Service and U.S. Department of Education following Columbine, examined 37 targeted shootings between 1974 and 2000 and had ten key findings, one of which being that most attackers had access to weapons before the attack (Vossekuil et al., 2002). Although limiting gun access would not necessarily prevent school shootings, it is important to note how stricter gun laws complicate a perpetrator's ability to get their hands on a firearm quickly and efficiently. This is interesting to consider when interpreting my results, as it is plausible that strict gun laws and safe storage laws have a notable interaction with gun prevalence, especially when considering that over two-thirds of perpetrators studied acquired their guns from their own homes and/or close family members. Next, the study found that before most incidents, other people were aware of the shooter's plan to attack. This is also referred to as leakage, and it provides support for the idea that targeted school shootings are usually premeditated, making the recognition of warning signs and clues important. Furthermore, the study found that most attackers were mentally unwell or depressed, with 71% having experienced bullying and harassment prior to the attack. However, being that bullying is present in almost every school across the nation, it can be thought of as a risk factor that exacerbates existing alienation and anger and contributes to a school's heightened vulnerability. Lastly, the study found that there is no accurate "profile" (set of demographic traits) of students who engaged in targeted school violence or shootings. Although shooters have some shared characteristics, such as all 41 shooters identifying as male, using this information to try to pinpoint those at true risk for perpetrating a school shooting would produce many errors, leaving many unidentified that should be and others profiled that present no true risk at all.

Identifying risk factors and potential determinants that can help prevent school shootings is important for many reasons, not just for the loss of life that results. Violence at school of any kind can impact the development of a student significantly through four primary theoretical mechanisms (Margolin

& Gordis, 2000). First, long-term psychological effects, such as poor mental health and depression, can occur due to the brain's malleability at young ages. Second, school violence can result in the development of post-traumatic stress disorder (PTSD), which can cause symptoms that last well past high school graduation. Third, cognitive consequences can result, such as damage to the hippocampus, a part of the brain involved in memory integration. Lastly, violence exposure can inhibit children's formation of relationships due to a reduced ability to form secure attachments (Beland & Kim, 2016). No matter the theory or belief about the efficacy of gun control, it is widely agreed that childhood exposure to gun violence is detrimental to a child's well-being.

IV. DISCUSSION OF DATA

A. Data Sets and Handling

This paper uses a collection of ten data sets. First, the dependent variable that measures school shootings comes from the K-12 School Shooting Database. This database is widely inclusive of all school shootings and documents every instance in which a gun is fired or brandished (pointed at a person with intent) or a bullet hits school property, regardless of the number of victims, time, day of the week, or reason. This dataset was chosen over other school shooting databases, such as the *Washington Post's*, because it uses the broadest definition of school shootings. These data, which includes over 1,800 school shootings dating back to 1966, can be obtained only by special request and have been cited in many studies, including Deb and Gangaram (2021) and Levine and McKnight (2020a). It continues to be updated in real-time as shootings occur. To populate this database, information from different databases was compiled into a single spreadsheet, then cross-referenced and deconflicted to avoid duplication. Each shooting incident was then cross-referenced with multiple sources, and based on the source and number of reports, the validity of the information on each incident was quantified using a reliability score from 1-5.

My study utilizes observations between the years 2000 and 2021. These years are chosen as they represent the post-Columbine period in which approximately 70% of shootings occurred. Additionally, given the detail provided for each incident, I was able to divide the school shootings into sub-categories, enabling analysis using various definitions of school shootings. These categorizations include shootings with/without injured victims, shootings with/without deaths, shootings that did/did not occur during school hours, elementary/middle/high school shootings, and shootings that were indiscriminate, targeted, suicide, or none of these, with this latter categorization restricted to shootings that occurred during school hours. Targeted shootings include situations of bullying, domestic violence, escalations of disputes, racial altercations, murder/suicides, intentional property damage, and anger over grade/suspension/discipline, while the "other" category includes self-defense, officer-involved shootings, psychosis, drive-by shootings, illegal activity, hostages, unknown circumstances, and accidental firings.

Creating these categorizations required manual inspection of all 1,821 incidents to fill in missing data based on supplemental online research. For example, the variable "school level" in the database, which was meant to describe the grades taught at the school, contained 150+ anomalies. Then, once corrected, I standardized observations to be elementary only, middle only, high only, 5-12, K-8, K-12, 6-12, 7-12, bus, or other, and I used these groupings to collapse the data into three non-mutually exclusive categories representing schools that included elementary, middle, and high school grades. If a school teaches all grades K-12, its shooting event would be counted as all three school levels, but if it teaches only high school, its shooting event appears only in the high school category. This double counting of some schools does not pose an issue to the validity of my regressions, given that school shootings are the dependent variable, and therefore, only one category of shootings is utilized in any given regression.

The basis for the creation of these smaller groupings of shootings is prior research finding that shootings falling into different categories affect very different populations. As such, ignoring these categories can be misleading when identifying the determinants and effects of such events (Levine & McKnight, 2020a). Relevant to my paper is that different types of school shootings might depend more or less on ease of access to firearms. I therefore run initial regressions using broader categories before examining narrower sub-categorizations.

I also use mortality data from the National Vital Statistics System (NVSS) of the CDC's National Center for Health Statistics. The NVSS data serves two purposes for my research. First, data on overall and firearm suicides is used to construct the fraction of suicides committed by firearm (FS/S or FSS), a commonly used proxy for gun prevalence in gun violence research, by state and year. Second, the number of gun homicides by state and year is used as a control for general gun violence in my regressions. Data from the NVSS has been utilized in many studies, such as Levine and McKnight (2020b) and Cook and Ludwig (2006).

Next, another proxy for gun prevalence, federal firearm background checks, is constructed using data from the National Instant Criminal Background Check System (NICS). The NICS was established by the Brady Act of 1993, which required a national namecheck system for federal firearms licensees (FFLs), particularly gun shop owners, to use when determining eligibility to buy a firearm legally. Maintained by the FBI, the NICS provides full service to FFLs in 31 states and D.C. and partial service to six states. The remaining 13 states perform their own checks through the NICS, making data on background checks in all states available through the NICS database. Since launching in 1998, more than 300 million checks have been done, including more than 1.5 million denials.

While vital to my research, these data require thoughtful adjustments due to idiosyncratic differences in laws and coding across states. For example, Kentucky has re-checked permits monthly since 2006 but only began distinguishing between these rechecks and new permit checks in the last few years. In this specific case, the recent coding change revealed that well over 99% of permit checks are rechecks that do not represent new permit issuances, suggesting that simply ignoring permit checks in the years where original checks and rechecks were not coded separately provides an accurate representation of new gun purchases in Kentucky. However, given noticeable irregularities in data for several other states (particularly Illinois, Indiana, and Utah, though each for only a small subset of years), a deeper investigation of these data would be useful.

