Crime and political effects of a concealed weapons ban in Brazil

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Abstract

This paper studies the effects of legislation in Brazil that banned the carrying of concealed weapons nationwide in 2003, and provided for a voter referendum to ban owning of concealed weapons 22 months later. Using a regression discontinuity design, I find that in the wake of the law gun-related homicides decreased by 10.8%, with the reduction especially pronounced among young black males living in high-crime areas. Other crimes involving guns (robberies) also declined, while crimes that did not involve guns were unaffected. Enrollment in adult education courses disproportionately increased in areas that saw the biggest drop in gun-related crimes. Economic benefits are estimated to exceed $3 billion. Analysis of the subsequent voter referendum, which was defeated by a wide margin, shows higher voter turnout and stronger support for the concealed weapons ban in the areas that had experienced the greatest decline in gun-related homicides.

JEL: D72, H11, I12, J17, K14

Keywords: Gun laws; Right-to-carry concealed weapons; Gun-related death; Voting Behavior; Policy feedback.

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1. Introduction

How do laws that regulate the carrying of concealed weapons affect levels of violence in society? Is violence reduced by enacting laws that allow citizens to carry concealed weapons, or by laws that forbid the carrying of concealed guns? On one hand, allowing citizens to carry concealed weapons may deter criminals from committing a crime because they may think that their intended victims could be armed. On the other hand, laws that forbid the carrying of concealed weapons may decrease violence by reducing the odds of serious injury or death occurring during criminal encounters or in disagreements that escalate. Extensive research has been conducted to understand the impact of laws that allow citizens the right to carry concealed weapons, but it has proved very difficult; empirical results are sensitive to minor variations in the data and model specifications, delivering mixed conclusions (Manski and Pepper 2016). As a result, the broad impacts of such laws are not clear, and little is known about who, if anyone, benefits from such legislation, and how this relates to the prospects for and public views of gun legislation.

This paper approaches the question about how concealed weapons laws affect violence by measuring the impact of a nationwide law that banned (rather than authorized) the carrying of concealed weapons. I examine gun-carrying restrictions that were passed by the National Congress of Brazil, and implemented in December 2003 in Brazil. The legislation prohibited carrying (but not owning) concealed weapons, and provided for a subsequent referendum 22 months later to allow voters to decide whether to implement a more stringent law to ban the ownership of such weapons and ammunition. The implementation of the law and the provision for the follow-up referendum provide natural experiments that allow me to analyze the impact of the policy on crime.

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and the political process. Using a regression discontinuity design analysis, I study the impact of the legislation on crime rates and on various communities and populations throughout Brazil. I then use a least square regression to exam whether the law drove voter behavior in the referendum.

Provisions of the Brazilian legislation present a rare opportunity to identify the effects of a ban on concealed weapons in a way that avoids some of the problems that have surfaced in analyzing the effects of gun legislation elsewhere. Most research on the impact of right-to-carry concealed weapons laws has been conducted in the United States, using variations in state gun legislation to find the impact on crimes. Nearly all of this legislation expanded the right to carry concealed weapon. Though extensive research has been conducted, results are inconclusive. Manski and Pepper (2016) explain this phenomenon by showing that empirical findings on the impact of such laws are highly sensitive to controversial assumptions about crime rates trends. Another shortcoming of this literature stems from endogeneity problems such as gun regulations potentially enacted in response to crime. The Brazilian law banned concealed weapons, and required people to comply immediately - thus allowing me to better identify its impact. This is in contrast to the literature that investigates the impact of authorizing the carrying of concealed weapons; even if one meets all requirements and applies for a concealed weapon license right after the law passes, obtaining it takes time.²

I construct an empirical model that overcomes challenges faced by the literature studying the impact of right to carry concealed weapons laws on crimes. I follow Davis’s (2008) empirical

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² The literature on the effects of right-to-carry concealed weapons laws is concentrated in the United States, where the time to obtain a license varies from state to state, and from place to place within certain states. For instance, in Florida, the state division of licensing has up to 90 days to review an application for concealed weapon license, while in Texas, the maximum time allowed for a license application is 60 days; and within the state of California, the time to obtain a weapon can vary from four to six months, according to the California Department of Consumers Affairs.
strategy of using time as the assignment variable in regression discontinuity design (RDD).\textsuperscript{3} As the law prohibiting the right to carry concealed weapons is a deterministic function of time, there are no confounding variables other than time itself and endogeneity problems are less of a concern.\textsuperscript{4} Moreover, as all Brazilian municipalities were imposed the same law, there is no need for comparisons between treatment and control groups, which is the reason why previous literature had to rely on controversial assumptions.\textsuperscript{5}

My results find that: prohibiting right to carry concealed weapons decrease gun-related crimes generating an economic value of $3 billion in one year. Using monthly data on homicides, available across the country, I find that gun-related homicides decreased by 3,900 (10.8% reduction) in the year following the law and that this reduction was larger in high-crime areas. However, non-gun-related homicides were not affected by the law. I consider the most conservative value of statistical life in Brazil and estimate the economic value of the law to be close $3 billion in one year. Using monthly data on non-homicide crimes at the municipal level, provided by the São Paulo state, I show that robberies, the number of guns that are carried illegally and total arrests decreased in response to the prohibition of right to carry concealed weapons, while non-gun-related crimes such as rape, drug trafficking and theft remained unchanged.\textsuperscript{6}

\textsuperscript{3} Lucas Davis investigated the impact that restricting automobile usage in Mexico City had on air pollution.

\textsuperscript{4} One problem of measuring the effect of right to carry concealed weapons on crime is dealing with the potential endogeneity of such laws (see Durlauf, Navarro & Rivers 2016).

\textsuperscript{5} Manski and Pepper (2016) argue that researchers studying the effects of right to carry concealed weapons laws on crimes, in the United States, had to rely on strong assumptions such as that states that enacted right to carry concealed weapons (treatment group) had identical propensities and environments for criminality as states that did not enact such laws (control group).

\textsuperscript{6} Notice that before the prohibition of right to carry concealed weapons, illegal gun carrying referred to carrying unconcealed weapon, but after the prohibition, even concealed weapons were prohibited to be carried. São Paulo state is the only Brazilian state to provide monthly data on these types of crimes since 2001. I thank Secretaria de Segurança do Estado de São Paulo for sending me this data after formal request.
I use two different empirical strategies to investigate who benefits from the prohibition of right to carry concealed weapons and whether it impacts social outcomes. Using an RDD, I find that the reduction in gun-related homicides was especially pronounced among young black males and in places with larger propensity to criminality. Moreover, the regulation decreased gunshots intended to kill, but did not affect accidental ones. Using the fact that the prohibition of right to carry concealed weapons shows heterogeneous effects, I construct a differences-in-differences (DID) model. Places more affected by the law compose my treatment group. The DID validates my RDD findings bolstering internal validity and finds evidence that the treatment group had larger enrollment in young and adult education.

I then utilize the fact that a gun ban referendum took place to examine the effect of public policies on politics. The legislation’s unique feature of asking voters to approve a more restrictive gun policy after experiencing the prohibition of right to carry concealed weapons allows me to examine how public policy and mass politics relate to each other and contribute to the literature on policy feedback that studies how policies affect politics.\(^7\) I use an ordinary least-square regression (OLS) and find that places affected by the prohibition of right to carry concealed weapon had larger participation and support for the gun ban referendum.\(^8\)

How generalizable are the homicides findings to other countries? While is not possible to know for sure without similar legislature being applied in different contexts, one can hypothesize that laws restricting the number of guns, as the one applied in Brazil, decrease the number of gun-

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\(^7\) There is a growing literature on policy feedback. See, for instance, Pierson 1993; Campbell 2003; Mettler and Soss 2004; Clinton and Sances 2017.

\(^8\) In the appendix, I corroborate these findings using a survey that took place two days before the referendum.
related deaths. In the Brazilian context, this effect was driven by gun-related homicides, especially the ones committed against young black males living in high-crime areas. Yet, is it possible that in other contexts, gun-related suicides would be affected as well. For instance, Leigh and Neill (2010) show that gun buybacks in Australia reduced gun-related suicides. Additionally, the 10.8% reduction in gun-related homicides that I find could be larger in a country in which policing and law enforcement are highly organized and effective, not the Brazilian case.

The gun prohibition referendum findings add to the study of policy feedback initiated by Schattschneider (1935) and summarized by his phrase “new policies create new politics.” Scholars of this branch of study want to understand how policies shape politics and, as this work shows, voters react to policies, and voting behavior varies according to their experiences with a given law. Unique aspects of the Brazilian policy format - of first exposing citizens to a gun restriction, and asking for a popular vote on a proposal to further restrict guns months later - isolates the impact of the policy on political behavior and provides knowledge about the way policies influence publics. However, the generalizability of the results is limited as there are not similar cases to be examined and compared.

This paper is divided into six sections as follows. In Section 2, I review relevant literature and explain the gun regulation. In Section 3, I provide an overview of the data and discuss the empirical strategy. In Section 4, I present the effect of the prohibition of right to carry concealed weapons on gun-related homicides as well as other crimes, and on different populations and finally, I propose a differences-in-differences model to bolster the internal validity of the RDD results. In Section 5, I show the connection between being benefitted by the prohibition of right to  

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9 The most generalizable find of this work is on how right to carry concealed weapons laws affect homicides. Data on non-homicide crimes is only provided by the São Paulo state. This is the most populous and wealthy state of the country and I do not claim it is representative of Brazil.
carry concealed weapons and supporting the 2005 firearm prohibition referendum in Brazil. In Section 6, I discuss my results and conclude.

2. Related Literature and the Gun Legislation

This section presents two distinct literature reviews followed by the description of the policy I study. First, I examine the literature on the impact of right to carry concealed weapons laws. Second, I cover the literature on how policies affect politics. Finally, I explain the gun carrying prohibition law in details.

2.1 What are the effects of gun laws? Who are their beneficiaries?

There is a vast literature investigating the first question, but no definitive answer to it. Without an answer to the first question, the second one is compromised. The main reason why the first question remains unanswered is because results showing the concealed carry laws effects are sensitive to minor modifications on researchers’ assumptions about crime trends.

