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The Effect of California's Open Carry Ban on Gun-Related Homicides

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While writing this thesis, I have not witnessed any wrongdoing, nor have I personally violated any conditions of the Skidmore College Honor Code.

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Abstract: *This study examines the effectiveness of the ban on the open carry of firearms in California (implemented in January, 2012). Data was taken from the U.S. Vital Statistics website on a monthly basis from January, 2006 to December, 2017, and it incorporated gun-related murder totals as well as totals for African Americans and Caucasians. RDD and DID regressions were run (using Texas as a control state) in order to determine the impact of the law. The RDD turned out insignificant results. The DID showed that the law had a significant negative impact on total homicides (decreasing them by about 1 murder every 4 months). It also produced significant negative impacts for both African Americans and Caucasians, although it was a more drastic decrease for Black citizens. This study concludes the effectiveness of the open carry ban and the need for further research on the impact of gun control laws.*

Introduction

Gun regulation is among the most controversial issues in modern American politics, with most Americans finding themselves on one of two drastically different ends of the spectrum. Most Democrats believe that if guns can be better regulated by local, state, and national governments, thereby reducing the number of privately-owned weapons, overall crime will drop. Simply put, this theory suggests that lower availability of guns will equate to a lower frequency of crime. The majority of Republicans, on the other hand, believe that greater availability of guns will put more power in the hands of "good" guys, thus preventing "bad guys" with guns from acting without consequence. As a result, their hypothesis is that crime will fall as the number of guns rises, given that potential perpetrators will have to go up against armed citizens before committing their crimes.

While debate over the second amendment "right to bear arms" is nothing new to United States politics, it had heated up even further in the midst of recent mass shootings within the country. Tragedies like the Las Vegas concert slaying, the Orlando night club shooting, and the Sandy Hook Elementary School murders have left Americans looking for answers, and causing them to place blame on everything from the murder weapons themselves to the parents of the perpetrators. While a quick scroll through any social media platform (facebook, twitter, Instagram, etc.) clearly outlines the controversy surrounding this topic, Pew Research Polls tell a more data-based story. Only 22% of Democrats favor the protection of the Second Amendment

right to own firearms over gun control laws to curtail their availability. As many as 76% of Republicans, on the other hand, value the "right to keep and bear arms" more than they support any infringement upon it. This 54 point gap in support for Second Amendment rights ranks second among all current public policy issues in terms of overall polarization, according to Pew's survey data. The only issue that ranks higher in terms of controversy is the building of a wall along the Mexican border to keep potential illegal immigrants out. Aside from that, gun regulation is more polarizing the healthcare, climate change, abortion rights, tax laws (whether the wealthy should be taxed higher than the rest of the population), free trade, same-sex marriage, and even marijuana legalization. This is significant considering the current state of division within American politics. Democrats and Republicans tend to be gridlocked and unwavering on a multitude of political issues. The nation is more divided than ever along the lines of its long-standing two-party system. For research to determine gun control laws to be at the forefront of this polarization (minus the wall that the most controversial president in history promised to build) demonstrates just how tense it really is.

Meanwhile, the topic of gun control is one of the few remaining political topics that has the potential for empirical findings. Issues abortion rights, tax debate and regulations, same-sex marriage, the border wall, and marijuana legalization (at least to some extent), are mostly matters of moral and opinion. In other words, in terms of statistical research, one cannot determine who is right in the pro-choice vs. pro-life debate. The same goes for building a wall along the border, allowing gay marriage, and most of the other polarizing American issues. These issues eventually boil down to a person's beliefs and what he or she believes is ethically right and wrong. Gun control, however, has the potential for research opportunity in that the effect of gun regulation on certain gun-related crime can be measured empirically. Researchers can determine whether a law had any impact on gun-related crime, whether it caused an increase as most Republicans would posit or a decrease in alignment with Democratic theories. Not only is the American political system beginning to become more divided (as previously demonstrated), but mass shootings and murders are occurring in the U.S. at an alarming rate. Research that determines the validity of gun restrictions (for positive or negative) can assist policy-makers in determining what kind of laws are effective. Even if gun regulation is found not to be impactful, this would help legislatures better invest time, money, and effort into other policy areas. Thus,

the need for more empirical research on this topic, in order to help prove or disprove either side of this argument, is critical to the health of the United States and its citizens.

The policy alteration used in this study is California's ban on the open (public) carry of firearms in January, 2012. In that month, California's new law stated that it was no longer legal to carry a firearm in public, and doing so could be punished by up to 364 days in prison or a maximum $1,000 fine. It was hypothesized that the implementation of a ban on the open carry of guns in California would have a significant negative impact on rates of homicide by firearm.

Literature Review

This study will examine the overall influence of California's open carry ban (implemented in January, 2012) on gun-related homicides. While there has been plenty of previous research on gun control and its effect on crime rates, both gun-related and otherwise, most is not directly related to this study (specifically an open carry ban in California). Most previous research either attempts to establish a correlation between rates of gun ownership and rates of violent crime; especially violent crime committed with a gun. Thus, many of these papers turn to survey data in order to determine levels of gun ownership and whether that region, either internationally or within the United States, has higher rates of gun-related crime. The majority of these types of studies tend to use a Spearman coefficient to determine a correlation, if any, between number of households reporting possession of a firearm and frequency of crime.

Other papers on this topic use data/methods similar to those proposed for this paper; however, they have looked at different policy implementations in different locations. In the midst of the controversial Trayvon Martin case in Florida, some studies focused their attention solely on "stand your ground" laws in that state. Others examine the same laws in a more national context, comparing all those states who have incorporated such laws to those who have not. In general, these studies have run either discontinuity (RDD) regressions or difference-in-difference (DID) regressions in order to determine results. Others still tend to focus their attention on restrictions like Child Access Prevention (CAP) laws, waiting periods and background checks, gun seizures, and assault rifle bans.

The common thread among most of the studies, regardless of whether they establish a mere correlation between guns and crime or they examine specific policy implementations, is that they find a positive connection between guns and gun-related crimes. In the case of the

studies that use survey data, higher frequency of household gun possession correlated with higher rates of gun-related crime. In the instance of "stand your ground" papers, those who incorporated such laws tended to have higher rates of gun-related homicide than those states who did not have such policies. Conversely, every paper that examined a law aimed to reduce gun-related crime either produced no effect or a significant negative one. In other words, none of the researched gun control laws found that incorporating such legislation actually caused a rise in homicide rates.