The next dataset used is state-by-year counts of the number of federal firearm licensees (FFL) that operated during any portion of a year in the state, available through the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). To engage in the dealing, manufacturing, or importing of firearms, or manufacturing or importing ammunition, one must apply for a federal firearms license from the ATF as mandated by the Gun Control Act of 1968, which, if granted, must then be renewed every three years. The two types of FFL licenses considered to be "dealer" licenses (i.e., able to buy and sell from the public and receive shipments of firearms) are the Type

1 license, for dealers and gunsmiths, and the Type 2 license, for pawnbrokers (Johnson & Robinson, 2023). One drawback to these data, however, is that they are available only from 2000 to 2020. In my study, the total of Type 1 and Type 2 FFLs is used alongside the FSS and data from the GSS and NICS to evaluate which gun proxy is most relevant.

Next, to control for economic concerns, state-level annual unemployment rates and employment-population ratios from the Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics (LAUS) are used. The LAUS program prepares employment and unemployment estimates for areas of various sizes, including census regions, states, and counties, based on responses to the Current Population Survey (CPS). Two additional economic controls are included in each regression: personal income per capita obtained from the Bureau of Economic Analysis and the poverty rate obtained from the U.S. Census Bureau. To convert personal income to real terms, nominal personal income per capita was deflated by the headline PCE price index with a base year of 2017.

Additionally, demographic controls for race, age, and population size are constructed using data from the U.S. Census Bureau using the CDC Wonder database. Race variables include percentages of the population that are Asian/Pacific Islander, Black/African American, and White (with American Indian/Alaska Native as the omitted category), and separately by Hispanic/Latino ethnicity. Age variables include percentages of the population that are 5-19 (school age), 20-64, and 65+ years old. Lastly, population size is controlled for using annual intercensal estimates available via CDC Wonder.

Finally, to control for mental health variation, the CDC's annual Behavioral Risk Factor Surveillance System Survey (BRFSS) is used. The BRFSS is a telephone survey that collects data on health-related risk behaviors, chronic health conditions, and the use of preventative services. The survey dates back to 1984 and collects data in all 50 states and D.C. Completing over 400,000 adult interviews each year, BRFSS is the largest continuously conducted health survey in the world. While the survey contains many questions, my mental health control variable is created based on the prompt: "Now, thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" Vitt et al. (2018) transformed this question into an aggregate mental health measure by calculating the percentage of survey respondents in a state each year reporting having had more than 20 not-good days of mental health in the last month, which was interpreted as a proxy for the percentage of the population suffering from extreme unhappiness. This paper takes a similar approach. After dropping observations with missing data, observations ranged from 0-30 days, based on which I generated a new binary indicator that equals 0 if the respondent reported 20 or fewer bad mental health days in the past month and 1 if they reported more than 20. In doing so, the percentage of a population reporting over two-thirds of the month that they experienced bad mental health for any given year or state is created by state and year to control for mental health.

A consolidated list of datasets utilized is included in Table A.1 of the appendix.

B. Descriptive Statistics

Of the over 1,800 incidents recorded in the K-12 database since 1999, approximately 60% occurred on strictly high school campuses, followed by 23% on strictly elementary school campuses and 12% at middle schools. Furthermore, 41% of shootings were classified as targeted shootings, while only 5% were recorded as indiscriminate, 6% as suicide, and 48% as other. Fortunately, the majority of the shooting events recorded were victimless. There was at least one wounded victim in 43% of school shootings, but only 14 shootings since 1999 have had more than five victims. More broadly, shooting events with deaths are relatively rare occurrences. Since 1999, 18% of shootings have resulted in at least one death. There have been thirteen mass school shooting events, with the highest number of fatalities coming from events at Sandy Hook Elementary, Robb Elementary, and Marjory Stoneman Douglas High School – the latter two having taken place in the last five years. Slightly more than half of all shootings occurred while classes were in session. Notably, 72% of all shootings recorded in the 25 years from 1999 through 2023 have occurred in the nine years since 2015.

Regarding the general profile of school shooters, roughly one-third of all perpetrators were adults, and the majority of the rest were teenagers; only approximately 4% were carried out by a child under the age of 13. Additionally, 74% of these perpetrators acted alone with no accomplice. Finally, while 75% of assailants utilized a handgun, 9% used a long gun (rifle or shotgun). To better understand how roughly two-thirds of all school shooters could be teenagers, it is crucial to note that about one-third of all GSS respondents report owning and storing a gun in their homes. Depending on the existence of and compliance with Child Access Prevention (CAP) laws in a given state, these guns may be stored in unlocked and easily accessible places.

The "AllShootings" variable used in my baseline regression is comprised ~55% of 0s, ~20% of 1s, and ~25% of observations greater than one. Furthermore, there are only four observations of more than 17 shootings in a given state and year, showing that the distribution is heavily skewed to the right. The main independent variable of interest in my regressions, NICS background checks per capita from 1999-2021, range widely across states and years, from 0.00001 to 0.668. This signifies that while some states and years have nearly no registered background checks, others have closer to one per person. To highlight a few control variables included in the regressions, it is noteworthy how narrow the range is for the variable that controls for the proportion of a male population, with each given state and year having near-equal male and female populations. Additionally, the age control variables reveal that most of the population lies between the ages of 20-64. In contrast, the racial proportions of a state in a given year vary significantly. Finally, it is interesting to note that despite the wide range of unemployment rates, the majority of the data lies between approximately 3% and 8%. Further summary statistics of the regression variables can be found in Table A.3 of the appendix.

V. EMPIRICAL STRATEGY

To evaluate the impact of gun prevalence on the likelihood of a school shooting, I conduct a difference-in-differences analysis, including fixed effects for states and years, which relies on both the parallel trends assumption for internal validity as well as the assumption that the composition of groups does not change meaningfully over time. Thus, the units of observation are each 50 states (and Washington D.C.) in as many years as data is available for the various proxies following 1999, the year of the shooting at Columbine High School. The model controls for demographic, economic, overall violence, and mental health concerns while looking at an explanatory variable of gun prevalence as measured by three separate proxies: the fraction of suicides committed by firearm (FSS), the number of federal firearm licensees (FFL), and the amount federal firearm background checks (NICS). Although researchers have used all three as proxies for gun prevalence, it is worth noting that each is likely to capture different margins of gun availability. As seen in Table 1 below, NICS and FFL are much more correlated than NICS and FSS, so FSS and NICS will likely generate very different results. Specifically, it is hypothesized that NICS will be most correlated with school shootings while FSS will be least correlated, with FFL somewhere in the middle, given its correlation with NICS. This is because FSS is likely most closely related to gun ownership on the extensive margin, which has been trending relatively flat in the last few decades until recently, as has FSS. This is true even as gun demand, proxied by background checks (NICS), has taken off. This is why NICS is likely to represent a better proxy. After running some initial regressions with all proxies, I proceed solely with background checks, which is likely to capture gun demand not just from new gun owners but also, and possibly especially, from existing gun owners purchasing additional guns.