The effects of concealed carry laws have been extensively studied, however, no definitive conclusion has been reached. Research by Lott and Mustard (1997) reached the controversial conclusion that right to carry concealed weapons laws reduced crime rates in the United States. This finding was challenged by Ayres and Donohue (1999 and 2003) and Black and Nagin (1998), on the grounds that the empirical models were not robust to reasonable changes in the model specifications and were sensitive to the correction of several coding errors. Other studies have showed empirically that concealed weapon laws do not reduce criminality (Duggan, 2001; Ludwig, 1998; Aneja et al. 2011). Aneja et al. (2014) describe a National Research Council panel discussion in 2004 that invited specialists to study county-level crime data from 1977-2000 in the

10 Using cross-section panel data at the county level from 1977-1992, their findings showed that approximately 1,500 lives would be saved per year if in 1992 all U.S. states had adopted laws allowing people to carry concealed weapons.
United States and concluded that it was impossible to state whether concealed weapons laws increased or decreased crimes.

Manski and Pepper (2016) explain how authors find contradictory results using similar data and empirical strategies. The authors’ answer to this puzzle is that data on crime cannot reveal counterfactual outcomes, which authors commonly solve by making “invariance assumptions asserting that specified features of treatment response are constant across space or time (p.3).”11 Yet, the literature on concealed weapons laws does not find a consensus on credible assumptions regarding crime rates trends. Relaxing invariance assumptions, Manski and Pepper show that there are no simple conclusions and that it is not possible to identify with certainty the sign of the impact of concealed weapons laws on crime.

Although the literature on the effect of laws allowing concealed weapons on crime is inconclusive, many authors find a positive relationship between the number of guns and crimes. However, these findings also face challenges.12 First, because data on the number of guns available are lacking, proxies are needed. For instance, to proxy for the number of firearms, Duggan (2001) uses the number of gun magazine subscriptions per county, and Cook and Ludwig (2006) use a ratio of gun-related suicides to suicides per county. Second, as Leigh and Neill (2010) point out, such research suffers from endogeneity problems. For instance, people who live in neighborhoods that have higher crime rates might buy more guns to protect themselves. Therefore, gun ownership could be related to current crimes or expectations of future crime rates.

11 The following case illustrates an example of invariance assumption: Virginia enacted right to carry concealed weapon law in 1989, but Maryland did not. Then, assume that in the absence of such law, Virginia and Maryland would experience the same changes in crimes between 1988 and 1990.
Leigh and Neil (2010) studied a gun buyback program in Australia and compared the states that had more guns bought back to the remaining ones to show that gun-related suicides decreased by 80% due to this program (the effects on gun-related homicides were less precise). Nonetheless, their work has the same problem as the ones that studied the impact of concealed weapon laws in the United States. That is, the research assumes that all Australian states would have had the same gun-related death changes if they had the same number of guns bought back. It also relies on the assumption that the buyback rate in each state had no relationship with preexisting trends.

The endogeneity problem faced by works examining the impact of concealed carry laws on crime, as well as the ones investigating the relationship between guns and crimes, is not easily addressed. These works need to rely on assumptions that preexisting annual crime trends do not affect gun ownership, implementation of anti-crime policies, and effectiveness of these policies. This work, however, uses monthly data on crime and the prohibition of right to carry concealed weapons to construct an RDD model that overcomes endogeneity problems and reliance on strong assumptions. The advantage of using an RDD model is that, by restricting the window of my analysis, it becomes more credible to assume that the only difference in crimes trends after the prohibition of right to carry concealed weapons is in response to the law.

Although effects of concealed carry laws are inconclusive, scholars agree that their impact might be sensitive to different environments. For instance, Duggan (2001) and Durlauf et al. (2016) believe that the underlying environments as well as rates of gun ownership and criminality can explain such laws’ effects. The literature on gun prevalence and crimes sustain such an argument. Cook and Ludwig (2004) find that the prevalence of youths carrying guns is positively related to local rate of youth violence. They also find that blacks and Hispanics are more likely to carry a gun than others. Cook and Ludwig (2006) show that gun ownership is linked to higher rates of
homicides, and this effect is accentuated in youth homicides. As the Brazilian gun prohibition allows me to identify the effect of concealed weapon laws on crime, I also investigate whether these effects are sensitive to race, age and the share of at risk-youth in the municipality.

2.2 Policy Feedback

The literature investigating how policies shape politics focuses on how policies affect voter turnout, but little is known about how policies affect voters’ choice. This work speaks to this gap and shows the effect of policy on both voter turnout and choice. More specifically, I find increased voting turnout and support for the gun ban referendum in areas where the drop in gun-related crime following the prohibition of right to carry concealed weapons was most pronounced.

Though Schattschneider (1935) initiated the study of policy feedback claiming that new public policies create new politics, empirical works have only recently begun to investigate this topic. Mettler and Soss (2004) argue that, although political scientists have a substantial knowledge about how voters influence policies, little is known about the ways policies influence the public. A growing literature aims to fill this gap by demonstrating how government policies reshape the political landscape (Campbell 2002; Hacker 2002; Lowi 1964; McDonagh 2010; Mettler 2002, 2005; Mettler and Soss 2004; Pierson 1993; Skocpol 1992; Soss 1999; Weaver and Lerman 2010; Rose 2017), and this work also contributes to this branch of knowledge.

Mettler (2002) was one of the first to empirically measure policy feedback, which she defines as the study that views public policies as an independent variable affecting politics. The author finds that the U.S. Servicemen’s Readjustment Act of 1944 (the G.I. Bill) positively impacted the civic participation of veterans, especially for those from less-privileged backgrounds. Similarly, Campbell’s (2003) work show how the U.S. Social Security program enhanced political
activism among senior citizens. More recently, Clinton and Sances (2017) use the variation in the implementation of the Affordable Care Act (ACA) within jurisdictions of the United States to show that counties within states expanding Medicaid had larger voter turnout than similar counties in non-expansion states, especially poorer ones.

Although policy feedback is concerned about policies shaping politics, most studies have focused on the impact of public policies on political participation, and only a few works show how public policies explain election results. Isolating the impact of the policy on political behavior remains a challenge and this work speaks to this gap by investigating a unique policy experiment. The Brazilian concealed weapon prohibition was implemented with a stated provision to hold a voter referendum on an additional and more restrictive nationwide gun policy 22 months later. Because the effect of the concealed weapon prohibition varied across places nationwide, the context is ideal for analyzing how the policy’s effectiveness affected voting outcomes. More specifically, using a least square regression I find that high-crime areas, which benefitted the most by the concealed weapon prohibition, provided stronger support for the gun ban referendum, and experienced larger voter turnout.

2.3 The prohibition of right to carry concealed weapon and the gun ban referendum

The Brazilian gun legislation prohibited gun carrying and provided for a gun prohibition referendum 22 months after its enactment. The former act allows me to measure whether prohibiting gun carrying decrease crimes and the latter can help me establish a relationship between being affected by gun laws and showing support for them.

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13 Other scholars have tested the effects on civic participation that stem from various types of experiences with specific government policies, among them pension reform (Pierson 1992), receiving welfare benefits (Soss 1999) and coming into contact with the criminal justice system (Weaver and Lerman 2010).

14 One exception is De La O (2013) work showing that beneficiaries of the Mexican conditional cash transfer program had not only larger voting turnout, but also supported more the incumbent in the 2000’s presidential election.
In the early 2000s, as Figure 1 illustrates, more than 30,000 gun-related homicides occurred in Brazil every year, and most of the victims were young.\(^\text{15}\) This number was much smaller in the 1980s but sharply increased in the 1990s. Although 60% of the victims of gun-related homicides were young (15-29 years old), this population only represented close to 30% of the population. The number of gun-related homicides per 100,000 people for this age group increased from 27.6 in the 1990 to 42.2 in 2000 – while the number of gun-related homicides per 100,000 people for all ages rose from 14.3 to 20.6. Therefore, the sharp increase in gun-related homicides in Brazil in the 1990s disproportionately affected young people.

Motivated by this dramatic increase in the number of firearm-related deaths in Brazil, legislators decided to pass a nationwide firearm regulation in December 22\(^{\text{nd}}\), 2003 (Law number 10.826), which was called *Estatuto do Desarmamento* (Disarmament Statute). The legislation prohibited citizens from carrying a gun outside of their residences or places of business; it provided exemptions for hunters (sporting or subsistence), private security employees, and police officers. The penalty for illegal possession (or carrying) increased from an incarceration period of one to three months, to two to four years.\(^\text{16}\) Finally, the requirement to obtain a gun permit became more expensive and restrictive.\(^\text{17}\) These stringent requirements were enacted to decrease gun violence.

An important and unique feature of the legislation was its thirty-fifth section, which set the stage for a national referendum to take place in October 2005 (22 months after the initial legislation was passed into law), to allow Brazilian citizens to vote on even more restrictive weapons laws. The law put forward in the referendum stipulated that any guns and ammunitions would be

\[^{15}\] Yearly data from 1979 to 2013 are available at DATASUS (data from Brazilian Health Ministry).

\[^{16}\] This penalty is harsher than most of the ones applied in the United States, where most states punish possession of gun without permit as a misdemeanor. For instance, in New York, possession without permit is punishable by up to one year in prison, a fine of up to $1,000, or both

\[^{17}\] An applicant should have no criminal record, be employed, show proof of residence, pay a fee close to $1,000 attend a gun safety course, and pass a psychological exam.
completely prohibited in the country (again, with exceptions for hunter and those with security-related jobs). The referendum would not change the prohibition of carrying concealed weapons enforced in the country, but if it passed, citizens would not be allowed to own concealed weapons (including inside of their residences or place of business). In what follows, I describe the referendum campaign and its outcome.

As argued by De Vreese and Semetko (2004), political campaigning is more relevant in referendums than regular elections, especially because heuristics (e.g. ballot cues) are absent and political parties’ attitudes may confuse voters. The 2005 Brazilian referendum had the two main opposing parties in the political arena, Workers Party (PT) and the Brazilian Social Democracy Party (PSDB), supporting the campaign in favor of prohibiting guns. At the same time, the Liberal Front Party (PFL, an extreme right wing party) worked together with the United Workers Socialist Party (PSTU, an extreme left wing party) against the gun ban. The mixed signal coming from parties’ political ideology can explain why voters could not rely on typical political cues and the political campaign, mostly active through TV ads, gained importance.\(^\text{18}\)

The campaign against the gun prohibition used exploitation of fear as its most effective argument against the referendum’s proposition.\(^\text{19}\) The televised advertisements argued that the inefficiency of the Brazilian state to provide security would leave citizens defenseless against criminals if firearms were banished.\(^\text{20}\) For instance, as noted by Lissovsky (2006), the second most televised ad of the campaign against the gun ban, which aired 38 times during three consecutive

\(^{18}\) The government provided one hour daily (each side had half hour) of free electoral airtime on free-to-air television (all radio stations broadcasted it simultaneously). In addition, each side had short TV ads available to them during the day.