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Perhaps the most similar published study to my own was conducted in 2000 (multiple authors) that examines an open carry ban in two Colombian cities. They use an interrupted time series regression (RDD) to determine any discontinuity in the overall trend of homicide rates within these locations. According to the paper, the law was implemented such that there were periods in which the open carry ban was in effect and others when it was not. Results showed that instances of homicide were significantly lower during periods in which the ban on carrying firearms was present compared to those in which it was not. Therefore, the carrying ban was associated with an overall lowering of homicides within both Colombian cities that were included in the study.

Despite its striking similarity to my study, however, the difference in location provides enough of a variation to potentially precipitate contrasting results. While the Colombian study did not mention what it was, the penalty for violation of such laws could have been much different in Colombia than it is in California. Also, Colombia is one of the world's most crime-ridden areas in the world, with drug trade and violence marring many cities within the country. While there are certainly unsavory areas of California, its overall crime rates per capita do not compare very well to those of Colombia. Moreover, racial and ethnic backgrounds between the two locations tend to be very different, establishing a cultural distinction that could bring about different results.

With these dissimilarities in mind, it is important to note that this study concluded a negative impact of an open carry ban. They used an RDD to demonstrate that homicide rates were significantly lower during periods in which the law was in effect, suggesting that the same may be true for California.

While other studies did not examine the effects of an open carry ban, specifically, some did attempt to capture the impact of similar gun-restrictive legislation. A study conducted in 2017 by multiple authors analyzed rates of overall homicide and gun-related homicide using monthly data in Florida between 1999 and 2014. They used an interrupted time series regression analysis (RDD) to determine if the implementation of a "stand your ground" law (October 1, 2005) influenced homicide rates and suicide rates within state bounds. The "stand your ground" law states that a person is free to defend themselves from any perceived threat, even by use of lethal force. Any person who uses deadly force in order to protect themselves from perceived danger will be able to claim self-defense according to this law. Researchers also collected data for control states who had not implemented “stand your ground” laws (New York, New Jersey, Ohio, and Virginia) to compare to Florida (Humphreys et. al, 2017). Given that they did not run a DID, this means that they likely just looked at trends to determine any interstate differences within their model.

Findings showed that after the law was implemented, there was an “abrupt and sustained increase” in the monthly rate of homicide by 24.4% and the rate of firearm-related homicide by 31.6% (which was significant and the 95% confidence interval) (Humphreys et. al., 2017). There was no change in control outcomes such as suicide rates (both gun-related and not gun-relation), nor did the comparison states experience any change in their homicide rates, suggesting that there was no external event or exogenous shock that would have caused murder rates to rise (Humphreys et. al., 2017).

In terms of methods and approach, this paper is extremely similar to mine. It uses an interrupted time series regression (RDD) in order to determine any discontinuity that may have existed after the implementation of the “stand your ground” law. They also compared this trend to control states in order to see if there were any externalities that might have explained their results aside from a change in public policy. Although research examined a firearm policy that was not related to open carry restrictions, “stand your ground” laws provide a similar basis of study. These laws are designed to make it more allowable for individuals to carry and use weapons if necessary, illustrating that the motivation behind such a law is opposite to that of California’s open carry ban. In other words, "stand your ground" laws are incorporated in order to make it easier for citizens to use deadly force by firearm. In this way, the correlation between

allowing open carry and use of a firearm and an upward trend in homicide rates would suggest that a restriction on open carry would have the reverse effect.

Similarly, in a 1995 study by multiple authors, research outlined the dangers associated with concealed carry. Although concealed carry and open carry allowances are obviously different (explained by their titles), both relate to the ability to carry guns in public. Researchers in this study refute the results of a pre-existing one that found the institution of concealed carry permits to correlate with a sharp decline in gun-related homicides.

Data for this study was taken for multiple cities in Florida (Miami, Jacksonville, and Tampa) Mississippi (Jackson), and Oregon (Portland), who implemented concealed carry permits ("shall-issue" permits) in 1987, 1990, and 1990, respectively (McDowall et. al., 1995). Regression results concluded that that homicide rates increased significantly for three out of five cities (one increased insignificantly and one decreased insignificantly). The overall average rates of homicides by firearm increased by 26% ($p<0.05$) when taking all five cities into account (McDowall et. al., 1995). Conversely, murders by weapons other than a firearm did not show any consistent effects within the five cities, failing to capture an exogenous increase in murder rates (McDowall et. al., 1995). In other words, the results demonstrated that implementation of concealed carry permits solely influenced gun-related homicides, making it more likely that the law itself precipitated the increase in firearm homicide rates. Therefore, this study suggests the drawbacks of allowing people to carry weapons in public, stating that they tend to increase the number of murders within a given area.

Likewise, a 1998 study refuted other evidence that concealed carry had beneficial effects on reducing homicide rates. In this study, the regression controls for age, given that permits for concealed carry were not allocated to persons who had not reached adulthood (Ludwig, 1998). Data was taken for each U.S. state from 1977 to 1994 and Ludwig ran a difference-in-difference regression while excluding murders for persons under the age of 18. Results showed that allowing concealed carry precipitated a rise in gun-related homicides among adults, although results were not significant (Ludwig, 1998). In this way, the study refutes any evidence pointing to the benefits of concealed carry, allowing researchers to assume that a ban on open carry (as in California) would precipitate similar results. A ban on open carry would presumably produce insignificant or significant negative effects on gun-related homicides.

In another multiple author study run in 2006, researchers sought to determine the effect of Child Access Prevention Laws, or laws that require safe storage of firearms within a household that shelters a child. States tend to enact this law in order to ensure the safety of children within a gun-owning household, attempting to lower the rate of accidental deaths by preventing an underage citizen from accessing a firearm. This study pooled cross-sectional time series data from 1979 until 2000 for all 50 states within the U.S., running negative binomial regressions in order to determine potential effects of the law (Hepburn et. al., 2006). Their initial output demonstrated higher subsequent declines in the rate of unintentional child gun deaths in the states who implemented CAP laws versus states that did not. When they controlled for firearm prevalence within states, however, Florida and California were the only states with statistically significant declines (Hepburn et. al., 2006).