Table 1: FFL, NICS, and FSS Correlations

	Type 1 and 2 FFL	**NICS**	**FSS**
Type 1 and 2 FFL	1.0000		
NICS	0.4258	1.0000	
FSS	0.2441	0.0767	1.0000

Demographic and economic concerns are controlled with vectors that eliminate the variation due to the association certain demographics and socioeconomic groups have with specific types of school shootings (Levine & McKnight, 2020a). Similarly, given that most assailants are unwell or depressed, the mental health control is necessary to help eliminate the variation in school shootings that is due to the general unhappiness of a population (Vossekuil et al., 2002). Lastly, as approximately 70% of all attackers report bullying and harassment prior to the incident, this variation is accounted for through the overall violence control of gun homicides, as mentioned in the previous section.

Furthermore, the NICS proxy used for the gun prevalence variable is lagged by one year to account for the time it takes for guns to circulate an area, end up in the hands of an attacker, and later be fired on school property. Additionally, the state population size control variable is logged in the Poisson regressions that are used for robustness checks to acknowledge that per capita shootings might be less or more frequent when the population rises. In all models, all variables are transformed into per capita form except controls already in percentage form, such as the employment-population ratio and the unemployment rate. Weighting by population is done in each panel regression to give more importance to observations from larger entities relative to observations from smaller entities in estimating the gun proxy coefficients. Trend variables for each state are also included to account for time trends specific to each state and other state-level factors that change over time but are not captured by other variables in my model. Finally, comparisons that my panel regressions draw from are restricted to be within census regions as a way to compare only states with similar gun cultures. Hypotheses and expected directionality of terms included in the regression can be found in Table A.2 of the appendix.

Additionally, multiple regressions were performed using sub-categories within the school shootings database. Literature has shown that aggregating school shooting data and not accounting for the differences inherent in various types of school shootings can result in misleading conclusions (Levine & McKnight, 2020a). Thus, dependent variable subcategories tested in my research include classifications by school level (elementary, middle, or high), shooting type (indiscriminate, suicide, targeted, or other), shootings with or without victims, shootings with or without deaths, and shootings that occurred during or outside of school hours.

Table 2: Baseline NICS Panel Regression

	(1)		
VARIABLES	AllShootings		
Variable of Interest		*Demographic Control Variables*	
L.NICSKYPermitsRechecksPerCap	**20.43*** **	Population	-6.14e-06***
	-7.30e+00		(0.0000012)
		PerCapBadMH	2,625
			(2,133)
Economic Control Variables		PerCapHisOrLatPop	-170.2***
ur	-0.010		(62.31)
	(0.12)	PerCapWhiPop	-182.2*
PerCapHgun	4,703		(95.51)
	(13,273)	PerCapBlackPop	-183.4
PovRate	-1.320		(125.70)
	(5.569)	PerCapAsianPop	61.61**
EPR	-1.04e+00		(23.19)
	(13.20)	PerCapAIAlskPop	253.2*
PersonalIncomeperCapitaBase	-2.66E-05		(136.00)
	(0.00012)	PerCapMale	582.3**
			(235.60)
		PerCapfivetonineteen	-114.3
			(111.90)
Constant	238.6	PerCaptwentytosixtyfour	-342.0***
	(208.40)		(96.55)
Observations	1,122	PerCapSixtyFivePlus	-265.8*
Number of StateCode	51		(158.60)
R-squared	0.724	o.PerCapzerotofour	-

Robust standard errors in parentheses

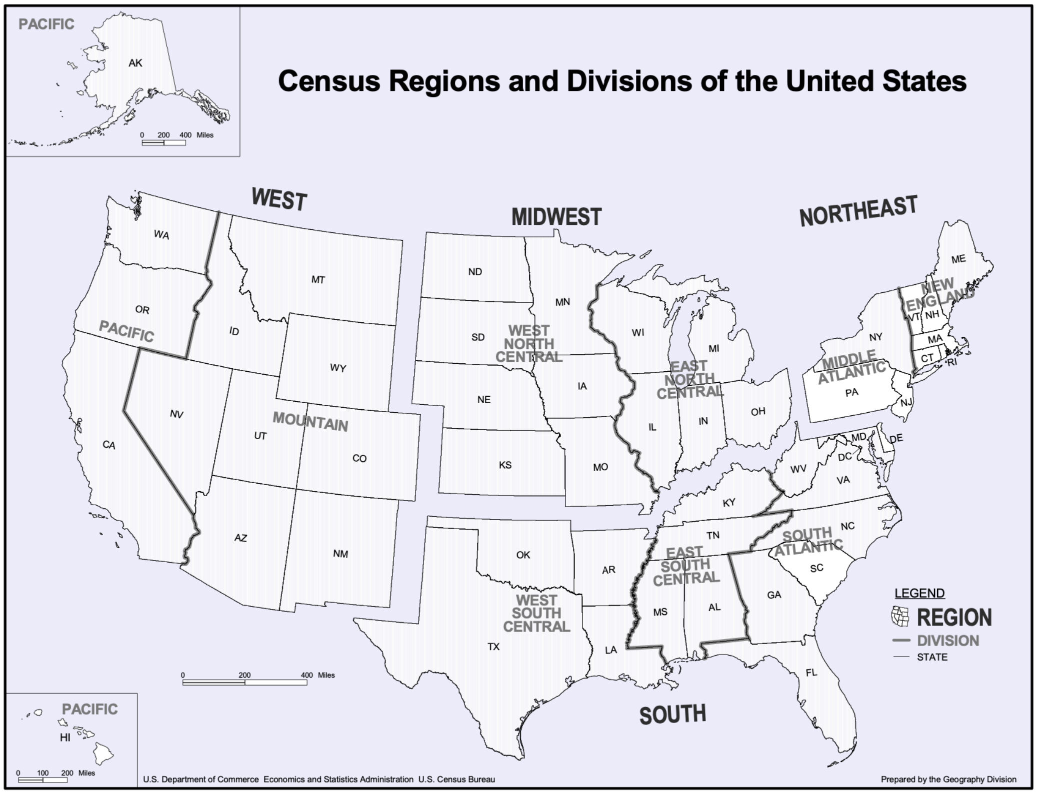
*** p<0.01, ** p<0.05, * p<0.1

The table above details the results of my baseline panel regression model using NICS as a proxy, which looks like:

$$Y_{it} = \beta_0 + \beta_1 L.G_{it} + \beta_2 V_{it} + \beta_3 M_{it} + \beta_4 E_{it} + \beta_5 X_{it} + S_i + Y_t + u_{it}$$

where Y_{it} represents all school shootings between 2000-2021. $\beta_0 - \beta_5$ represent regression coefficients, S_i represents state fixed effects, Y_t represents year fixed effects, and i and t are subscripts for state and year. Additionally, u_{it} represents the error term, which is uncorrelated with G_{it} (NICS gun prevalence lagged & Kentucky adjusted), V_{it} (overall violence control variable of gun homicides), M_{it} (BRFSS mental health control variable), and E_{it} (income, EPR, unemployment, and poverty rate), and conditional on X_{it} (race, age, and size demographic control variables), S_i (state or county fixed effects), and Y_t (year fixed effects). This baseline regression groups all school shootings together and ignores different sub-categories hidden in the aggregated data. Furthermore, this regression restricts comparisons within census regions, as visualized in Graph 1 below, made by the geography division of the U.S. Census Bureau. After running this same baseline regression utilizing FSS and FFL, my hypothesis that NICS looks to be the best proxy of the actual number of guns circulating has proven to be correct, and I proceed with the rest of the paper using an analysis of NICS as the primary gun proxy. A full list of the variables included in the regressions is in Table A.2 of the appendix.