\(^{19}\) See Anastasia, Inacio and Novais 2006; Araújo and Santana 2006; Inacio 2006; Lissovsky 2006; Mota 2006; Cunha 2006; Esteves 2007; Goldstein 2007; Veiga and dos Santos 2008; Cavalcanti 2016.

\(^{20}\) Cunha (2006) argues that vulnerability, sense of fear and uncertainty were the most common themes explored by the campaign against the gun ban, particularly at the last ten (out of 20) days of campaign.
days,\textsuperscript{21} showed a citizen (representing a family man) placing a sign at his front door informing passersby that he did not possess any weapons. After the man installed the sign and admired his work, the soundtrack becomes dark. It becomes clear to the audience that he immediately regrets his decision. Consequently, he removes the sign while the speaker concludes: the problem is not for me not to have a gun; the problem is that the criminal will know for sure that I do not have one.\textsuperscript{22} This exploitation of fear created uncertainty about citizen security in a counterfactual post-referendum environment and lead many to vote in favor of the status quo.

In addition to dispelling fear and uncertainty in voters, the campaign against the gun ban had more financial means and was well organized. Cavalcanti (2016) argues that the National Rifle Association (NRA) provided the campaign against the gun ban with financial means and expertise.\textsuperscript{23} It provided the campaign with strategic advice and propaganda materials that were previously used in the U.S. Moreover, the campaign against the gun prohibition, as Lissovsky (2006) characterizes it, was well organized, had twice as much money,\textsuperscript{24} and its main message was direct and focused: Prohibiting guns was an attempt of suppression of rights, (even though possessing guns was never a constitutional right in Brazil as it is in the U.S.) which would increase citizens’ vulnerability to crime.

By contrast, the campaign in favor of the gun ban was supported by researchers and criminologists. However, as Soares (2006, p.75) argues, “(…) that tremendous and cognitive and factual advantage was not transformed into a political and electoral advantage.” The most

\textsuperscript{21} From October 15-17\textsuperscript{th}. These dates are close to the last day of campaign, which was October 20\textsuperscript{th}, showing the relevance and appeal of the message.
\textsuperscript{22} This advertisement can be accessed at: https://www.youtube.com/watch?v=Nu4okj8yPws
\textsuperscript{23} The author claims that the NRA should be interested in the referendum because if the gun ban passed and provided evidence that the society was better after it, many other countries could attempt to do the same.
\textsuperscript{24} The campaign against gun ban was financed by the gun industry and got $2 million, while the campaign in favor of gun ban got $960 thousand.
problematic issue with this campaign was its lack of organization. As Mota (2006) argues, one of the main coordinators of the campaign in favor of the gun prohibition, Ruben César Fernandes, admitted that he had no specific strategy. Another mistake, according to Mota (2006), was the usage of celebrities to deliver the campaign message. Common citizens’ testimonies reporting their daily struggles with gun-related homicides would better connect with the audience. For all of these reasons, it seems clear that the campaign against the gun ban was better organized than the campaign in favor of it, and these differences in campaign capabilities can help to explain the referendum final outcome in which 64% of the population voted against the gun ban. In section 5, I establish a link between the effectiveness of the prohibition of carrying concealed weapons and support for the prohibition of owning concealed weapons as a way to explain voters’ choice in the Brazilian referendum, which has been so far neglected by the literature.

3. Data and empirical strategy

3.1 The impact of prohibiting gun carrying and who benefits from it

I begin my study of the effects of the prohibition of concealed carry on homicides and then I examine its effects on non-homicide crimes. Monthly homicides data at the municipality level have been available across the country since 1996 in the Brazilian National System of Mortality Records (DATASUS). Monthly data on non-homicides crimes are only available for the state of São Paulo provided by the Secretaria de Segurança Pública de São Paulo since 2001.

Following Davis (2008), I use an RDD where time is the forcing variable to evaluate the impact of the concealed carry prohibition on crimes. This method is also known as Interrupted Times Series (ITS) and has been widely used to estimate the effects of policy changes (Gonzalez-Navarro 2013; Moscoe et al. 2015; Bernal et al. 2017). As Moscoe et al. (2015) argue, ITS can be
interpreted as a sub-type of RDD, in which time is the assignment variable and the cutoff is defined as the date when a new policy is implemented.

Bernal et al. (2017) makes a tutorial on when and how to use an ITS. They argue that this methodology is validated when the expected trend of the variable of interest, in the absence of the intervention (i.e. calculated using pre-intervention data), should be different than the one observed once the intervention is enacted. At the same time, the conditional expectation of confounding variables that can affect the variable of interest must be continuous around the intervention. Figure 2 shows satisfaction of this requisite. While gun-related homicides deviate from the trend after the prohibition of right to carry concealed weapons, non-gun related homicides, which captures the effect of unobservable variables related to crimes that could be driving my results, follow the trend predicted using pre-intervention data and are continuous around the cutoff (January 2004).\textsuperscript{25}

Studies examining crimes usually restrict their sample because of few occurrences. For instance, Cerqueira and Mello (2013) study the impact of a gun law on crimes in the state of São Paulo. They use as dependent variable the annual change in the number of gun-related suicides to total suicides and argue that this variable is noisy in small municipalities because of low incidence. Therefore, they consider only municipalities with more than 50,000 inhabitants. Cook and Ludwig (2006) use a similar strategy and consider only the 200 counties that had the largest population in the United States. As the number of homicides is not as uncommon as suicides, I consider municipalities with more than 10,000 inhabitants.\textsuperscript{26}

\textsuperscript{25}As I only have access to monthly data, I defined January 2004 as my cutoff point. However, the last eight days of December 2003 are contaminated because the gun prohibition was already in effect. Nonetheless, if anything, this fact would underestimate my results.

\textsuperscript{26}Municipalities with more than 10,000 inhabitants account for 92.4\% of the total Brazilian population and 98\% of all gun-related homicides occur in these areas. I show in the Appendix (Table A1) that choosing different threshold options (50,000 and 100,000 inhabitants) do not change my results.
My empirical model is constructed as the following least square estimation:\(^\text{27}\)

$$GRH_{mt} = \alpha + \lambda D + \beta_1(r - c) + X_{mt} + \Lambda_t + \epsilon_{mt},$$

such that: \((c - h) \leq r \leq (c + h)\) \hspace{1cm} (1)

where \(GRH_{mt}\) is the number of gun-related homicides per 100,000 people at municipality \(m\) at month \(t\), \(c\) represents the cutoff, \(r\) indicates the months surrounding the cutoff, \(D\) is a dummy indicating that the prohibition of right to carry concealed weapons became effective, and \(h\) represents the selected bandwidth (in months). \(\lambda\) is my main independent variable, which captures the law effect. \(X_{mt}\) contains monthly data for temperature and rainfall accumulation for each municipality \(m\) at month \(t\).\(^\text{28}\) \(\Lambda_t\) are dummies indicating each calendar month to capture any seasonal effect.\(^\text{29}\) Finally, \(\epsilon_{mt}\) contains the error term for each observation.

Using population and gunshot wounds data, I verify whether the prohibition of right to carry concealed weapons had heterogeneous effects, and whether its effects were driven by intentional gunshots. Using the RDD strategy proposed, I split the sample among different races and age of gun-related homicides’ victims to study the law effects on various populations. Then, using data on gunshot wounds, provided by the DATASUS, I examine whether gunshot wounds intended to kill were more affected than accidental ones.

I then examine if the effects of the concealed carry prohibition are larger in places having more youth that are vulnerable to become criminals. Young people are overrepresented as both

\(^{27}\) I do not add municipal fixed effects because, as Lee and Lemieux (2010) argue, including fixed effects is unnecessary for identification in a RD design. Nonetheless, it is important to highlight that including fixed effects do not significantly change the results as reported in the appendix.

\(^{28}\) I control for monthly rainfall and temperatures because researchers have demonstrated that weather is related to crime (see Cohn, 1990 for a review of this literature). Monthly rainfall and temperatures data were collected from Matsuura and Willmott (2009). The authors provide estimation of monthly worldwide precipitation and temperature data at the 0.5 x 0.5 degree level. Each point is characterized by a specific geographic coordination (latitude and longitude), and the monthly precipitation and average temperature for each point is associated to the rainfall and temperature data collected from its 20 closest weather station.

\(^{29}\) In Brazil summer starts in December and ends in March. As showed by (Waisekfisz & Athias (2005) – Mapa da Violência SP), the number of homicides reaches its peak in the summer.
victims and perpetrators of violence, and the likelihood that someone carries a gun is larger in places with higher rates of youth violence and among high-risk groups (Cook and Ludwig 2004). I construct an index, at the municipality level, which I call vulnerability index to measure youth violence and then assess whether the effects of the prohibition of carrying concealed weapons varies in accordance to such an index.  

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To measure how the vulnerability index relates to the law effects, I build on equation one and construct the following RDD analysis:

\[
GRH_{mt} = \alpha + \lambda D + \beta_1 (r - c) + \beta_2 \text{vuln. index}_m + \beta_3 D \cdot \text{vuln. index}_m + X_m + \Lambda_t + \epsilon_{mt},
\]

where \(\beta_3\) is now my main coefficient of interest. It measures whether the effectiveness of the prohibition of concealed carry is related to the \text{vuln. index}_m (vulnerability index in municipality \(m\)). My analysis indicates that there are heterogeneous effects of the law.

Lastly, I use a DID to validate my RDD findings in equation (2). Taking advantage of how the law effects varies in accordance to the vulnerability index, I propose the following DID estimation:

\[
GRH_{mt} = \alpha + \beta_1 \text{year}_t + \beta_2 \text{index}_m + \beta_3 \text{year}_t \cdot \text{vuln. index}_m + X_{mt} + \Lambda_m + \epsilon_{mt},
\]

where \(\text{year}_t\) is a dummy variable equal to one when \(t = 2004\) and equal to zero when \(t = 2003\), \text{vuln. index}_m is the vulnerability index in municipality \(m\) discussed above. Vector \(X_{mt}\) includes control variables that vary across time and municipalities. The dependent variable \(GRH_{mt}\) corresponds to the gun-related homicides in municipality \(m\) and year \(t\).  