Despite lesser results, this study still suggests the importance of firearm legislation on reducing rates of gun death. Results were still significant for accidental death decline in California, which hints that the state may be receptive to gun policy changes like an open carry ban. Although this paper only examined the effects of CAP laws rather than other forms of gun legislation, its findings highlight a more overall concept that restrictions on access to firearms can reduce death rates related to guns. This study, like others, did not break down their results by demographics, nor did it incorporate a discontinuity regression that may have been more telling as to an overall disruption in death trends.

A more recent study on Australia (2017) and their 1996 gun policies used time series robustness checks to examine the effects of a multi-faceted law on firearm-related mortality. While the law addressed a large agenda of issues, its main takeaway was the banning of assault weapons (although they still granted licenses to own them for reasons other than self-defense) following the Port Author Massacre that left 35 dead and 23 wounded. This study incorporated time series interruptions that allowed researchers to determine whether the empirical model they use has effects in years other than 1996, in which the law was implemented (Ukert et. al., 2017). They found that using such a method demonstrated the alleviating effects of the model to be less than previously reported in another study. They did, however, find that the overall downward trend of firearm mortality rates after the incorporation of the 1996 policy change remained, even if it was less drastic than previously reported.

This method is similar, although not the same, as the proposed RDD regression for California's open carry ban. Thus, the fact that its results may be more robust than those of a normal binomial regression bode well for the introduction of an RDD. Further, these results show that, although they are not as drastic as expected, gun restrictions continue to possess a negative relationship with overall gun-related mortality. Thus, this study concludes the same correlation that others have in that the lower the availability of weapons that exists, the lesser the overall gun-related death rate. Again, however, results were not broken down demographically.

Another 2000 study, conducted by Ludwig and Cook examined the effects of the Brady Handgun Violence Prevention Act, which was implemented by the U.S. government in 1994 and required background checks to be conducted on all potential gun owners. The study ran a DID regression using treatment states as the 32 that were impacted by the Brady Act and the control states as those who already had "equivalent legislation" (Ludwig & Cook, 2000) in place. They found that treatment and control states were did not produce different outcome other than for suicides in persons aged 55 or older. The reduction in 55+ suicides was also significantly better in states that instituted both waiting periods and background checks in comparison to those who only instituted background checks. Of the articles that have examined policy changes, this is one of few that has failed to find an overall negative influence of gun restriction on firearm mortality rates. This could be a product of the flaws in a DID regression or in general, background checks could be a less effective policy implementation than many others. Moreover, the law was implemented differently in each state (given that it was a federal law applied to the states), potentially precipitating skewed results.

In contrast, the implementation of background checks and waiting periods in accordance with Canada’s Bill C-17 (adopted in 1991) correlated with significant decreases in firearm suicides and homicides (Bridges, 2004). Statistics were taken from a period of seven years before and after the incorporation of the law. Results of the regression analysis showed that suicides by firearm dropped significantly from an average of 4.09 per 100,000 people to 3.17 per 100,000 (yearly average) (Bridges, 2004). Likewise, homicide rates by firearm significantly decreased from a rate of .69 to .57 while overall homicide rates decreased from 2.04 to 1.71 (Bridges, 2004). These results contradict those of Ludwig and Cook (2000), demonstrating that background checks and waiting periods may be a viable gun control option. The fact that they

were not significant within the United States, however, suggests that alternative methods of gun restriction may be more effective in reducing gun-related homicides in America.

Another study attempts to determine whether further restrictions on gun availability would reduce homicide rates. Zimring looks at data comparing gun violence to knife violence in the city of Chicago in order to determine whether gun restrictions are likely to reduce homicide rates. Comparing guns (the most frequently-used weapon in deadly attacks within the area) to knives (the second most frequently-used weapon), the study determines that deaths by gun are five times as likely as deaths by knife (in terms of violent attacks) (Zimring, 1967). Whereas most knife attacks are meant to kill for most incidents, based on the location of the stab wounds (vital areas of the body), most gun attacks show that the intention of the attack was not necessarily to kill (Zimring, 1967). In other words, many of those who were killed by a firearm were not wounded in a vital area of the body (abdomen, chest, head, etc.). Conversely, many deaths resulted from shots to the extremity area, causing either excessive blood loss or shock to result in death. This led researchers to assume that the attack was not meant to be deadly.

Zimring uses this data to make a connection to gun control legislation, arguing that the nature of most gun-related deaths suggests that laws restricting access to firearms would be effective (Zimring, 1967). Given that gun killings are much more frequent than deaths by any other weapon, and that most gun killings were likely not intended to kill, gun restrictions would likely reduce the accidental nature of most gun-related deaths within the city of Chicago.

The major flaw of this study is that it does not actually determine the effectiveness of a specific law. Instead, it merely suggests that the implementation of any law to restrict access to guns, and thus the amount in circulation, would likely be effective in reducing deaths based on the assumed accidental nature of most gun-related homicide. It does, however, reinforce the potential for successful gun legislation, given that Zimring's main argument is that laws the reduce gun availability are likely to reduce gun-related, and thus overall, homicide rates.

More concrete evidence from a 2006 study by Sherman and Rogan shows that physically removing guns from high violence areas correlated with a significant decrease in gun-related homicides within that area. Researchers in this study collect data over a six month period of gun seizures in high violence regions of Kansas City (Sherman & Rogan, 2006). Target areas of the city, in which gun seizures saw a 65% increase over the six month span, showed a significant 49% decrease in firearm-related crime following police seizures (Sherman & Rogan, 2006).

Therefore, results from this study help partially corroborate Zimring's (1967) assertions that reducing access to guns will reduce violent crime, specifically homicide rates.

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In addition to those that examine a specific change in gun policy, some studies simply attempt to establish a correlation between levels of gun ownership and rates of homicide. In 1993, Martin Killias conducted his study on international gun ownership and overall rates of homicide. Using data from a 1989 survey on international crime, Killias studies the relationship between gun ownership and rates of gun-related homicide and suicide within various countries. These countries included Australia, Belgium, Canada, England and Wales, Finland, France, the Netherlands, Northern Ireland, Norway, Scotland, Spain, Switzerland, the United States, and West Germany (Killias, 1993). Using the Spearman rank correlations system, research shows that ownership of a gun is positively related to gun-related homicide and suicide rates as well as overall homicide and suicide rates (committed by any means). In other words, the results show that gun ownership correlates to an increase in both overall homicide/suicide rates and gun-related homicide/suicide rates (Killias, 1993).