Graph 1: Census Regions Visual



This initial result indicates that at the 1% confidence level (with the restriction of comparisons to states within the same census region) when NICS per capita is increased by 1 standard deviation, the number of all shootings increases by an average of 0.764. This effect is slightly stronger than the effect found without region restriction, which is 0.64. This makes sense, however, as comparing states to others in the same region with similar gun cultures should produce stronger and more precise results; this observation of within-region precision and lower standard errors is consistent even as subcategories are created in the next section. This initial result is also robust when testing for non-linear trends, using a Poisson specification, the quartic root of the all shootings count, and testing the data with a binary model.[2] Specifically, I remain confident that a linear panel regression is the correct model because when testing a panel regression for non-linear trends, nearly the same coefficient is produced (20.43 when linear and

[2] These models are chosen given the nature of the data. Difference-in-differences estimates the causal effect of gun prevalence by comparing changes in school shootings over time among groups with different gun prevalence levels. Adding quadratic trends allows the parallel trends assumption to be non-linear. Poisson models suit count data, which is the focus of my research. The quartic root specification adjusts for outliers. Binary panel regressions are apt for examining the correlation between gun prevalence and the two most important margins of school shootings.

18.62 when quadratic); it is only the standard error that inflates (7.30 to 9.62), signaling the unfitness of the quadratic model.

Furthermore, when using a Poisson specification, the model predicts at the 1% significance level that if NICS per capita increases by 1 standard deviation, there will be a 7.53% increase in the number of shootings on average. Stata, however, cannot run this regression restricting comparisons to within regions, so this result compares all states to each other. Although this Poisson specification indicates robust results, I do not use it as the primary model for several reasons. First, around 55% of all observations in the data are zero (each observation indicates the count of shootings in a given state and year), and it is unclear what amount of zeros in a data set constitutes an "excessive amount" for Poisson. Additionally, as I continue further into the paper by grouping the school shootings into appropriate subdivisions, the number of zeros in the data naturally increases, and Stata can no longer fit a Poisson model. Thus, this model is useful solely for its ability to indicate robustness. Still, the primary regression for my research remains a panel regression controlling for state and year fixed effects and restricting comparisons to be within census regions. Specifically, as shown in the results in the following section, the primary specifications analyzed are the binary panel regressions, as they focus on the most important margins where the majority of data lies, from 0 to 2 shootings in a given state and year.

VI. RESULTS AND DISCUSSION

The results of this analysis will be discussed in a specific sequence. First, a brief overview of the results found using all school shootings in the dataset. Then, an analysis of these same regressions with various subcategories of school shootings replacing the dependent variable, such as school level, shooting type, and extent of deadliness, will be conducted. Results of the two primary regressions for each sub-category, one-binary and two-binary, are included throughout this section.

A. Aggregated Dataset: All Shootings Results

As discussed above, the initial panel regression controlling for state and year fixed effects and restricting comparisons to be within census regions predicts at the 1% confidence level that when NICS per capita is increased by 1 standard deviation, the number of all shootings increases by 0.76 on average. This result remains robust in several models, including that of the quartic root of the all shootings count variable, a technique that works to diminish the effect of outliers in the data when logging the variable is not possible due to the extent of zeroes. Two further primary models are also tested, referred to from here on out as one-binary and two-binary. The one-binary model transforms the y-variable to be 0 if no shootings occurred in a given state and year and 1 if any number of shootings greater than or equal to 1 occurred. Similarly, the two-binary model transforms the y-variable to be 0 if 0 or 1 shootings occurred in a given state and year and 1 if any number of shootings greater than or equal to 2 occurred. This subtle difference in binary models allows the former to focus on the likelihood of the first incidence of a school shooting and the latter to focus on the likelihood of multiple shootings taking place. After employing these binary models, the results show that the NICS per capita coefficient is significant in the one-binary regression model when comparing within a region. The one-binary specification finds that at the 5% significance level, a 1 standard deviation increase in NICS per capita increases the likelihood of a shooting by 2.51 percentage points, which amounts to a 5.68% increase in the likelihood of a shooting relative to the mean.

The results of these models can be seen in Table 3 below. As would be expected, the baseline panel regression produces the highest goodness of fit value, with approximately 72% of the variation in school shootings being explained by the variation in NICS per capita. The R^2 values of the one-binary, two-binary, and quartic root regressions are much lower, however, because the dependent variables in these regressions inherently have less variation than count data, which can encompass a wider range of values. Additionally, it is important to mention that I choose not to interpret the population variable or any other control variables, as the population variable has a high correlation with many of its age and race subcategories that are likely leading to multicollinearity issues and confounding results. The same issue is true for the economic control variables.

Table 3: All Shootings Regressions for Robustness

	Poisson		Baseline	One-Binary	Two-Binary	Quartic
VARIABLES	**AllShootings**	**VARIABLES**	**AllShootings**	**BinaryAll Shootings**	**TwoBinaryAll Shootings**	**QuarticRtAll Shootings**
L.NICSKYPermits RechecksPerCap	2.013***	*L.NICSKYPermits RechecksPerCap*	20.43***	0.671**	0.570	1.661***
	(0.68)		(7.47)	(0.32)	(0.37)	(0.46)
LnPopulation	-2.756	*Population*	-6.14e-06***	-6.52e-08	-7.59e-08	-4.09e-07***
	(5.01)		(0.00)	(0.00)	(0.00)	(0.00)
Constant	-	*Constant*	238.6	25.99	22.24	51.6
			(208.40)	(27.83)	28.85	-37.7
Observations	1,100	*Observations*	1,122	1,122	1,122	1,122
Number of StateCode	50	*Number of StateCode*	51	51	51	51
		R-squared	0.724	0.363	0.439	0.483

Robust standard errors in parentheses

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

B. Targeted Shootings During School Hours

The same regressions run with the aggregated data are performed here with a new dependent variable consisting of only targeted school shootings that occurred during school hours. Targeted shootings include cases of bullying, domestic violence, escalation of disputes, racial targeting, intentional murders, intentional property damage, and anger over a grade, suspension, or discipline. In short, the category encompasses acts done with intent to someone or something and represents 44% of all shootings between 2000-2021. The binary models predict at the 5% (one-binary) and 1% (two-binary) significance levels that a 1 standard deviation increase in NICS per capita increases the likelihood of one targeted shooting during school hours by 4.23 percentage points (24.61% relative to the mean) and multiple targeted shootings during school hours by 4.31 percentage points (130.83% increase relative to the mean). This shows a pattern evident in several shooting categories, which is that the effects become much more magnified when looking at how NICS impacts the likelihood of one shooting occurring vs multiple, a result of the small magnitudes of the means of the two-binary variables. As discussed previously, the R^2 values produced in these regressions are as expected for binary dependent variable regressions, given the low amount of variation inherent in the dependent variables.