31 Using the DID methodology I can access whether the prohibition of right to carry concealed weapons impacted educational outcomes. More specifically, I test whether places with higher vulnerability indices had a relatively larger young and adult education enrolment (i.e. young and adult education enrolment is my dependent variable in equation 3).
fixed effects and $\epsilon_{mt}$ is the error term. The coefficient $\beta_3$ is the parameter of interest that captures the effect of the prohibition of carrying concealed weapons on gun-related homicides.

3.2 The effects of the prohibition of concealed carry on the gun ban referendum

To establish a connection between policy and political behavior, I examine the Brazilian 2005 referendum proposing a prohibition of firearm and ammunition. My dependent variables are the percentage of votes in favor of the prohibition, as well as the turnout-to-registered voters’ ratio. These data are available from the Brazilian Superior Electoral Court (TSE). The control variables are collected from both IBGE and IPEADATA. They are composed of socioeconomic and demographic data.\(^{32}\) I also control for variables that are especially relevant in the literature on support for gun control.\(^{33}\) However, my main independent variable is the vulnerability index. As places with higher vulnerability indices were disproportionately affected by the prohibition of concealed carry, I can identify how the policy effectiveness explain voting and turnout behavior.

I propose the following OLS regression to test the impact of policies on politics:

$$Y_m = \alpha + \beta_1 \text{vuln. index}_m + X_m + A_s + \epsilon_m.$$  \hspace{1cm} (4)

---

\(^{32}\) More specifically, the control variables are mostly collected from the 2000 census and are composed by: number of women to men ratio, per capita GDP (in 2005), total population (in 2005), percentage of people living in rural areas, years of schooling, percentage of households with TV access, number of households receiving government conditional cash transfer (Bolsa Família) to total population ratio, distance to the state capital (which in Brazil is the main city in the state in terms of GDP and population), change in the income distribution (between 1991 and 2000), number of cattle per people living in rural areas, and government initiated agricultural land distributed to total agricultural land ratio.

\(^{33}\) For a discussion on why people support gun control, see Esposito & Finley, 2014; Carlson, 2012; Neiva, 2010; Kleck, Gertz & Bratton, 2009; Grafton & Permaloff, 2005; Kleck, 1996; Ellison, 1991. I included an index that measures the political ideology of the municipality (Schneider, 2016). I also included a dummy indicating land reform protest within a year of the referendum (source: Lab of Agriculture Geography - LAGEA). This is an important variable as farmers use guns to defend themselves against land invasion. Finally, I included a dummy indicating drought within one year of the election (source: Integrated System of Disaster Information - S2ID). Drought may increase landless peoples’ propensities to invade land (see, for instance, Ralston 2013).
where $Y_m$ is the dependent variable in municipality $m$ and can be both the percentage of the vote in favor of the prohibition as well as the turnout-to-registered voters’ ratio. The vector $X_m$ includes all control variables relevant to explain support for gun control. $\Lambda_s$ represents state fixed effects and $\epsilon_m$ is the error term. The coefficient $\beta_1$ is the parameter of interest that captures the effect of the policy on the dependent variable. As I show later, the $vuln.index_m$ variable explains the effectiveness of the prohibition of concealed carry and should, therefore, be related to political outcomes associated to the referendum.

4. Effects of the prohibition of concealed carry on crimes and beneficiaries of the law

I first investigate the impact of prohibiting concealed carry on crimes, then I show who benefits the most from the regulation. I focus on homicides because this type of crime is available across the country. Using population data, I investigate which groups were more affected by the gun carrying prohibition. Finally, I validate my RDD findings using a DID model, which also allows me to study whether places more benefitted by the gun carrying prohibition had a larger young and adult education enrollment.

4.1 The effects of the prohibition of concealed carry on gun-related homicides

Using the regression proposed in equation (1), I estimate the impact of prohibiting concealed carry on gun-related homicides, non-gun-related homicides and total homicides. Figure 3 shows the graphical results and the magnitudes of the effect are reported in Table 1. Before proceeding further with Table 1 analysis, it is important to comment on two facts. First, gun-related suicides were only marginally affected by the concealed carry prohibition. Second, not taking

$^{34}$ The coefficients measuring the impact of prohibiting concealed carry on gun-related suicides was -0.025 and the standard deviation was equal to 0.0145. This result contrast the findings of Leigh & Neil (2010) showing that gun buyback in Australia reduced gun-related deaths, but mostly suicides.
seasonality into account decreases the magnitude and significance of the gun-related homicides coefficient, suggesting that seasonality plays an important role: the decrease in gun-related homicides in January, a month in which this variable would usually reach its annual peak, is showing of the strength of the law.

The results on Table 1 shows a strong relationship between the prohibition of concealed carry and gun-related homicides. Column 1 indicates that the legislation decreased the monthly gun-related homicides per 100,000 people by 0.194 on average. In 2003, Brazil had 167,546,532 people living in municipalities with more than 10,000 inhabitants, so 3,900 lives were saved in 2004 due to the implementation of the law, which corresponds to 10.8% of the total gun-related homicides in 2003. This result is close to the finding by Waisekfisz (2016) using a linear trend of gun-related homicides in Brazil between 1997-2003. Waisekfisz (2016) predicted that there should be 4,391 more gun-related homicides in Brazil in 2004 than the number observed and attributed this positive impact to the gun control legislation. My estimation, however, controls for weather and seasonality effects, uses monthly data at the municipality level and examines a much shorter period than Waisekfisz (2016) to overcome my inability to control for important economic and social changes that can affect my dependent variable. In the appendix (Table A1 and Figure F1), I show that the estimations are not sensitive to model specifications and that restricting the bandwidth to 6 months do not significantly change the results.

As a robustness check, I present a falsification test where I simulate different dates for the beginning of the gun control regulation. Table 2 shows coefficients estimated from these

---

35 The monthly gun related homicide per 100,000 people mean is .75 and the standard deviation is 2.
36 I obtained this number by multiplying 0.19 by 12 to get an annual measure. Next, I multiplied the outcome by 167,546,532 and divided by 100,000.
37 6 months is the optimal bandwidth using Calonico, Cattaneo, and Titiunik (2014) method.
simulations. The only significant result is obtained when I consider the correct date in which the prohibition of concealed carry took effect, i.e., January 2004.

4.2 What about the effect of the prohibition of concealed carry on other crimes?

To answer this question, I use monthly data on non-homicides crimes that are only provided by the state of São Paulo. I find that robbery, illegal gun carrying and total arrests were reduced while rape, drug trafficking and theft remained unchanged.

Figure 3 below shows the impact of the law on 8 crimes plus total arrests, which are: illegal gun carrying, drug trafficking, rapes, total homicides, gun-related homicides, non-gun-related homicides, robbery and theft. For each crime, there is first a placebo measurement using January 2003 (one year before the concealed carry prohibition) as the cutoff point and next the correct cutoff point (January 2004). As one can notice, the concealed carry prohibition decreased the number of crimes related to guns as well as total arrest. The monthly illegal gun carrying per 100,000 people decreased by 0.57 (16% reduction); the monthly gun-related homicides per 100,000 people decreased by 0.36 (17% reduction); the monthly robbery per 100,000 people decreased by 8.87 (12.33%); and the monthly arrests per 100,000 people decreased by 3.1 (14.8% reduction).

The finding presented in Figure 3 indicates that the law decreased crimes that involve the use of guns. The fact that robbery and illegal gun carrying decreased, but theft was not affected is an indication that the legislation decreased gun-related homicides by decreasing the number of guns on streets. Robbery, in contrast to theft, involves criminal and victims’ interaction with force, intimidation, and/or coercion, so criminals usually use guns in these situations. Illegal gun

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38 In Brazil, each state is responsible for providing its own public security and the state of São Paulo is the only state to provide monthly data on crime since 2001.
carrying, which necessarily involve guns decreased, while rape and drug trafficking, were not affected. Additionally, the law decreased gun-related homicides in São Paulo just as observed across the entire country, while non-gun-related homicides were not affected.  

I find evidence that the concealed carry prohibition affects gun-related crimes, but do not change the remaining ones indicating that the law inhibited criminals from carrying guns. These results should be interpreted with care as the sample covers only the São Paulo state. I do not claim that São Paulo is representative of the entire country: it is a relatively rich state (largest GDP and second largest GDP per capita) and the most populous of Brazil. Nonetheless, it can provide some insights about the entire country because it shows results on gun-related homicides that are similar to Table 1. Next, I return to the data on gun-related homicides for the entire country and investigate the conditions explaining the effectiveness of the concealed carry prohibition.

4.3 Who benefits the most from prohibiting the right to carry concealed weapons?

I propose a demographic division to better understand which population group benefitted the most from the concealed carry prohibition. I use the same RDD proposed in equation (1), but split the sample by age and race of gun-related homicides’ victims, and also by the location where gun-related homicides took place. Before showing the results, I present descriptive statistics in Table 3. It shows the number of gun-related homicides in 2003 divided across race, age and locality.

The reduction in gun-related homicides was especially pronounced among young black males. Table 4, Panel A, shows that the law effect on gun-related homicides is driven by blacks.

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39 Although there was a decrease in non-gun-related homicides in São Paulo, this decrease was also observed in the placebo analysis indicating that there was a previous downward trend of this variable not related to the legislation.

40 I chose not to focus on gender because mostly of the victims of gun-related homicides are males (about 94% of the total).
Although only 56% of the victims of gun-related homicides are blacks (Table 3), the concealed carry prohibition effect was almost exclusive for this group. Waisekfisz (2012) performs an analysis of homicides’ victims in Brazil by race. The author argues that blacks, compared to whites, are disadvantaged in terms of education, income and security, and that they are the main victims of violent crimes. Therefore, my results indicate that the concealed carry prohibition was more effective in areas that lack security, and have high rates of crime. Panel B of Table 4 suggests that young people (between 15 and 29 years old) benefitted more from the law, however, this should be expected as this group represents much of gun-related homicides’ victims (Table 3). Finally, Panel C shows that gun-related homicides happening in what I call “out of home” locations were affected more by the concealed carry prohibition. This is not a surprising result, but it could be underestimated as 46.8% of all gun-related homicides’ locations are not precisely identified.