Following Killias's outline, Kaplan and Geling (1998) conduct similar research specified within the United States. They examine the effects of gun ownership on firearm-related homicides and suicides within the United States. Data for this study was taken from 1989 to 1991 and was broken down by race, gender, and region. Researchers outlined 9 different regions within the United States to include each individual state (Kaplan & Geling, 1998). Survey data determined whether or not a household possessed a gun and the National Center for Health Statistics gave researchers homicide and suicide totals, which were then converted into rates based on state/regional population (Kaplan & Geling, 1998). They then calculated a "Spearman rank correlation coefficient" for each of the four demographic groups they chose to test (White males, White females, Black males, Black females).

Results of the study showed that there was a significant positive correlation between gun-ownership and rates of suicide among all four demographic groups at a 90% confidence level (95% for all except Black females). Correlations between rates of homicide and gun ownership were only significant, however, for both female groups, suggesting a greater likelihood of homicide from a female member of a gun-owning household (Kaplan & Geling, 1998).

Likewise, Moore and Bergner (2016) extend previous research, using county level data within the United States to determine the correlation between gun ownership and various types of violent crime (not just homicide and suicide). In addition to homicides, they examine any effects of gun ownership levels on rape, robbery, and assault. Data was taken for gun ownership for 1,997 counties within the United States, and findings showed that a greater prevalence of gun ownership correlated with a higher frequency of all violent crime (Moore & Bergner, 2016). They ran negative binomial regression and found that for every unit increase in firearm ownership within the U.S., research showed that total violent crime jumped by 82% (Moore & Bergner, 2016). Although, like Killias, Moore and Bergner only establish a loose connection between guns and crimes, their study shows that stricter gun ownership laws have the potential to decrease violent crime rate within the country.

Further research, conducted by multiple authors in 2017, compiled previous research from 1950 to 2014 on the effects of various gun control regulations. They looked at 130 studies conducted in 10 different countries in order to aggregate their results, finding an overall negative correlation between gun restrictions and gun-related deaths. Results showed that the simultaneous implementation of multiple laws that targeted gun-restriction lessened gun violence in most nations. The most effective of these policy changes, according to the compilation of results, included background checks prior to purchasing guns, child access prevention laws (CAP), bans on assault weapons, and bans on carrying firearms (which boded well for the potential effectiveness of California's ban). Restrictions of purchase (i.e. background checks) and access (i.e. safer storage laws) held a negative relationship specifically with intimate partner homicides and accidental deaths in children.

This study lacks, however, in determining the impact of a specific policy implementation on a specific location. By aggregating data from multiple studies over a long period of years and various areas, the authors miss out on any specific results. Obviously, they were also unable to break down results based on race, gender, or socioeconomic background, given that their data was reviewed from the articles they chose.

Hemenway and Miller conducted their study on the correlation between gun availability and the rate of homicides within 26 different countries. Each of these countries was highly-industrialized and possesses high income levels (in accordance with World Bank standards), and it had a population of at least 1 million citizens (Hemenway & Miller, 2000). As a proxy for gun

availability, the study incorporated two variables (both of which were found to have high correlations with actual gun availability within a country): percentage of suicides with a firearm and the average of the percentage of homicides and suicides that could be attributed to firearm use (Hemenway & Miller, 2000).

Researchers then conducted a simple regression analysis (without control variables) to determine whether there was a correlation between availability of guns and homicide rates within a certain nation (Hemeway & Miller, 2000). Results demonstrated a "strong and statistically significant" positive relationship between gun availability/ownership and rates of homicide (Hemenway & Miller, 2000). Thus, the study concluded that the United States (which has the highest gun availability and homicide rates in the world) was not an exception. In other words, the more guns available within developed, affluent nations, the more likely it is to have a high rate of homicide. Thus, the problem of more guns equating to higher levels of crime is not a problem relegated to impoverished countries.

Lit Review Conclusion

Of the articles that have been included in this paper, each tends to add its own mark on previous gun research. While some simply examine the correlation between gun ownership and gun violence (suicide, homicide, robbery, rape, assault, etc.), others choose to determine the impact of a specific legislative change. From open carry laws and background checks, to “stand your ground laws” and assault rifle bans, gun research to this point has touched upon an extremely diverse compilation of subject matter that may only continue to grow as gun debate rages on. The common thread in all of this research – the result that links all papers with the exception of that on background checks – is that each finds a correlation between gun restrictions and its negative effects on gun violence. In the case of policy changes, the tougher it is to access or carry a firearm, the lower the homicide/violent crime rate in that area. As for “stand your ground” laws, the more freedom people have to use their firearms openly (without repercussion), the higher the homicide and suicide rates in those areas. Also, more generally, the higher the rate of gun ownership, the more gun violence tends to exist in that area.

With this knowledge in mind, however, it remains unsafe to assume that the effect of certain policy implementations is uniform in all locations and for all cultures. Therefore, my research question, dealing with the effect of California’s 2012 ban on the public carry of

firearms, adds another element to this story. The topic seeks to apply a background of research on gun legislation to a new law, with new punishments, in a new location and to determine whether the previous studies continue to ring true in the midst of modern policies institutions.

Analytical Framework

Regression Outlines

Monthly data on deaths by assault with a firearm (gun-related homicides) for California was collected from the U.S. Vital Statistics website. In order to allow for time both before and after the implementation of the law, which took place in January, 2012, the initial data point in the time series was January, 2006 (155 total gun-related murders) and the final one was December, 2017 (125 total gun-related homicides). For a given month in California, the average number of total homicides by firearm was 121.35. Conversely, Texas averaged 84.4 gun-related homicides per month from 2006 to 2017.

These numbers were then converted into homicide rates per 100,000 residents within that state. In order to do this, the homicide total per month was divided by the population of California for that year and multiplied by 100,000. Average murder rates by firearm, unlike total homicides, were very similar between states. California averaged 0.322 gun-related homicides per 100,000 state citizens per month. Texas average 0.326 gun-related homicides per 100,000 state citizens per month. These numbers were expected to be much more similar, however, with California being prone to more total murders by firearm given their greater population over the given time period.