Table 4: Binary Targeted vs. Non-Targeted Specifications

VARIABLES	One-Binary Binary TgtedShootings	Two-Binary TwoBinary TgtedShootings	One-Binary BinaryNon TgtedShootings	Two-Binary TwoBinaryNonT gtedShootings
L.NICSKYPermits RechecksPerCap	1.132**	1.154***	0.662*	0.329
	(0.44)	(0.37)	(0.36)	(0.40)
Population	-5.34e-07***	-3.65e-07***	-2.20e-08	-1.31e-07
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-4.539	-62.35**	30.89	81.87***
	(39.74)	(24.77)	(27.92)	(28.83)
Observations	1,122	1,122	1,122	1,122
Number of StateCode	51	51	51	51
R-squared	0.375	0.467	0.384	0.462

Robust standard errors in parentheses

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

C. Indiscriminate, Suicide, and Other Shootings During School Hours

Contrary to the strong relationship found between targeted school shootings and gun prevalence, no significant relationship is found between indiscriminate shootings during school hours and gun prevalence. In the various specifications, the NICS coefficient flips between being positive and negative yet remains close to zero and insignificant. The lack of significance may be due to the lack of indiscriminate shooting observations in the dataset (only 76) that are unable to capture sufficient variation, but it would also make sense given that, based on the literature, indiscriminate shootings are often premeditated, and people that are planning to carry out such an event have time to acquire weapons through various methods no matter the level of gun prevalence. Targeted shootings, on the other hand, can be either premeditated or spur-of-the-moment reactions to a situation. When it is an impulsive reaction, the more guns that are lying around and easily accessible, the more likely a gun will be brought into school, and the situation will be escalated through the use of one.

Suicide shootings during school hours is another sub-category with little observations relative to the larger dataset (7% of all observations). However, these results are notably different from those derived from indiscriminate shootings during school hours in that although none of the specifications are found to have a significant coefficient on NICS per capita, all of the coefficients are consistently positive. This makes it mostly likely to be the case that a significant coefficient would be found with suicide school shootings if more years of data were available, but indiscriminate shootings would remain random and uncorrelated. However, it is also likely that certain gun laws, such as safe storage laws, have interactions with gun prevalence that are skewing coefficients towards zero or altering results. For example, a significant effect might be found in states with weak gun laws but not those with strict storage laws. No matter the reason, Table 4 displays how when all of these other school shooting categories are grouped to be "non-targeted shootings," low or no significance is found.

D. Elementary, Middle, and High School Shootings

Significant results are found in the two-binary specification only for elementary and high school. This is interesting, given that high and elementary schools have the greatest number of observations in the dataset, while middle schools have fewer recorded incidents. At the 5% significance level, the models predict that when NICS per capita increases by 1 standard deviation, the likelihood of multiple elementary school shootings increases by 4.88 percentage points (86.97% relative to the mean). At the 1% significance level, the likelihood of multiple high school shootings increases by 3.77 percentage points (25.95% relative to the mean). It makes sense to see such strong effects and large magnitudes when looking at the likelihood of multiple shootings through the two-binary regressions, as this specification focuses on how the prevalence of guns affects the types of shootings most likely to repeat – such as targeted school shootings.

Table 5: Binary Specifications for Elementary, Middle, and High School

VARIABLES	One-Binary Binary Elementary Shootings	Two-Binary TwoBinary Elementary Shootings	One-Binary Binary Middle Shootings	Two-Binary TwoBinary Middle Shootings	One-Binary Binary High Shootings	Two-Binary TwoBinary High Shootings
L.NICSKYPermits RechecksPerCap	-0.0671	1.306**	-0.0175	0.302	0.655	1.008**
	(0.41)	(0.54)	(0.48)	(0.62)	(0.55)	(0.42)
Population	-2.80e-07**	-1.27e-07	-2.60e-07**	-4.59e-07***	-2.75e-07**	-3.46e-07**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	15.79	9.75	13.63	-21.04	15.74	56.78*
	(28.07)	(25.10)	(35.20)	(23.58)	(27.08)	(33.58)
Observations	1,122	1,122	1,122	1,122	1,122	1,122
Number of StateCode	51	51	51	51	51	51
R-squared	0.457	0.524	0.409	0.475	0.323	0.464

Robust standard errors in parentheses

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

E. Deadly vs. Non-Deadly Shootings

The number of school shootings with deaths is approximately 20% of the data used in the final models. Despite this small dataset, it is found at the 1% significance level that increasing NICS per capita by 1 standard deviation increases the likelihood of multiple shootings with deaths by 3.64 percentage points (107.39% increase relative to the mean). Furthermore, in the larger subset of shootings with no deaths, it is found at the 5% significance level that when NICS per capita is increased by 1 standard deviation, the likelihood of multiple shootings with no deaths is increased by 3.03 percentage points on average (15.66% increase relative to the mean).

Table 6: Binary Specifications for Deadly and Non-Deadly Shootings

VARIABLES	**One-Binary** **BinaryDeath Shootings**	**Two-Binary** **TwoBinaryDeath Shootings**	**One-Binary** **BinaryNoDeath Shootings**	**Two-Binary** **TwoBinaryNoDeath Shootings**
L.NICSKYPermits RechecksPerCap	-0.116	0.972***	0.686*	0.809**
	(0.36)	(0.24)	(0.38)	(0.33)
Population	-2.90e-07**	-5.16e-07***	-8.89e-08	-2.21e-07*
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	12.39	-22.72	5.081	63.38**
	(27.22)	(21.72)	(32.42)	(26.39)
Observations	1,122	1,122	1,122	1,122
Number of StateCode	51	51	51	51
R-squared	0.327	0.528	0.387	0.463

Robust standard errors in parentheses

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

F. Limitations

Despite all of these findings signaling a positive relationship between gun prevalence and school shootings, I find it important to note the limitations of this study. First, there are general limitations to using a difference-in-differences model. In particular, the model assumes that the composition of groups that have and have not experienced school shootings remains the same when a shooting occurs. This is likely the case given several studies that find no evidence of migration in response to school shootings, but we cannot be certain (Cabral et al., 2022; Deb & Gangaram, 2021; Levine & McKnight, 2020b). Second, there is currently no perfect measure of gun prevalence. I find that federal firearm background checks represent the best measure of guns in circulation and not just the number of people who own guns, but the data nevertheless has many shortcomings. Until recently, the background checks registered by the federal system were not appropriately broken up into sufficient classifications. While the categorizations are clearer in recent data, it is still hard to be sure what is included in the total background check number. This makes it difficult to adjust the total background check number to be only inclusive of those triggered for new gun purchases.