Table 4 indicates that the effect of the prohibition of carrying concealed weapons is related to crime rates. In addition, the concealed carry prohibition probably does not affect family-related gun-related homicides (the law had no effect on gun-related homicides committed inside the residence or farm). This should be expected because although people were prohibited to carry, they were not forbidden to keep a firearm at their homes. Next, I present evidence that the law had no effect on accidental gunshots.

The subsequent analysis investigates data on monthly gunshot wounds at the municipality level, which are classified as “accidental” or “intended to kill.” As gunshot wounds happen less frequently than gun-related homicides (in 2003 there were 21,484 gunshot wounds), I restrict my sample to municipalities with more than 50,000 people.\textsuperscript{41} Table 5 presents an RDD estimation

\textsuperscript{41} The decision to restrict the sample to municipalities with more than 50,000 people results in analysis of 65% of the Brazilian population, but that group includes 98% of gunshot wounds intended to kill and 93% of accidental gunshot
showing that only the gunshots intended to kill were affected by the law. My estimation indicates that the law caused a reduction of 12.3% in the total gunshot wounds in the “intended to kill” category. This is additional evidence that prohibiting concealed carry affects victims of murder instead of involuntary manslaughter. Therefore, high-crime areas should be largely affected by this gun regulation.

4.4 The vulnerability index

To investigate the previous subsection indication that high-crime areas are disproportionately benefitted by the law, I construct an index considering the level of at-risk youth in each municipality.\(^{42}\) The goal of this index is to map the places that have more young people susceptible to become criminals. People living close to them, as well as themselves are the ones more likely to be exposed to gun-related homicides. The index I construct is based on the index of vulnerable young people developed by the SEADE Foundation (State System of Data Analysis) for the São Paulo city neighborhoods.\(^{43}\) Formally, the index is constructed as follows:

\[
vulnerability\ index_m = \frac{\sum_{i=1}^{6} \left( \frac{\text{var}_{m,i} - \text{Min}(\text{var}_i)}{\text{Max}(\text{var}_i) - \text{Min}(\text{var}_i)} \times 100 \right) + \left( \frac{\text{var}_{6,i} - \text{Min}(\text{var}_6)}{\text{Max}(\text{var}_6) - \text{Min}(\text{var}_6)} \times 100 \right)}{6}
\]

(5)

where \(i\) represents the six variables described in Table 6.\(^{44}\)

The decision to use such an index finds support in the literature. As Cook and Ludwig (2006) argue, young people comprise “a relatively high percentage of whom are killed in gang- and felony-related attacks by youthful criminals” p.387. Young people are also overrepresented as

\(^{42}\) Here, at-risk youth measures how unlikely young people are to avoid a life of crime.

\(^{43}\) See http://produtos.seade.gov.br/produtos/ivj/

\(^{44}\) This index hypothetically ranges from 0 to 100. However, the minimum and maximum values are respectively 11.49 and 58.32. Its average equals 32.10.
gun-related homicides’ victims in Brazil (Figure 1) and experienced a larger effect of the concealed carry prohibition (Table 4). Also, it should be expected that high-crime areas are going to be more affected by the law as its effects were focused on gun-related crimes. Thus, prohibiting concealed carry should disproportionately affect gun-related homicides in places with higher vulnerability indices. Figure 5 illustrates this argument. The dashed and solid lines show, respectively, the annual average of gun-related homicides per 100,000 people in areas with above- and below-median vulnerability index. As one can notice, the law (red line cutoff) had a much larger effect in places where the vulnerability indices were larger than the median.45

Next, I show that the number of gun-related homicides disproportionately decreased in places where the vulnerability indices were larger. Table 7 uses the RDD proposed in equation (2) and finds that an increase of one unit in the vulnerability index intensifies the effect of the concealed carry prohibition by additionally reducing the annual gun-related homicides by 160.8. Therefore, high-crime areas benefitted more from the law.

4.5 Bolstering internal validity with a differences-in-differences (DID) model

The previous subsection shows that high-crime areas had their gun-related homicides disproportionately decreased. This conclusion allows me to validate my RDD findings using a difference-in-differences model, where the treatment group is composed of high-crime areas (more affected by the law).

Strong internal validity is a great advantage of RDD models. However, one common criticism of the methodology is that internal validity is obtained at the expense of external validity.

45 The municipalities where the vulnerability indices were larger than the median contains 39% of the Brazilian population because municipalities with less than 10,000 people are out of the sample.
One feature of my analysis helps mitigate this concern, namely the fact that many municipalities (2,875) had more than 10,000 people, and so my sample contains 51.6% of Brazilian municipalities. In addition, to demonstrate the robustness of the findings I estimate the DID proposed in equation (3).

Table 8 presents the results showing that an increase of one unit in the vulnerability index intensifies the law effect by additionally reducing the annual gun-related homicides by 244.6. The estimated coefficient ($\beta_3$) is similar to the one estimated in Table 7, bolstering the internal validity of the RDD estimates. Taking advantage of this DID strategy, I show next an analysis using annual data on school enrolment as the dependent variable to check if there is any indication of larger school enrollment of young males in high-crime areas.

4.6 School Enrollment

The empirical evidence presented thus far indicates that young black males living in high-crime areas were disproportionately affected by the legislation. This group should, therefore, be participating more in alternative activities such as education. Using data of the Censo Escolar (Brazilian school census),\textsuperscript{46} I find empirical evidence that male enrollment in adult education increased more in high-crime areas after the concealed carry ban took effect. Adult education is a public program focused on giving young adults who dropped out of or never attended school the opportunity to finish their basic studies. In 2004, 63% of people enrolled in this program were between 15 and 29 years old (85% were between 15 and 39 years old). Though collection of race-related data only began in 2005, thus preventing a racial analysis given my time window, the initial

\textsuperscript{46} Data for the Censo Escolar (Brazilian school census) can be found at: http://portal.inep.gov.br/censo-escolar
information from 2005 indicates that blacks used adult education more than other races; among the male students who declared their race, 67.4% were black.

Figure 6 illustrates my argument; it shows that male enrollment in adult education increased disproportionately more in places with an above-median vulnerability index (treatment group), while female enrollment did not change. I use female enrolment as a placebo because women are almost not affected by gun-related homicides (94% of such victims are male). Schools release enrollment figures annually, at the beginning of the year. Therefore, the year 2005 captures the effect of the concealed carry ban at a time when the law had been in place for about a year at the time.

Table 9 tests the significance of the results using the same methodology proposed in equation (3), but using enrollment in adult education per 100,000 people as the dependent variable. It shows that an increase of one unit in the vulnerability index amplifies the effect of the concealed carry prohibition on male enrollment by increasing it by 6.5 enrollments per 100,000 inhabitants.

To conclude, section 4 main result is that prohibiting concealed carry reduces gun-related homicides and that high-crime areas benefitted more from the regulation. In the next section, I show that high-crime areas were also more likely to turnout to vote in the referendum and support the gun prohibition.

5. Policy feedback: the 2005 Brazilian referendum case

This section investigates the relationship between public policy and politics. More specifically, I examine whether being affected by the gun-carrying prohibition affected electoral outcomes in the subsequent gun prohibition referendum. I test this hypothesis using the regression proposed in equation (4). Places with high vulnerability indices disproportionately benefitted from
the law; thus, I expect these places to have higher voter turnout and to show more support for the gun prohibition referendum.

As mentioned before, the vulnerability index was originally constructed to measure young people’s vulnerabilities to crime in the neighborhoods of the São Paulo municipality. As São Paulo is the largest city of Brazil, the Superior Electoral Court makes electoral neighborhood-level data available for the São Paulo municipality. Taking advantage of this neighborhood data availability, Figure 7 presents the estimated relationship between voting in favor of the gun ban and the vulnerability index, after adjusting for income and population. As expected, the relationship is positive and strong. Next, I show that this relationship also exists across the country.

Table 10 presents an OLS regression using the vulnerability index to explain the vote in favor of the prohibition (equation 4). I find a positive relationship between vulnerability index and support for gun prohibition. The coefficient estimated in column 1 is remarkably close to the one estimated for the São Paulo city’s neighborhoods (Figure 7), showing that the vulnerability index has external validity. Even after all control variables are added to the model, as Column 2 presents, the estimated vulnerability index impact remains close to the one estimated for São Paulo city’s neighborhoods. One way to interpret the vulnerability index coefficient is to compare municipalities with the “best” and “worst” indices. In moving from a municipality with the “best” index (11.49) to a municipality with the “worst” index (58.32), the likelihood of voting in favor of the prohibition increases by 12.27 percentage points. This is a relevant number as an increase of 13.94 percentage points for the “Yes campaign” would have been enough for the prohibition to win.

47 “Best” index in this context means that the municipality had the lowest vulnerability index.
Although my estimations provide strong and expected results, it may suffer from omitted variable bias, especially due to the lack of control for the number of guns in the municipalities. This could explain the significance of the results. For instance, it could be the case that places without gun-related homicides are also places where many citizens have firearms and where firearms serve as a deterrent to violence. To address this potential omitted variable problem, I collect municipal data on the number of unlawful gun firings and unlawful gun carrying after the law’s passage to serve as a proxy for the number of guns in the municipality. Unfortunately, these data are only available for the state of São Paulo. As Column 3 of Table 10 shows, the number of guns in the municipalities is not driving my results. Once again, the vulnerability index coefficient remains close to the ones estimated for São Paulo’s neighborhoods and the whole country. This confirms my previous results, and I further validate them in the appendix. Next, I discuss the vulnerability index effect on voting turnout.

Before investigating the effect of vulnerability index on the turnout-to-electorate ratio, I discuss the turnout bias introduced by mandatory voting in Brazil. As Cepaluni and Hidalgo (2016) argue, in Brazil, a compulsory voting system increases inequality in turnout. The participation gap between poorer and wealthier voters is heightened by the Brazilian compulsory voting system because nonmonetary penalties for abstention disproportionately affect middle- and upper-class voters. Therefore, they turnout more to vote. As examples of these nonmonetary fines, the authors

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48 This argument is accessed through a model of crime in Donohue & Levitt (1998).
49 This data is aggregated by year, at the municipal level. The year considered in the sample is 2004.
50 I use a survey that took place two days before the referendum to corroborate my argument that people more likely to benefit from the concealed weapon ban (i.e. people more exposed to gun violence) had larger support for gun prohibition (Tables A2). I also present in the appendix (Tables A3 and A4) an analysis showing that the closer to the referendum a gun-related homicide takes place, the more it positively affects support for gun ban.
mention prohibiting violators from obtaining a passport and/or taking a civil service exam - services that are primarily used by members of middle and upper classes.