Using this data, this study ran two different types of regressions in order to help determine the significance of California's policy change. The first of these regressions was an RDD in order to examine whether the policy demonstrated discontinuity in its trend upon its adoption. Obviously, the cutoff point for the analysis was in January, 2012, given that the ban on the open carry of concealed firearms was implemented during that month. Gun-related homicides served as the main dependent variable while the implementation of the open carry ban will be used as the independent variable. Control variables also included income per capita, unemployment rates, and population metrics (to be explained later).

The second of these regression analyses incorporated a difference-in-difference (DID) model in order to determine whether a treatment effect existed with the implementation of

California's open carry ban. Based on similarities in population, size, urbanization, and immigration rates, Texas was the proposed control state to compare with California (the treatment state). When looking at general trends in homicides rates, results confirm that Texas is a good control state. Figure 1 shows the pre-treatment trend in gun-related homicide rates for California and Texas. In other words, these graphs contain monthly homicide rates for both states from January, 2006 to December, 2011 (right before the open carry ban was implemented in January, 2012). Evidently, the states contain a similar downward trend in homicide rates by firearm during the pre-treatment period (2006-2011), demonstrating the Texas is a good control state in terms of its comparability to California. As was the case for the RDD proposal, the main dependent variable is homicides by firearm per month and the independent variable is the incorporation of the open carry ban in 2012, with controls including income per capita, unemployment rates and population metrics.

Difference-in-difference models, however, are not without drawbacks. While Texas was shown to be a relatively good fit for a control group, treatment and controls almost never match up with complete efficiency. The only true control group would be an exact remake of each facet of California, from population numbers and breakdown to city specifics. For obvious reasons, such an exact control group would be impossible, and thus the DID model presents potential flaws in terms of state-to-state comparison.

In spite of this drawback, the DID still fits the data and research question rather well. While California and Texas are not the exact same, they are similar enough in many ways to be compared to one another. As long and the control group is generally like the treatment group, the DID regression can be very effective in measuring the impact of a law. Given that one state implemented the law and the other did not, a comparison of the two in the years preceding and succeeding its incorporation captures its true impact rather well. In other words, with the exception of exogenous shocks that the model cannot account for, a DID can be very effective in determining a laws impact.

A negative binomial regression was run with the DID model in order to determine whether the law had any impact on gun-related homicides. Below is the model for the DID regression:

$$\boldsymbol{homicide\_totals_i = \beta_0 + \beta_1 treatment_i + \beta_2 post_i + \beta_3 interaction_i + \beta_4 unemployment\_rate_i + \epsilon}$$

Negative binomial DID regressions were also run in order to determine the impact of the law based on race. Much of the previous research on gun control has pointed out that gun regulation has a disproportionate effect on black populations. In order to test this, murder totals for black and white populations were regressed using the same dependent variables as the original (treatment dummy, post-treatment dummy, interaction variable, unemployment rate control variable). It was hypothesized that the open carry ban in California would have more of an impact on murder totals among African Americans than on Caucasian populations. Below are the regression models:

$$\boldsymbol{homicides\_black_i = \beta_0 + \beta_1 treatment_i + \beta_2 post_i + \beta_3 interaction_i + \beta_4 unemployment\_rate_i + \epsilon}$$

$$\boldsymbol{homicides\_white_i = \beta_0 + \beta_1 treatment_i + \beta_2 post_i + \beta_3 interaction_i + \beta_4 unemployment\_rate_i + \epsilon}$$

Control Variables

As previously mentioned, the main control variable in the regression analyses is unemployment rate.

Unemployment rate was included given that prior research and evidence shows that areas with greater levels of unemployment tend to have higher overall crime rates, including homicide rates. Higher unemployment rates tend to correlate with higher crime rates, presumably because the opportunity cost of committing a crime decreases when a person is without a job. They may find themselves in a situation in which committing a crime (robbery, murder, etc.) is a beneficial alternative to securing a wage-paying job. Conversely, the opportunity cost of committing a crime rises when people have steady jobs. In other words, getting caught for committing a crime has more significant consequences for a person earning pay than a person who is jobless. Thus, there tends to exist a distinct correlation between rates of unemployment and the overall crime rate of a state.

In order to use this as a control variable, data was collected on unemployment rate on a yearly basis. Although murder rates by firearm are taken on a monthly basis within the dataset, there is no monthly measure of income per capita, so this variable must be applied to each month within a given year. It was hypothesized that the higher the unemployment rate, the higher the gun-related murder total within the model.

Income per capita (real GDP per capita) and population were also examined as potential control variables, but they were dropped over concerns about multicollinearity. Income per capita would have served a similar purpose to that of unemployment rate, given that the lower a person's level of income, the lower the opportunity cost of committing a crime. Population was proposed with the idea that more people (and potentially higher levels of population density) would produce higher crime totals.

Results

Figure 2 and Table 1 show the results of the RDD regression. Results for the RDD were largely insignificant, with a slight upward jump in homicide rates following the implementation of the law. The coefficient for the dummy treatment variable was .013, which was not statistically significant (see table 1). This slight jump is also visible in the time series graph in figure 2 (the vertical line represents the aforementioned cutoff point of January, 2012). Likewise, none of the controls showed any statistically significant effects on the model, and the f-statistic was rather low (30.85).

These results from the discontinuity regression potentially highlight an exogenous shock in California during this time period. While results showed a very slight upward jump in gun-related homicide rates following the open carry ban, they were insignificant. Further, California's murder rates had been trending downward prior to the January, 2012 cutoff point (see figure 1). This shows that the law was implemented during a time in which the murder rate was already decreasing, making potentially compromising the efficiency of an RDD regression. Thus, the introduction of a control state like Texas would help to compare California with a state whose laws did not change during the same time period.