VII. CONCLUSION

There is no doubt that school shootings can have adverse effects on the children who witness them. This thesis contributes to the existing literature surrounding school shootings by studying how gun prevalence, as measured through a proxy of federal firearm background checks, affects the likelihood of a school shooting. Specifically, this paper utilizes proprietary data from the K-12 School Shooting Database, along with numerous control variables in a panel regression that controls for fixed effects, to isolate the variation in school shootings caused by the variation in gun prevalence. Specifically, two binary specifications are interpreted as they represent the two most prevalent margins in the dataset, the difference between 0 and 1 school shooting (one-binary model) and the difference between 1 and 2 school shootings (two-binary model).

Strong statistical significance is found in multiple specifications when the aggregated all shootings data is used in the dependent variable. At the 95% confidence interval, a 1 standard deviation increase in NICS per capita increases the likelihood of a shooting by 2.51 percentage points, which amounts to a 5.68% increase in the likelihood of a shooting relative to the mean. Additionally, the subcategory of targeted school shootings shows results of particularly strong significance. At the 99% confidence level, a 1 standard deviation increase in NICS per capita increases the likelihood of multiple targeted shootings during school hours by 4.31 percentage points (130.83% increase relative to the mean). This outcome is of interest for how it displays the magnified effect of gun prevalence on the likelihood of multiple shootings occurring as compared to the likelihood of a one-off event. Interestingly, strong statistical significance for a positive relationship is found in the two-binary model for both shootings with deaths and shootings without deaths. Lastly, the two-binary model shows a statistically positive coefficient on NICS per capita for elementary and high school shootings but not for middle school shootings, a result that can potentially be attributed to the lack of school shooting data in middle schools.

Given these results, in combination with previous literature, it can be concluded that high gun prevalence has adverse effects on students' short- and long-term achievement and mental health through the occurrence of school shootings. Many opportunities exist to further the research done in this paper. First, the federal firearms background check data can be closely examined to create the most accurate data to be used as a gun prevalence proxy. Additionally, Google Trends can be explored as the frequency of a search, such as "gun shops nearby," can be seen as a proxy for gun demand. Lastly, it would be interesting to look at how safe storage laws and permitless carry laws interact with gun prevalence in their effect on school shootings, as there is likely to be an undiscovered interaction between the two. Such studies would complement the work done in this thesis and help further bridge the gap between gun prevalence and school shooting literatures.

References

Abouk, R. and Adams, S., 2013. “School Shootings and Private School Enrollment.” *Economics Letters* 118(2): 297-299. https://doi.org/10.1016/j.econlet.2012.11.009.

Ali, Shirin. “Why Are Mass Shootings on the Rise This Year?” *Slate Magazine*, Slate, 15 May 2023, slate.com/news-and-politics/2023/05/how-to-make-sense-of-the-recent-increase-in-mass-shootings.html. Accessed 27 Feb. 2024.

Alper et al., 2019. “Source and Use of Firearms Involved in Crimes: Survey of Prison Inmates, 2016.” *Bureau of Justice Statistics (BJS).* www.bjs.gov/index.cfm?ty=pbdetail&iid=6486

Anderson et al., 2021. “Child access prevention laws and juvenile firearm-related homicides.” *Journal of Urban Economics* 126: https://doi.org/10.1016/j.jue.2021.103387.

Anderson, D. Mark and Joseph J. Sabia, 2018. “Child-Access-Prevention Laws, Youths’ Gun Carrying, and Shootings.” *The Journal of Law and Economics* 61(3): https://doi-org.proxy.lib.duke.edu/10.1086/699657

Azrael et al., 2018. “Firearm Storage in Gun-Owning Households with Children: Results of a 2015 National Survey.” *Journal of Urban Health* 95(3):295-304. Doi: 10.1007/s11524-018-0261-7.

Azrael, D., P. J. Cook, and M. Miller, 2004. “State and local prevalence of firearms ownership measurement, structure, and trends.” *Journal of Quantitative Criminology* 20(1): 43–62.

Beland, L.P. and Kim, Dongwoo, 2016. “The effect of high school shootings on schools and student performance.” *Educational Evaluation and Policy Analysis* 38(1): 113–126. https://doi.org/10.3102/0162373715590683

Bharadwaj, Prashant, Manudeep Bhuller, Katrine V. Løken, and Mirjam Wentzel, 2021. "Surviving a mass shooting," *Journal of Public Economics*, Elsevier, vol. 201(C). doi:10.3386/w28642.

Billings, Stephen B., 2023. “Smoking gun? Linking gun ownership to crime victimization.” *Journal of Public Economics* 222, https://doi.org/10.1016/j.jpubeco.2023.104874

Brownlee, Chip. “In 2019, Congress Pledged Millions to Study Gun Violence. The Results Are Nearly Here.” *The Trace*, 6 June 2022, www.thetrace.org/2022/06/gun-violence-study-data-cdc-nih-funding/.

Cabral, Marika, et al., 2020. *Trauma at School: The Impacts of Shootings on Students’ Human Capital and Economic Outcomes*, doi:10.3386/w28311.

Carniglia et al., 2019. “California's comprehensive background check and misdemeanor violence prohibition policies and firearm mortality.” *Annals of Epidemiology* 30: 50-56 https://doi.org/10.1016/j.annepidem.2018.10.001

Depetris-Chauvin, Emilio, 2015. “Fear of Obama: An empirical study of the demand for guns and the U.S. 2008 presidential election.” *Journal of Public Economics* 130: 66-79. https://doi.org/10.1016/j.jpubeco.2015.04.008.

Cook, P.J., 2018. “Gun Markets.” *Annual Review of Criminology* 1: 359-377 https://doi.org/10.1146/annurev-criminol-032317-092149

Cook, P. J. and J. Ludwig, 2006. “The social costs of gun ownership”. *Journal of Public Economics* 90(1-2): 379–391. https://doi.org/10.1016/j.jpubeco.2005.02.003.

Cox, John Woodrow, et al. “More than 356,000 Students Have Experienced Gun Violence at School since Columbine.” *The Washington Post*, WP Company, 3 Apr. 2023, www.washingtonpost.com/education/interactive/school-shootings-database/.