As higher vulnerability index is associated with poverty and voting turnout is biased toward upper class, a negative relationship between this index and turnout should be expected. To solve this problem, I include previous turnout-to-registered voters’ ratio (turnout in the 2004 elections) and interact this variable with the vulnerability index. Table 11 presents the results. As one can notice, given a certain level of 2004 turnout-to-registered voters’ ratio, an increase of one unit in the vulnerability index increases voting turnout for the referendum by 1.3 percentage points, indicating that experiencing benefits of the concealed weapon ban increased political engagement.  

As argued by Clinton and Sances (2017), establishing causality is the main challenge faced by empirical studies investigating the impact of policies on politics. The coefficient measuring the effect of the vulnerability index on voting in favor of the gun ban and voting turnout may not be accurately estimated due to selection bias. Put succinctly, places more affected by the concealed carry prohibition may have specific characteristics that would explain their support for gun prohibition and voting turnout even in the absence of the policy.

To solve for selection bias, I run a two-stage least square regression. The second stage estimate is based on the variation of the two dependent variables studied in this section (i.e. share of the vote in favor of the gun prohibition and voting turnout in the referendum) explained by rural population (percentage of the total) at the municipality level in 1950.  

---

51 In the appendix I show (Table A2) that people who would vote in the referendum even if voting was not mandatory supported the gun ban more.
was used by Cook and Ludwig (2004) because of its ability to predict county-level gun prevalence in the United States in 1995.

The ideal instrumental variable must satisfy three conditions: be highly correlated with the vulnerability index, not affected by the 2005 referendum results and uncorrelated with omitted variables that affected the 2005 referendum outcomes. The notes under Table 12 presents the first stage results and shows that past rural population is highly predictive of the vulnerability index. Also, it is reasonable to argue that past rural populations are not affected by the 2005 referendum outcomes. I cannot rule out the possibility that past rural population is uncorrelated with omitted variables that affected the 2005 referendum results, however, controlling for percentage of rural population in 2000 and income per capita increase my confidence on the satisfaction of the third requisite.

The coefficients estimated are remarkably close to the ones presented in Tables 10 and 11 reinforcing the credibility of my findings. Table 12 shows two-stage least square estimations of the vulnerability index effect on the share of the vote in favor of the gun ban and voting turnout in the referendum. It suggests that the previous estimated impact of the vulnerability index on the share of vote in favor of the prohibition did not suffer from omitted variables. In addition, the two-stage least square model shows that the instrumental variable isolates in a satisfactory way the impact of the vulnerability index on voting turnout. Although the relationship between vulnerability index and voting turnout is primarily negative (Table 11), the instrumented vulnerability index is positively related to voting turnout and validates my previous interpretation that an increase of one unit in the vulnerability index increases voting turnout for the referendum by close to 1.2 percentage points.

6. Discussion and conclusions
Many countries have gun regulations, and measuring their impact is both important and extremely difficult. Right-to-carry laws are the most-studied gun regulation (Leigh & Neil, 2010); nonetheless, as Manski & Pepper (2016) argue, it is not possible to make any conclusions about the effects of such laws without making strong assumptions. The authors show that different assumptions lead to different conclusions about their impact on crime rates, and conclude their paper by saying “…we do not report findings with incredible certitude: there are no simple conclusions.” However, certain aspects of Brazil’s gun legislation allow one to circumvent problems that have plagued other natural experiments, and, thus, allow for a window onto the issue that offers clearer insights and conclusions.

This paper provides the first regression discontinuity design analysis of the impact of concealed weapons bans on crime. Following a ban on carrying of guns in Brazil, gun-related homicides fell by 3,900 (10.8% of the total number of such homicides in the country) in the year following the regulation, the analysis shows. The paper shows that young black males living in high-crime areas disproportionately benefitted from the regulation – both because the drop in gun-related homicides was particularly pronounced among that population, and because in the wake of the law young black men were more likely to enroll in public adult education. The research here also shows that non-gun-related homicides were not affected by the regulation, and that the number of gunshots intended to kill decreased after the law, but accidental gunshots were not affected.

The economic value of the regulation I study can be estimated using the literature on the value of a statistical life. In Brazil, estimations of the value of statistical life vary from $0.77 to $6.1 million (Ortiz, Markandya & Hunt, 2009). Therefore, using the most conservative value and my estimation for the reduction in gun-related homicides caused by the gun regulation, I can make the following claim: The prohibition of the right to carry concealed weapons generated an
economic value of $3 billion in one year. This number is about six times the value of the Australian gun buyback (Leigh & Neil, 2010). Although, the decreased in the number of gun-related deaths per year brought by the gun buyback in Australia was much smaller than the one estimated in this work (200 and mostly suicides), the value of statistical life in Australia is close to $2.5 million, i.e., 3.2 times larger than the one my estimation considers for Brazil. My calculation, therefore, could be understated as I considered only the most conservative value of statistical life. Additionally, as I showed in my analysis, gunshot wounds intended to kill were reduced by 12.3%. The total health spending in gunshot wounds intended to kill in 2003 was 13.2 million Brazilian Reais (equivalent to $4.6 million at the time). Therefore, an additional economic value of $565.8 thousand were generated by prohibiting concealed weapons.53

I also show that the legislation decreased illegal gun carrying, robbery and total arrests. However, reported rapes, thefts and drug trafficking incidents were not affected. Investigating the conditions affecting the effectiveness of the concealed carry prohibition, I show that young black males living in high-crime areas disproportionately benefitted by the regulation – both because the number of gun-related homicides among that group fell and because the group also was more likely to enroll in public adult education in the wake of the law. Lastly, this work establishes a link between the concealed carry prohibition law that came to pass in December 2003 and a firearm prohibition referendum that took place in October 2005 in Brazil. My results show that places that experienced a larger decrease in gun-related homicides experienced higher voter turnout and great level of support for the referendum banning firearms.

53 This calculation is underestimated as it does not consider the days of work missed by the gunshot wounds’ victims while they were hospitalized and during their post-hospital recovery, nor it does consider the rehabilitation costs (such as medical drugs).
The places that experienced a larger decrease in gun-related violence following the concealed weapon ban were largely concentrated in regions that represent about 39% of the Brazilian population (i.e. places with above median vulnerability index). By comparison, 36% of voters cast ballots in favor of the gun ban. These findings underscore potential problems for direct democracy (i.e. referendums and initiatives put directly to voters rather than legislation passed by elected representatives); when the benefits of decreasing negative externalities, in this case gun externalities, are concentrated in a share of the population representing less than 50% of the voting public, these benefits might be ignored by the majority of voters. If these externalities are large enough, ignoring them will result in an outcome with a lower social welfare. Therefore, in these situations, referendums should not be used (Maskin and Tirole, 2004).

My results could be even larger in a context such as more effective policing and easier border controls. Leigh & Neil (2010) conclude their work by saying that extrapolating their results to other countries is not trivial. First, because Australia does not have land borders making it easier to control illegal firearm imports and secondly, because its government and policing services are highly organized and effective. Brazil, on the other hand, do not have any of these advantages. Therefore, prohibiting gun carrying in a country with effective policing and easier border controls could provide a larger decrease in gun-related homicides than the one I find.

References


Araújo, P. and Santana, L. (2006). ‘O referendo sobre o comércio de armas: processo decisório,


Table 1 – RDD estimating the concealed carry prohibition effect on Gun and Non-Gun related homicides

<table>
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<th>VARIABLES</th>
<th>(1) Gun Related Homicides</th>
<th>(2) Non-gun Related Homicides</th>
<th>(3) Total Homicides</th>
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<td>-0.030</td>
<td>-0.224***</td>
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<td></td>
<td>(0.050)</td>
<td>(0.044)</td>
<td>(0.066)</td>
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<tr>
<td>Observations</td>
<td>71,492</td>
<td>71,492</td>
<td>71,492</td>
</tr>
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</table>

Robust standard errors clustered at the municipality level are in parenthesis. Bandwidth is equal to 12 months. All regression control for calendar months, rain and temperatures. All municipalities with more than 10,000 people are considered. *** p<0.01, ** p<0.05, * p<0.1
Table 2 – Falsification test

<table>
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<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
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</tr>
<tr>
<td>– Cutoff: January 2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concealed Carry Prohibition</td>
<td>-0.194***</td>
<td>0.041</td>
<td>0.056</td>
<td>0.002</td>
<td>0.005</td>
<td>0.048</td>
<td>-0.020</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.046)</td>
<td>(0.047)</td>
<td>(0.047)</td>
<td>(0.043)</td>
<td>(0.047)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>Observations</td>
<td>71,492</td>
<td>71,404</td>
<td>71,223</td>
<td>71,049</td>
<td>70,248</td>
<td>69,451</td>
<td>69,354</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at the municipality level are in parenthesis. Bandwidth is equal to 12 months. All regressions control for calendar months, rain and temperatures. All municipalities with more than 10,000 people are considered. *** p<0.01, ** p<0.05, * p<0.1
Table 3 – Descriptive statistics

<table>
<thead>
<tr>
<th>Race</th>
<th>Gun-related homicides</th>
<th>Age</th>
<th>Gun-related homicides</th>
<th>Localilty</th>
<th>Gun-related homicides</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>13,224</td>
<td>Less than 15</td>
<td>495</td>
<td>Out of home</td>
<td>16,388</td>
</tr>
<tr>
<td>Black</td>
<td>20,291</td>
<td>Between 15 and 29</td>
<td>21,371</td>
<td>Detention center</td>
<td>126</td>
</tr>
<tr>
<td>Other</td>
<td>2,600</td>
<td>More than 29</td>
<td>14,249</td>
<td>Residence</td>
<td>2,503</td>
</tr>
<tr>
<td>Total</td>
<td>36,115</td>
<td>Total</td>
<td>36,115</td>
<td>Farm</td>
<td>183</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>36,115</td>
<td>Non-identified</td>
<td>16,915</td>
</tr>
</tbody>
</table>