Table 2 shows the results of the DID regression in which California represented the treatment group and Texas represented the control group. As shown in the table, the interaction (DID) term had a significant negative effect on gun-related homicide rates. In other words, the implementation of the open carry ban in California correlated with a .22 drop in murder totals by firearm per month (~1 murder every 4 months). This confirms the original hypothesis that California's open carry ban would have a significant negative impact on total homicides. Unemployment rate was also found to have a significant negative impact on gun-related homicides within the model, precipitating a drop in totals by .03 per month ($p < 0.01$). Although

the impact of unemployment rate was not as drastic as the implementation of the open carry ban, it was still statistically significant at a 1% level. This contradicts the hypothesis that unemployment rate would have a direct correlation with homicide totals, given that previous research has found that the higher the unemployment rate, the lower the opportunity cost of committing a crime.

Tables 3 (the law's impact on African Americans) and 4 (the law's impact on whites) break down the results based on race. Although results for both races were significant, the open carry ban in California disproportionately affected black citizens. The law correlated with decrease in murders by gun per month by .39 ($p < 0.01$) among African Americans, while it correlated with a .16 decrease in gun-related murders per month among whites ($p < 0.01$). This confirms previous research that presents similar findings, suggesting that gun regulation tends to benefit black populations more than white populations.

No multicollinearity existed within the model given that all VIF values were under the threshold of 5 (see table 5).

Discussion of Results

The issue of gun regulation goes well beyond the realm of economics and public policy; rather, it is a wholly human issue. The analysis concludes that California's ban on open carry saves lives (approximately 3 lives every year) that are far more valuable than any econometric can measure.

The findings in this paper confirm previous research that has found the same results, despite this being one of few to look at specific legislation within the United States. It supplements previous research that has been used to confirm the effectiveness of policies like "stand your ground" in Florida (Humphreys et. al., 2016), gun seizures in Kansas City (Sherman & Rogan, 2006), and concealed carry (Ludwig, 1998) and child access prevention laws (Hepburn et. al., 2006) around the country. It confirms the conclusion of many that the less access to guns, the lower the homicide rates within a given region. California's open carry ban did not directly prohibit individuals from purchasing or owning firearms, nor did make background checks and waiting periods mandatory. It did, however, restrict when and where an individual is allowed to carry a firearm, thus curtailing the number of weapons being carried openly at any given moment.

Additionally, the law had its intended effect despite the punishment for its violation being relatively loose. State penalty for violating the open carry ban in California could result in a maximum fine of $1,000 and/or up to 364 days in prison (left up to the sentencing judge who presides over any open carry case). In other words, the worst that can happen to a violator would be a year in prison or a $1,000 penalty payment (both of which are usually reserved for repeat offenders or those with a prior criminal record).

Despite the fact that the ban decreased homicide totals by a significant margin, it does not necessarily confirm the long-held Democratic belief that more gun regulation will precipitate a drop in gun-related deaths. At the very least, however, it suggests that more research and more experimentation with gun control policies is paramount to solving the issue of murder in the United States. The fact that open carry, along with several other types of firearm legislation, has confirmed the theory that less guns will precipitate less murder, should provide a mandate for policymakers to pass new laws to restrict availability of guns. They can choose to implement an open carry ban, to rid an area of "stand your ground" laws, to have police departments seize firearms, or to require background checks, waiting periods, and safe-keeping measures. Each of these whether in the U.S. or not, has been proven to work at least to some degree. Conversely, none of these policies have been found to increase gun homicides, demonstrating that attempts to restrict gun access are harmless at the very least. In other words, there has yet to be a study that concluded that gun control laws increased crime. Consequently, policymakers should be willing to experiment with such laws or even others (assault rifle bans, criminal firearm confiscations, etc.) in order to examine a potential positive impact on homicides.

Likewise, more research needs to be done on the topic of gun control and its potential effects. Not only does homicide in America present a clear human issue, but also the debate surrounding is further dividing and polarizing two party politics within the United States. Every existing piece of gun legislation should be researched and every new law should be examined over time to see what is effective and what is not in the interest of saving lives.

Limitations

While multiple regression analyses and robustness checks were included in order to make this study sturdier, there are still multiple limitations that will likely need to be addressed in future studies. First and foremost, there may have been exogenous shocks within California that

could have led to the observed decrease in gun-related homicides. The observed time period (2006-2017) was large enough for factors like population growth, shifting demographics, unemployment rates, and overall citizen behavior to alter rather significantly. California's local and state police forces may have also become more effective during this time period. Officers may have begun to receive better training and education. More funding may have been incorporated into criminal justice and prevention, leading homicide totals to drop. National police (FBI, DEA, etc.) presence in California may have risen during this time period, leading crime to slow within the region (although this may not have been likely due to the already declining murder rate prior to 2012 as shown in figure 1).

Another limitation that may have influenced the results of the DID regression was the use of Texas as a control state. Given the size and density of California, Texas was the only state in the U.S. that is comparable in terms of population. While its immigration rates and crime rates (see figure 1) are certainly similar to those of California, there are certain intangible cultural measures that are very different. The most obvious of these is that Texas is a historically red (Republican) state and California is a more blue (Democrat) state. As previously mentioned, Democrats and Republicans tend to disagree strongly on whether the Second Amendment right to "keep and bear arms" presents a national issue. Thus, while culture in California may not have previously promoted self-defense by firearms, Texas's culture may do just that. In other words, Texas's citizens may be more likely to possess and wield guns in general, not accounting for California's 2012 law change.

Similarly, urban populations between the two states are very different. While both have high levels of urban density within state bounds, 95% of California's population lives in metropolitan areas compared to only 84% of Texas's (according to the 2010 census). Higher urban densities generally tend to correlated with higher rates of crime, potentially skewing the comparison between California and Texas. Additionally, the law enforcement efficiency could be different between the two states, leading one to be more responsive to criminal activity than the other. Given that the study's main results are extracted from the DID regression, the fact that the control state does not match perfectly could present a problem.

Despite the inclusion of unemployment rate as a control variable, omitted variable bias is likely to exist within the regression analyses. Including the initially proposed controls of income per capita and population, there are many variables that can influence homicide totals. While

some were not included in this study due to concerns over multicollinearity or lack of available data, others cannot even be measured in any concrete way. The effectiveness and overall presence of law enforcement agencies within a certain region most certainly influences the level of crime within it. Its effectiveness, however, is difficult to measure. Levels of funding, hours of training, and number of officers can hint at the impact (or lack thereof) of a certain law enforcement agency; however, the actual impact of police (in terms or rightful arrests, convictions, and number of criminals remaining free) cannot be accurately quantified.