Deb, Partha and Anjelica Gangaram, 2021. *Effects of School Shootings on Risky Behavior, Health and Human Capital*, doi:10.3386/w28634.
Donohue et al., 2019. "Right-to-Carry Laws and Violent Crime: A Comprehensive Assessment Using Panel Data and a State-Level Synthetic Control Analysis." *Journal of Empirical Legal Studies* 16(2): 198-247 https://doi.org/10.1111/jels.12219
Donohue et al, 2022. "Why Does Right-to-Carry Cause Violent Crime to Increase?" *National Bureau of Economic Research*, doi: 10.3386/w30190
Duggan, M., 2001. "More guns, more crime." *Journal of Political Economy* 109(5): 1086–1114.
Elinson, Zusha, and Cameron McWhirter. "Gun Thefts Are Rising and Leading to More Crime, Including Sacramento Mass Shooting." *The Wall Street Journal*, Dow Jones & Company, 28 Apr. 2022, www.wsj.com/articles/rise-in-first-time-gun-owners-linked-to-more-gun-thefts-in-major-cities-11651160540.
Everytown. "Gunfire on School Grounds in the United States." *Everytown Research & Policy*, Everytown for Gun Safety Support Fund, 28 Feb. 2023, everytownresearch.org/maps/gunfire-on-school-grounds/.
Everytown. "The Impact of Gun Violence on Children and Teens." *Everytown Research & Policy*, Everytown for Gun Safety Support Fund, 20 Feb. 2020, everytownresearch.org/report/the-impact-of-gun-violence-on-children-and-teens/. Accessed 23 Nov. 2023.
Johnson, David Blake and Joshua J. Robinson, 2021. "Gun Dealer Density and its Effect on Homicide." http://dx.doi.org/10.2139/ssrn.3867782
Kellermann, Arthur L. and Frederick P. Rivara, 2013. "Silencing the Science on Gun Research." *JAMA* 309(6): 549–550 doi:10.1001/jama.2012.208207
Koenig, Christoph and David Schindler, 2023. " Impulse Purchases, Gun Ownership, and Homicides: Evidence from a Firearm Demand Shock." *The Review of Economics and Statistics* 105(5): 1271–1286. doi: https://doi.org/10.1162/rest_a_01106
Lang (Kate) Yang and Maithreyi Gopalan, 2023. "The Effects of Campus Shootings on School Finance and Student Composition." *Education Finance and Policy* 18(2): 277–301. doi: https://doi.org/10.1162/edfp_a_00350
Lang, Matthew, 2013. "Firearm Background Checks and Suicide." *The Economic Journal* 123(573): 1085-1099. http://www.jstor.org/stable/42919269
Lang, Matthew, 2016. "State Firearm Sales and Criminal Activity: Evidence from Firearm Background Checks." *Southern Economic Journal* 81(1): 45-68. https://doi.org/10.1002/soej.12134
Levine, Phillip and Robin McKnight, 2017. "Firearms and accidental deaths: Evidence from the aftermath of the Sandy Hook School shooting." *Science* 358(6368):132-1328 DOI: 10.1126/science.aan8179
Levine, Phillip and Robin McKnight. *Not All School Shootings Are the Same and the Differences Matter*, 2020a, doi:10.3386/w26728.
Levine, Phillip and Robin McKnight. *Exposure to a School Shooting and Subsequent Well-Being*, 2020b, doi:10.3386/w28307.
Lott, John R. and David B. Mustard, 1997. "Crime, Deterrence, and Right-to-Carry Concealed Handguns." *The Journal of Legal Studies* 26(1): 1-68 https://www.jstor.org/stable/10.1086/467988

Lott, John R. and William M. Landes, 2000. "Multiple Victim Public Shootings." http://dx.doi.org/10.2139/ssrn.272929

Lott, John R. and Rujun Wang, 2020. " Concealed Carry Permit Holders Across the United States: 2020." *Report from the Crime Prevention Research Center,* http://dx.doi.org/10.2139/ssrn.3703977

Margolin, Gayla and Elana B. Gordis, 2000. "The Effects of Family and Community Violence on Children." *Annual Review of Psychology* 51(1): 445-479, doi: 10.1146/annurev.psych.51.1.445. PMID: 10751978.

Matthews, Alex Leeds. "School Shootings in the US: Fast Facts." *CNN*, Cable News Network, 29 Sep. 2023, www.cnn.com/2023/09/22/us/school-shootings-fast-facts-dg/index.html.

Nabors, Yolunda *A. School Gun Violence, Mental Health, and Labor Outcomes Among Fragile Families and Disadvantaged Communities in the United States.* Middle Tennessee State University, 2023.

Rabin, Roni Caryn. "Gun Deaths Rising Sharply among Children, Study Finds." *The New York Times*, 5 Oct. 2023, www.nytimes.com/2023/10/05/health/gun-deaths-children.html#:~:text=But%20according%20to%20an%20analysis,of%20accidental%20death%20in%20children.

Rossin-Slater, Maya, et al. *Local Exposure to School Shootings and Youth Antidepressant Use*, 2019, doi:10.3386/w26563.

Shaffer, Rachel, 2000. " Child Access Prevention Laws: Keeping Guns Out of Our Children's Hands." *Fordham Urban Law Journa*l 27(6) https://ir.lawnet.fordham.edu/ulj/vol27/iss6/7

Siegel, M., C. S. Ross, and C. King III, 2013. "The relationship between gun ownership and firearm homicide rates in the United States, 1981–2010." *American journal of public health* 103 (11): 2098–2105.

Soni, Aparna and Erdal Tekin. *How Do Mass Shootings Affect Community Wellbeing?,*2020, doi: 10.3386/w28122.

Valeeva, Anastasia, and Wendy Ruderman. "What You Need to Know about the Rise in U.S. Mass Shootings." *The Marshall Project*, 6 July 2022, www.themarshallproject.org/2022/07/06/what-you-need-to-know-about-the-rise-in-u-s-mass-shootings. Accessed 27 Feb. 2024.

Vossekuil, B., Fein, R., Reddy, M., Borum, R., & Modzeleski, W., 2002. "The final report and findings of the Safe School Initiative: Implications for the prevention of school attacks in the United States." *Washington, DC: U.S. Secret Service and Department of Education.*

Wike, Traci L. and Mark W. Fraser, 2009. "School Shootings: Making Sense of the Senseless." *Aggression and Violent Behavior* 14(3): 162-169. https://doi.org/10.1016/j.avb.2009.01.005.

Appendix

Table A.1: Data Sources

Dataset	Years Available	Years Pulled in Data File	Use	Frequency	Region Units	Authors Used By
K-12 School Shootings Database	1966-Present	1999 - 9/25/2023 (date pulled)	Dependent Variable of School Shootings	Constantly Updated	City, State	Deb & Gangaram, 2021; Levine & McKnight, 2020a; Levine & McKnight, 2020b
National Vital Statistics System Mortality Data	1979-2021	1998-2021	FSS Proxy for Gun Prevalence; Control for Overall Area Violence	Every Year	State	Levine & McKnight, 2020b; Cook & Ludwig, 2006
NICS Firearm Checks from the FBI: Month/Year by State	1998-Present	1998-2021	NICS Proxy for Gun Prevalence	Every Month	State	Lang, 2013
GSS Gun Ownership Responses	1972-2022	1998-2022	"Gold standard" for Measuring Gun Ownership	Every 2 Years	Census Regions	Cook & Ludwig, 2006
Bureau of Alcohol, Tobacco, Firearms and Explosives: FFL Listings	2000-2020	2000-2020	FFL Proxy for Gun Prevalence	Every Month	State	Johnson & Robinson, 2023
BLS Employment Data	1948-present for Seasonally Adjusted Numbers (Prior unadjusted years available in archive)	1998-2021	Economic Control Variables (Employment-Population Ratio and Unemployment Rate)	Every Month	State	Several Papers
US Census Bureau Demographics Data	2000-2020 (with prior years available in archives, and intercensal estimates provided)	1998-2021 (using intercensal estimates)	Demographics Control Variable	Census Every 10 Years (Intercensal Estimates Yearly)	Zip Code Tabulation Areas (ZCTAs)	Several Papers
CDC's annual Behavioral Risk Factors Surveillance System Survey (BRFSS)	1984-2022	1998-2021	Mental Health Control Variable	Every Year	State	Deb & Gangaram, 2021; Vittt et al., 2018
BEA Macroeconomic Data	1998-Present (with previous years archived)	1998-2021	Economic Control Variable (Personal Income Per Capita)	Every Year	State	Several Papers
US Census Bureau American Community Survey (ACS)	2000-2020 (with prior years available in archives, and intercensal estimates provided)	1998-2021	Economic Control (Poverty Rate)	Every Year	State	Deb & Gangaram, 2021