Note: The descriptive statistics correspond to the year of 2003. Race is divided in three groups: white, black (composed by black and a race denominated “pardo” in Brazil, commonly translated by mulatto), and other (composed by yellow, Indians and not-identified). Locality is divided in five groups: out of home (composed by places where people drive on and places where people go to walk, work, study, shop, practice sport, enjoy leisure and so on), detention center (composed by prison, youth detention center, orphanage, hospice, nursing home), residence (gun-related homicides inside the residence), farm (gun-related homicides inside the farm), and non-identified.
Table 4 – Gun-related homicides by race, age and locality

Panel A - race

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White</td>
<td>Black</td>
<td>Other</td>
</tr>
<tr>
<td>Concealed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carry</td>
<td>-0.024</td>
<td>-0.141***</td>
<td>-0.030**</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.035)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Prohibition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>71,492</td>
<td>71,492</td>
<td>71,492</td>
</tr>
</tbody>
</table>

Panel B - age

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 – 29 years’ old</td>
<td>More than 29 years’ old</td>
<td>Less than 15 years’ old</td>
</tr>
<tr>
<td>Concealed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carry</td>
<td>-0.108***</td>
<td>-0.081**</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.033)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Prohibition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>71,492</td>
<td>71,492</td>
<td>71,492</td>
</tr>
</tbody>
</table>

Panel C - locality

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
<th>Gun Related Homicides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Out of home</td>
<td>Detention center</td>
<td>Residence</td>
<td>Farm</td>
<td>Non-identified</td>
</tr>
<tr>
<td>Concealed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carry</td>
<td>-0.097***</td>
<td>-0.004</td>
<td>-0.024</td>
<td>0.003</td>
<td>-0.072**</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.006)</td>
<td>(0.016)</td>
<td>(0.007)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Prohibition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>71,492</td>
<td>71,492</td>
<td>71,492</td>
<td>71,492</td>
<td>71,492</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at the municipality level are in parenthesis. Bandwidth is equal to 12 months. All regression control for calendar months, rain and temperatures. All municipalities with more than 10,000 people are considered. *** p<0.01, ** p<0.05, * p<0.1
Table 5 – Gunshot wounds by intention

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Gunshot wounds intended to kill</th>
<th>(2) Accidental gunshot wounds</th>
<th>(3) Total gunshot wounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concealed Carry</td>
<td>-0.116*** (0.037)</td>
<td>-0.017 (0.048)</td>
<td>-0.115* (0.061)</td>
</tr>
<tr>
<td>Prohibition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>13,906</td>
<td>13,906</td>
<td>13,906</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at the municipality level are in parenthesis. Bandwidth is equal to 12 months. All regression control for calendar months, rain and temperatures. All municipalities with more than 50,000 people are considered. *** p<0.01, ** p<0.05, * p<0.1
Table 6 – Socioeconomic variables used to construct the vulnerability index

<table>
<thead>
<tr>
<th>i</th>
<th>Variables</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>% of moms (15-17 years)</td>
<td>5507</td>
<td>8.5</td>
<td>6.5</td>
<td>0</td>
<td>57.9</td>
</tr>
<tr>
<td>2</td>
<td>% of people (15-17 years) that have never been to school</td>
<td>5507</td>
<td>2.1</td>
<td>3</td>
<td>0</td>
<td>34.3</td>
</tr>
<tr>
<td>3</td>
<td>% of people (15-19 years)</td>
<td>5507</td>
<td>10.7</td>
<td>1.3</td>
<td>4.4</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>Male homicides per 100,000 pop. (15-29 years)</td>
<td>5507</td>
<td>29</td>
<td>40</td>
<td>0</td>
<td>431</td>
</tr>
<tr>
<td>5</td>
<td>% of population growth (1997 to 2001)</td>
<td>5507</td>
<td>6.1</td>
<td>13.6</td>
<td>-50.2</td>
<td>171.6</td>
</tr>
<tr>
<td>6</td>
<td>Monthly household per capita income (in Brazilian Reais)</td>
<td>5507</td>
<td>170.8</td>
<td>96.4</td>
<td>28.3</td>
<td>954.6</td>
</tr>
</tbody>
</table>

54 Variables 1 to 3 and variable 6 are collected from the 2000 Census obtained at IBGE (Brazilian Institute of Geography and Statistics). The remaining variables are obtained at IPEADATA (Institute of Applied Economic Research). Variable 4 calculates the average between 1996 and 2005 as this variable oscillates substantially across years.
Table 7 – Relationship between the concealed carry prohibition and the vulnerability index

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gun Related Homicides</td>
<td></td>
</tr>
<tr>
<td>Concealed Carry Prohibition*Vulnerability Index</td>
<td>-0.008***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
</tr>
<tr>
<td>Observations</td>
<td>71,492</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at the municipality level are in parenthesis. Bandwidth is equal to 12 months. All regression control for calendar months, rain and temperatures. All municipalities with more than 10,000 people are considered. *** p<0.01, ** p<0.05, * p<0.1
Table 8 – DID analysis showing the effect of concealed carry prohibition on gun-related homicides

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gun Related Homicides</td>
<td></td>
</tr>
<tr>
<td>Year*Vulnerability Index</td>
<td>-0.146***</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
</tr>
<tr>
<td>Observations</td>
<td>5,757</td>
</tr>
</tbody>
</table>

The regression is controlled by municipal fixed effects. Robust standard errors are in parenthesis. The regression is additionally controlled by population and income. All municipalities with more than 10,000 people are considered. *** p<0.01, ** p<0.05, * p<0.1
Table 9 – DID analysis showing the effect of concealed carry prohibition on school enrolment

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>School enrollment men</td>
<td>School enrollment women</td>
</tr>
<tr>
<td>Year*Vulnerability Index</td>
<td>6.494***</td>
<td>3.036</td>
</tr>
<tr>
<td></td>
<td>(2.066)</td>
<td>(2.241)</td>
</tr>
<tr>
<td>Observations</td>
<td>5,770</td>
<td>5,770</td>
</tr>
</tbody>
</table>

The regression is controlled by municipal fixed effects. Robust standard errors are in parenthesis. The regression is additionally controlled by population and income. The year dummy assumes the value of one when year equals to 2005 and zero when year equals to 2004. All municipalities with more than 10,000 people are considered. *** p<0.01, ** p<0.05, * p<0.1
Table 10- OLS regression using vote in favor of gun prohibition as the dependent variable

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Vote in favor of the prohibition Brazil</th>
<th>(2) Vote in favor of the prohibition Brazil</th>
<th>(3) Vote in favor of the prohibition São Paulo state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulnerability index</td>
<td>0.227*** (0.046)</td>
<td>0.262*** (0.044)</td>
<td>0.204*** (0.068)</td>
</tr>
<tr>
<td>Socio-economic controls</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Proxy for number of guns</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>State fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Microregion fixed effects</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>São Paulo state only</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>5,507</td>
<td>5,505</td>
<td>645</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.650</td>
<td>0.682</td>
<td>0.532</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at the microregion (557 total) level are in parenthesis. The socio-economic controls contain population, percentage of people living in rural areas, per capita GDP, ideology, distance to state capital, per capita conditional cash transfer, women to men ratio, per capita number of cattle, dummy for drought, dummy for land reform protest, percentage of land bought by the government and redistributed to landless farmers. The proxies for number of guns are defined as the number of illegal gun carrying and illegal gun firing. *** p<0.01, ** p<0.05, * p<0.1
Table 11- OLS regression using voting turnout in the referendum as the dependent variable

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Voting Turnout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voting Turnout in 2004</td>
<td>0.322***</td>
</tr>
<tr>
<td></td>
<td>(0.090)</td>
</tr>
<tr>
<td>Vulnerability index</td>
<td>-0.014***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>Voting Turnout in 2004 * Vulnerability index</td>
<td>0.013***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
</tr>
</tbody>
</table>

Observations 5,502
R-squared 0.729

Robust standard errors clustered at the microregion (557 total) level are in parenthesis. The regression is additionally controlled by population and per capita GDP. *** p<0.01, ** p<0.05, * p<0.1
Table 12- Two-stage least square regression using percentage of rural population in the past as instrumental variable; and share of the vote in favor of the gun ban and voting turnout in the referendum as dependent variables

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vote in favor of the gun ban</td>
<td>0.243** (0.095)</td>
<td>0.214** (0.101)</td>
<td>0.349** (0.144)</td>
<td>0.330*** (0.106)</td>
<td>0.286*** (0.077)</td>
</tr>
<tr>
<td>Voting Turnout</td>
<td>0.012*** (0.002)</td>
<td>0.012*** (0.002)</td>
<td>0.010*** (0.002)</td>
<td>0.011*** (0.002)</td>
<td>0.011*** (0.001)</td>
</tr>
</tbody>
</table>

Observations: 1,891 2,765 3,950 3,990 4,490

Robust standard errors clustered at the microregion level are in parenthesis. The socio-economic controls contain population, percentage of people living in rural areas in 2000, per capita GDP and average years of schooling. Columns (1) – (5) uses as instrumental variable, respectively, the percentage of rural population in 1950, 1960, 1970, 1980 and 1990. The table presents coefficients from a two-stage least squares model where the first stage calculates the predicted value of the vulnerability index as a function of the percentage of rural population (in 1950 – 1990, depending on each column number) and the remaining control variables mentioned above. The estimated coefficient for the vulnerability index as a function of percentage of rural population in 1950 – 1990 is respectively -1.56**, 2.76*, -2.15***, -2.82*** and **2***. Rows one and two show, respectively, how the instrumented vulnerability index affect the share of the vote in favor of the gun ban and voting turnout in the referendum. *** p<0.01, ** p<0.05, * p<0.1
Figure 1 – Yearly gun-related homicides (GRH) in the Brazilian territory (in thousand).