Further, the FBI's database lists several other variables that influence crime rates that cannot be easily measured. One of these includes the modes of transportation and the effectiveness of the highway system within a given area. Given that California and Texas are both diverse in terms of urbanization and demographic diversity, the modes of transportation most used in specific areas likely vary greatly within state bounds. Family conditions and togetherness also tend to influence the level of crime within a region, presenting another metric that cannot be easily quantified due to high levels of uncertainty. Attitudes toward crime, public efficiency in reporting crimes, residential mobility, and intangible cultural characteristics are all variables that influence crime rates but cannot be quantified.

With these limitations in mind, the analysis conducted in this study turned out to be rather robust. No multicollinearity existed, control variables were included, measures of fit were relatively high, and the best possible comparison to the treatment state (California) was selected as the control state (Texas). Thus, regression results were determined to be rather accurate in determining the actual impact of California's ban on the open carry of firearms.

What Future Studies Should Address

Future studies on gun control should help to sure up existing research and begin to look impact of new laws or new impacts of existing ones. In other words, in terms of existing research, more studies should look at the demographic breakdown of a law's impact. This study concludes that California's open carry ban disproportionately affected African Americans but it did not examine its effects on immigrant populations or Hispanic citizens. It also did not determine if it influence one sex more than another (although a lot of previous research has demonstrated that gun control impacts males more than females). Therefore, this opens the door for results to be broken down even more, allowing policymakers to make informed decisions on

certain measures. In other words, demographic breakdowns of results will help legislators better target certain populations with a given law.

Further, more research should be done for different states who have implemented different laws. California's open carry ban proved to be effective, but other states may have implemented a measure that decreased homicide rates more drastically or that prevents a certain gun-related crime more than another. For instance, had California chosen to implement an alternative gun restriction (i.e. background checks, waiting periods, assault rifle bans, gun seizures, etc.), it may have had a different level or type of impact. Other laws may influence certain groups more drastically than others or simply have a greater or lesser overall effect. Therefore, more research is necessary to conclude which laws provide the most efficient way to reduce murder rates and protect U.S. citizens. Although there are very few gun control laws passed at the federal level, any that made it through Congress would make for interesting research. In other words, the best course of future research would be to determine the impact of legislation that has yet to be studied.

References

Bridges, F. Stephen. (2004). Gun Control Law (Bill C-17), Suicide, and Homicide in Canada. *Psychological Reports,* 94. 819-826.

Enten, Henry. (2017, October 4). The U.S. Has Never Been So Polarized on Guns. https://fivethirtyeight.com/features/the-u-s-has-never-been-so-polarized-on-guns/.

Hemenway, David & Miller, Matthew. (2000). Firearm Availability and Homicide Rates Across 26 High-Income Countries. *The Journal of Trauma,* 49, 985-988.

Hepburn, Lisa et. al. (2006). The Effect of Child Access Prevention Laws on Unintentional Firearm Fatalities, 1979-2000. *The Journal of Trauma,* 61, 423-428.

Humphreys, David et. al. (2016). Evaluating the Impact of Florida's "Stand Your Ground" Self-Defense Law on Homicide and Suicide by Firearm: An Interrupted Time Series Study. *The Journal of the American Medical Association,* 178(1), 44-50.

Kaplan, Mark & Geling, Olga. (1998). Firearm Homicides and Suicides in the United States: Regional Variations and Patterns of Gun Ownership. *Social Science Medical Journal,* 46(9), 1227-1233.

Killias, Martin. (1993). International correlations between rates of gun ownership and homicides and suicides. *Canadian Medical Association Journal,* 148(10), 1721-1725.

Ludwig, Jens. (1998). Concealed-Gun-Carrying Laws and Violent Crime: Evidence from State Panel Data. *International Review of Law and Economics,* 18, 239-254.

Ludwig, Jens & Cook, Philip. (2000). Homicide and Suicide Rates Associated With Implementation of the Brady Handgun Violence Prevention Act. *The Journal of the American Medical Association,* 284(5). 585-591.

McDowall, David et. al. (1995). Easing Concealed Firearms Laws: Effects on Homicide in Three States. *Journal of Criminal Law and Criminology,* 86(1), 193-206.

Moore, Matthew & Bergner, CariAnn. (2016). The Relationship Between Firearm Ownership and Violent Crime. *Justice Policy Journal,* 13(1), 1-20.

Santaella-Tenorio, Julian et. al. (2016). What Do We Know About the Association Between Firearm Legislation and Firearm-Related Injuries. *Epidemiologic Reviews,* 38. 140-157.

Sherman, Lawrence & Rogan, Dennis. (2006). Effects of Gun Seizures on Gun Violence: "Hot Spots" Patrol in Kansas City. *Justice Quarterly,* 12(4). 673-693.

Ukert, Benjamin et. al. (2017). Time series robustness checks to test the effects of the 1996 Australian firearm law on cause specific mortality. *Springer Science and Business Media.*

Villaceves, Andres et. al. (2000). Effect of a Ban on Carrying Firearms on Homicide Rates in 2 Colombian Cities. *The Journal of the American Medical Association,* 283(9). 1205-1209.

Zimring, Frank. (1967). Is Gun Control Likely to Reduce Violent Killings? *The University of Chicago Law Review,* 35, 721-737.