Table A.2: Regression Variables

Variable	Label	Type	Source	Description	Interpretation	Predicted Relationship
School Shootings	AllShootings, QuarticRtAllShootings, BinaryAllShootings, TwoBinaryAllShootings, etc.	Scale	K-12 School Shootings Database	Comprehensive data set of all school shootings that have occurred since 1966	Collapsed data into state-by-year counts of school shootings used as the **dependent variable**	+
NICS Firearm Background Checks Excl. KY Permits & Rechecks	NICSKYPermitsRechecksPerCap	Scale	National Instant Criminal Background Check System (NICS)	# of federal firearm background checks performed in a given state and year, subtracting out permits and permit rechecks in Kentucky	**Main independent variable** of interest; proxy for gun prevalence; background checks are triggered by the purchase of a gun; KY permits and rechecks do not represent new gun purchases and are excluded	+
Unemploy-ment Rate	Ur	Scale	Bureau of Labor Statistics (BLS)	Percentage of people unemployed in a state or county	Control variable	+
Poverty Rate	PovRate	Scale	U.S. Census Bureau	Percentage of people living below the poverty line in a state	Reveals the number of people living with an income that falls below that needed for basic needs; control variable	+
Employment-Population Ratio	EPR	Scale	Bureau of Labor Statistics (BLS)	Civilian labor force currently employed against the total working-age population of a state	Shows true proportion of a population that is employed; control variable	–
Personal Income Per Capita	PersonalIncomeperCapitaBase	Scale	U.S. Bureau of Economic Analysis (BEA)	The income that people living in each state and D.C. get from wages, proprietors' income, dividends, interest, rents, and government benefit	Measured in 2017 U.S. dollars; control variable	–
Mental Health	PerCapBadMH	Scale	BRFSS	Variable reports # of bad mental health days in the past month; transformed into into categorical variable showing % of population in a given state year reporting at least 20 not-good days of mental health	% of population reporting more than 20 not-good mental health days; proxy for extreme unhappiness in an area; control variable	+
Race of Population	PerCapHisOrLatPop, PerCapWhiPop, PerCapBlackPop, PerCapAsianPop, PerCapAIAlskPop	Scale	CDC Wonder	Percentage of individuals reporting as various races	Control variable showing % White, % Black/African American, % Asian/Pacific Islander, % Hispanic/Latino, % American Indian/Alaska Native	?
Age of Population	PerCapzerotofour, PerCapfivetonineteen, PerCaptwentytosixtyfour, PerCapSixtyFivePlus	Scale	CDC Wonder	Percentage of people in various age groups	Control variable showing % of population of different age groups divided into groups as follows: 5-19 (school age), 20-64, 65+; the omitted age group is 0-4	?
Population Size	Population	Scale	CDC Wonder	Population of individuals residing in a state/county	Control Variable	?
Male Population	PerCapMale	Scale	CDC Wonder	Percentage of people reporting as male	Control variable	+
Violence	PerCapHgun	Scale	National Vital Statistics System (NVSS)	# of gun homicides in a specific state and year	Used as a control variable for the overall violence of an area	+

Table A.3: Summary Statistics of Regression Variables (n = 1,122 | Years = 2000-2021)

Scale Variable	Mean	Median	Std. Dev.	Min.	Max.
AllShootings	1.10	0.00	2.10	0.00	23.00
QuarticRtAllShootings	0.52	0.00	0.61	0.00	2.19
BinaryAllShootings	0.44	0.00	0.50	0	1
TwoBinaryAllShootings	0.23	0.00	0.42	0	1
BinaryTgtedShootings	0.17	0.00	0.38	0	1
TwoBinaryTgtedShootings	0.03	0.00	0.18	0	1
BinaryNonTgtedShootings	0.38	0.00	0.49	0	1
TwoBinaryNonTgtedShootings	0.18	0.00	0.39	0	1
BinaryElementaryShootings	0.19	0.00	0.40	0	1
TwoBinaryElementaryShootings	0.06	0.00	0.23	0	1
BinaryMiddleShootings	0.14	0.00	0.35	0	1
TwoBinaryMiddleShootings	0.03	0.00	0.17	0	1
BinaryHighShootings	0.35	0.00	0.48	0	1
TwoBinaryHighShootings	0.15	0.00	0.35	0	1
BinaryDeathShootings	0.16	0.00	0.37	0	1
TwoBinaryDeathShootings	0.03	0.00	0.18	0	1
BinaryNoDeathShootings	0.39	0.00	0.49	0	1
TwoBinaryNoDeathShootings	0.19	0.00	0.40	0	1
L.NICSKYPermitsRechecksPerCap	0.0590	0.0513	0.0470	0.00001	0.66800
UR	5.57	5.20	2.02	2.10	13.80
PovRate	0.12	0.12	0.03	0.04	0.23
EPR	0.62	0.62	0.05	0.50	0.73
PersonalIncomeperCapitaBase	39,478.21	37,176.89	14,174.30	15,966.26	106,274.00
PerCapBadMH	0.0002	0.0001	0.0001	0.00	0.00074
PerCapHisOrLatPop	0.105	0.075	0.098	0.007	0.500
PerCapWhiPop	0.809	0.839	0.132	0.252	0.979
PerCapBlackPop	0.121	0.086	0.112	0.004	0.618
PerCapAsianPop	0.048	0.028	0.091	0.006	0.676
PerCapAIAlskPop	0.021	0.008	0.033	0.002	0.176
PerCapzerotofour	0.064	0.064	0.007	0.043	0.097
PerCapfivetonineteen	0.201	0.201	0.017	0.142	0.269
PerCaptwentytosixtyfour	0.594	0.594	0.018	0.552	0.682
PerCapSixtyFivePlus	0.141	0.139	0.025	0.057	0.220
Population	6,059,282	4,248,904	6,808,204	494,300	39,400,000
PerCapMale	0.493	0.492	0.008	0.471	0.527
PerCapHgun	0.00004	0.00003	0.00003	0.00	0.0003