Tables/Figures

Figure 1: Pre-Treatment Trends for California and Texas

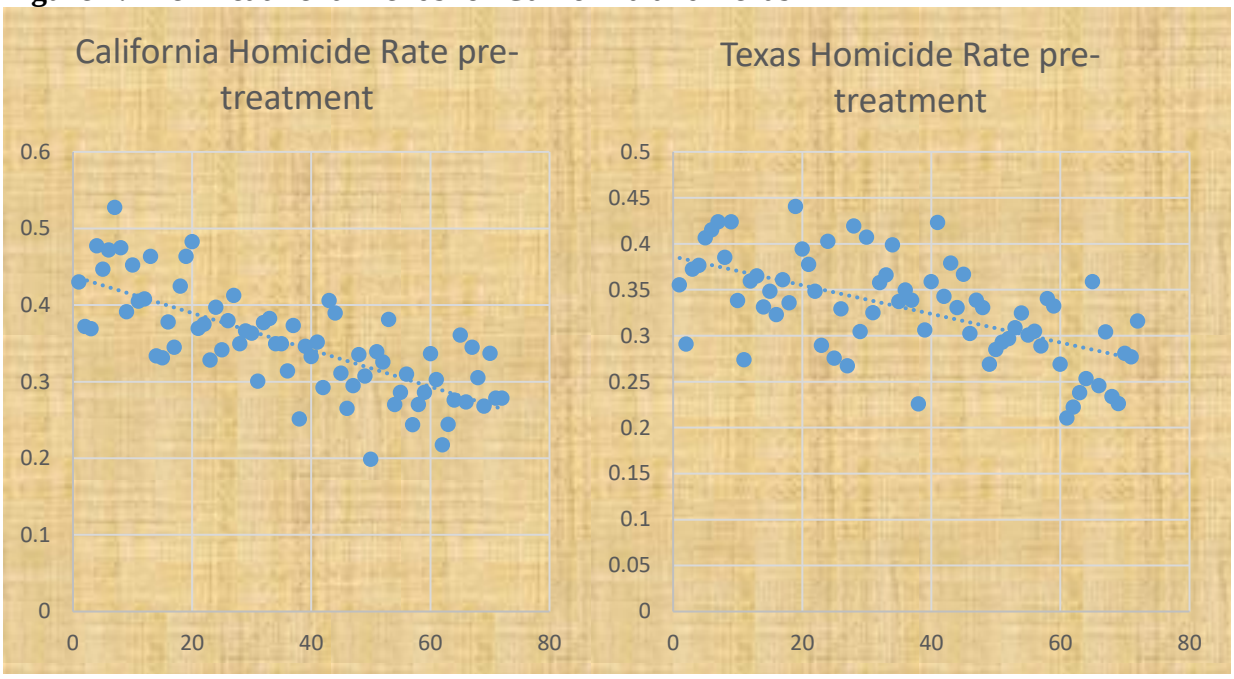

Figure 2: RDD Graph (January, 2012 cutoff point)

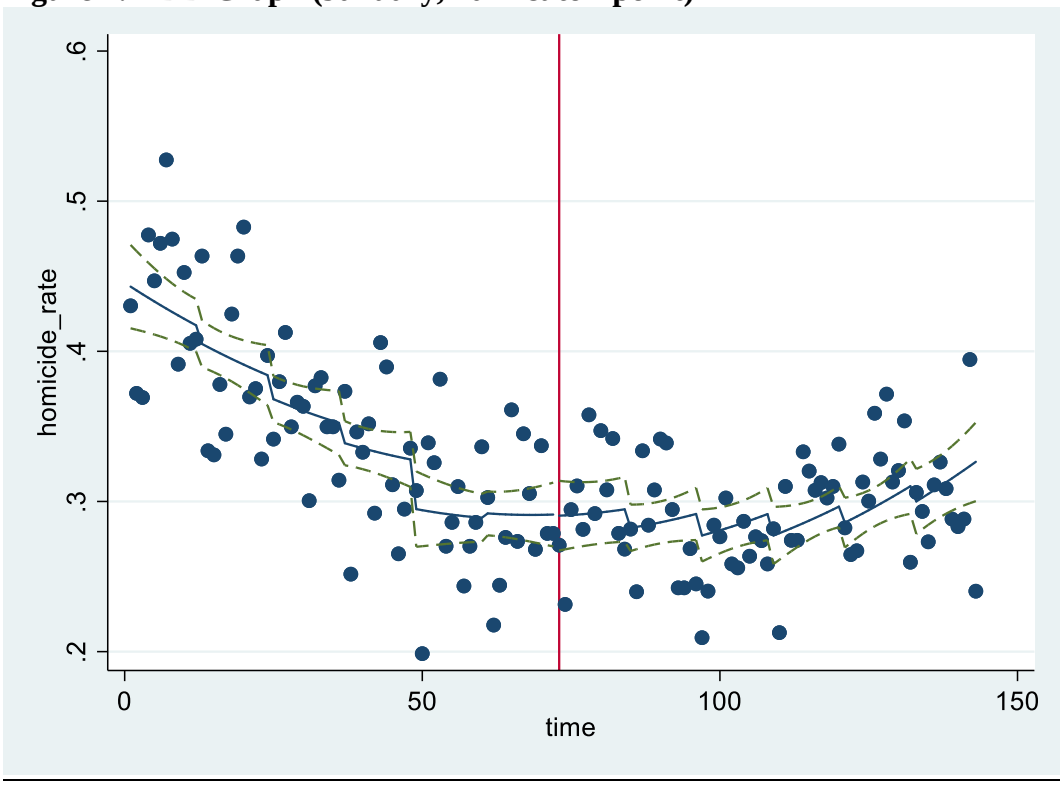

Table 1: RDD Regression Output

Variable	Coefficient (Standard Deviation)
Running Variable	.0002 (.000)
Dummy Treatment Variable	.013 (.02)
Unemployment Rate	-.001 (.008)
Number of Observations	143
F statistic	30.85

Table 2: DID Regression Output

Variable	Coefficient (standard deviation)
Treatment Dummy	.561*** (.026)
Post-Treatment Dummy	.052 (.026)
Interaction	-.228*** (.35)
Unemployment Rate	-.038*** (.004)
Number of Observations	288
Chi-squared	307.64

Table 3: DID Regression Output for African American Populations

Variable	Coefficient (standard deviation)
Treatment Dummy	.559*** (.043)
Post-Treatment Dummy	.243*** (.041)
Interaction	-.395*** (.056)
Unemployment Rate	-.032***(.006)
Number of Observations	288
Chi-squared	137.77

Table 4: DID Regression Output for White Populations

Variable	Coefficient (standard deviation)
Treatment Dummy	.493*** (.033)
Post-Treatment Dummy	-.049 (.032)
Interaction	-.159*** (.043)
Unemployment Rate	-.038*** (.005)
Number of Observations	288
Chi-squared	206.35

Table 5: VIF Table (Robustness checks for multicollinearity)

Variable	**VIF**
Interaction	3.01
Treatment dummy	2.39
Post-treatment dummy	2.06
Unemployment rate	1.42