Notes: The data is available at DATASUS. The dashed line shows the total gun-related homicides, and the solid line shows the gun-related homicides concentrated on 15-29 years old people (close to 60% of the total gun-related homicides).
Figure 2 – Gun-related and non-gun related homicides trends

Notes: The top graph shows scatter plots representing the monthly gun-related homicides per 100,000 people and the bottom graph shows scatter plots representing the monthly non-gun related homicides per 100,000. The vertical line at month zero represents the intervention. The solid function is fitted using an OLS regression and the dashed line represents the 95% confidence interval. The part of the function after the intervention contains predicted values using the pre-intervention data. I regress first regress the dependent variables on calendar months, monthly rainfall and temperatures to take seasonality into account. Then, I regress the predicted residuals on time and pairs of cosine and sine functions.
Figure 3 – Effect of the concealed carry prohibition on gun-related homicides, non-gun-related homicides and total homicides per 100,000 people

Notes: Figure 3 shows three time-varying functions using a 12 months’ bandwidth and a vertical red line representing the cutoff point (January 2004). The solid line is fitted separately on each side of the threshold, and the dashed line represents the 95% confidence interval. The scatter plots show monthly averages. I regress the predicted residuals after regressing my dependent variables on calendar months, monthly rainfall and temperatures to take seasonality into account.
Figure 4 – Concealed prohibition effect on gun-related homicides (GRH), non-gun-related homicides (NGRH), total homicides and other crimes

Notes: Figure 4 shows, for each crime, two time-varying function using a 12 months’ bandwidth and a vertical red line representing first the placebo cutoff point (January 2003) and next the correct cutpoint (January 2004). The solid line is fitted separately on each side of the threshold, and the dashed line represents the 95% confidence interval. The scatter plots show monthly averages. I regress the predicted residuals after regressing my dependent variables on calendar months, monthly rainfall and temperatures.
Figure 5 – Average annual gun-related homicides (GRH) per 100,000 inhabitants

Notes: The solid line represents the municipalities with above median vulnerability index. The dashed line represents the municipalities with below median vulnerability index. All municipalities with more than 10,000 people are considered.
Figure 6 – Average enrollment in adult education per 100,000 inhabitants

Notes: The dashed line represents the municipalities with above median vulnerability index. The solid line represents the municipalities with below median vulnerability index. All municipalities with more than 10,000 people are considered.
Figure 7 – Relationship between voting for the prohibition and vulnerability index

Notes: The dashed line represents the least square estimation of the relationship between the residuals of the linear regression of support for gun control on population and income and the residuals of the linear regression of the vulnerability index on population and income. The regression considers all 47 neighborhoods of the São Paulo municipality for which the TSE provides information on.
Appendix
A1, F1 – Model specifications and restricting the bandwidth

I first show that the concealed carry prohibition effects on gun-related homicides are not sensitive to varying the model, presented on Table 1, specifications. Table A1 shows that adding an interaction between concealed carry prohibition enactment and closeness to the cutoff to capture a change in slope do not substantially change the results. When I use a Poisson regression I find that gun-related homicides were reduced by 10.36%.\(^{55}\) Adding fixed effects or Fourier terms do not impact the results as well. Finally, restricting the sample to municipalities with more than 50,000 and 100,000 people slightly change the concealed carry prohibition impact on gun-related homicides. In the former case, concealed carry prohibition reduces gun-related homicides by 3,753 in 2004 and in the latter, it reduces gun-related homicides by 4,027 in 2004. Both numbers are close to the original estimation of 3,900.

I then show that restricting the bandwidth to 6 months gives a similar result as the 12 months’ bandwidth. Figure F1 below provides a graphical representation of the discontinuities on homicides induced by the concealed carry prohibition. It shows three time-varying functions (6 months’ bandwidth) and a vertical red line representing the month (January 2004) in which concealed carry prohibition went into effect. The solid line is fitted separately on each side of the threshold, and the dashed line represents the 95% confidence interval. The scatter plots show monthly averages. I regress the predicted residuals after regressing my dependent variables on

\(^{55}\) As the coefficient of interest is a dummy variable, the interpretation of the Poisson estimation is intuitive. The percentage change in gun-related homicides is equal to \(e^{\hat{\beta}} - 1\). The 10.36% reduction in gun-related homicides is very close to the reduction estimated using the original model (10.8%). This result is not sensitive to municipalities’ threshold selection. For instance, when I restrict my sample to municipalities with more than 50 and 100 thousand inhabitants, I find respectively that gun-related homicides were reduced by 9.33% and 9.1% (all significant at the 0.01 level).
calendar months and monthly rainfall and temperatures. Therefore, I can take seasonality into account. As one can notice, the enactment of concealed carry prohibition led to a decrease in the number of gun-related homicides and homicides. The results are close to the ones presented in Figure 2 (12 months’ bandwidth).

A2 – Using a survey data as robustness check

To increase confidence in my results showing that exposure to gun violence explain vote in the referendum, I use a public opinion survey asking voters whether they would vote in favor of or against the gun prohibition. This survey took place two days before the referendum. The questionnaire also asked voters if they, themselves, were subjected to gun violence or if they had a family member or close friend who sustained a gun injury. The remaining survey questions relevant for this paper asked voters whether they had guns in their homes, if they were robbed at least once, if they would vote even if it was not mandatory to vote, and if they ever considered buying a gun to protect themselves. I also take race into account as blacks were disproportionately affected by the concealed carry prohibition. As the dependent variable is binary, I use a logistic regression to assess whether groups more likely to be benefitted by the concealed weapon ban (i.e. people more exposed to gun violence), voted more in favor of the gun prohibition.

Table A2 shows how personally being exposed to gun injury or having a close relationship with someone exposed to gun violence is an important predictor of casting a vote in favor of the prohibition. In accordance to the argument defended in this paper, people exposed to gun violence were 1.48 times more likely to vote in favor of the prohibition.\(^56\) Additionally, income, gun ownership, and ever considering to buy a gun was negatively related to voting in favor of the gun

\(^{56}\) 1.48 represents the ratio of the odds for being exposed to gun violence to the ratio of the odds for not being exposed, which is calculated by exponentiating the coefficient for being exposed to gun violence (0.393).
ban. Blacks were more likely to support the gun prohibition and the variable “would vote” showed that those willing to vote in the referendum, even if vote was not mandatory, were 1.76 times more likely to support the gun ban. This shows that people supporting the gun prohibition were more willing to politically participate in the referendum.

A3, A4 – Does timing matter?

This subsection investigates whether having an increase in gun-related homicides close to the election is important in explaining the vote for the gun ban. Angatuba, a small town (20,000 inhabitants) in the countryside of the state of São Paulo serves as an anecdotal evidence. Angatuba showed the largest support for gun ban in the São Paulo state, and one way to explain this support is through the gun-related homicide that happened in this municipality one month before the referendum took place. This is especially relevant in this case because Angatuba did not have gun-related homicides since August 2002. To test this argument for the whole country, I propose a variable that measures gun-related homicides’ deviation from the historical average. This variable is constructed to measure the impact of an increase in gun-related homicides, within one year of the referendum, on its outcome. Table A3 presents the estimated coefficient and shows that one deviation from the mean increases the support for gun prohibition by .62 percentage points Table A4 shows that this effect vanishes as the gun-related homicides’ deviation from the historical average happens further from the referendum, which I test by simulating different months in which the referendum took place (in which October 2005 is the correct month).

Formally, this variable is constructed as follows: \[ \text{Std. Death}_i = \frac{(\sum_{m=1}^{12} \text{deaths}_{mi}) - \text{Yearly Historical Average}_i}{\text{Standard Deviation}_i}, \] where \( \text{deaths}_{mi} \) indicates the number of gun related deaths at municipality \( i \), on month \( m \). More specifically, \( \text{deaths}_{12,i} \) represents the number of gun related deaths, at municipality \( i \), on the month in which the referendum happened (12). The Yearly Historical Average and standard deviation takes into account the period between 1996 and 2005. The monthly data on gun related death was collected at DATASUS.
Table A1 – RDD estimating the ED effect on Gun and Non-Gun related homicides

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Gun Related Homicides</th>
<th>(2) Non-gun Related Homicides</th>
<th>(3) Total Homicides</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED - original</td>
<td>-0.194***</td>
<td>-0.030</td>
<td>-0.224***</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.044)</td>
<td>(0.066)</td>
</tr>
<tr>
<td>ED - slope</td>
<td>-0.163***</td>
<td>-0.024</td>
<td>-0.188***</td>
</tr>
<tr>
<td></td>
<td>(0.052)</td>
<td>(0.045)</td>
<td>(0.069)</td>
</tr>
<tr>
<td>ED - fixed effects</td>
<td>-0.153***</td>
<td>-0.000</td>
<td>-0.153**</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.045)</td>
<td>(0.067)</td>
</tr>
<tr>
<td>ED - sine, cosine</td>
<td>-0.249***</td>
<td>-0.017</td>
<td>-0.266***</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
<td>(0.056)</td>
<td>(0.085)</td>
</tr>
<tr>
<td>ED - Poisson</td>
<td>-0.109***</td>
<td>0.030</td>
<td>-0.069***</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.040)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>ED - 50,000</td>
<td>-0.284***</td>
<td>-0.057</td>
<td>-0.341***</td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td>(0.053)</td>
<td>(0.099)</td>
</tr>
<tr>
<td>ED - 100,000</td>
<td>-0.324***</td>
<td>0.010</td>
<td>-0.315**</td>
</tr>
<tr>
<td></td>
<td>(0.103)</td>
<td>(0.066)</td>
<td>(0.123)</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at the municipality level are in parenthesis. Bandwidth is equal to 12 months. All regression control for calendar months, rain and temperatures. Rows 1 – 4 consider municipalities with more than 10,000 people and contains 71,492 observations. Row 1 uses the original estimation presented on Table 1. Row 2 adds the interaction between the dummy for ED enactment and \((r - c)\) term in equation (1). Row 3 adds fixed effects. Row 4 adds sine and cosine functions and their interaction. Row 5 uses the Poisson regression model with municipality fixed effects and uses homicides counts instead of homicides rates as dependent variable. This model drops municipalities that contains all zero outcomes, therefore, the number of observations for columns 1, 2 and 3 are respectively 54,194; 56,682 and 63,504. Row 6 and 7 use the original estimation, but restrict the sample to municipalities with respectively more than 50,000 and 100,000 people. Row 6 and 7 contain respectively 13,906 and 6,227 observations. *** p<0.01, ** p<0.05, * p<0.1
Table A2 – Logistic regression showing the relationship between exposure to gun injury and voting in favor of the prohibition

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Vote in favor of the prohibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly household income</td>
<td>-0.103***</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
</tr>
<tr>
<td>Blacks</td>
<td>0.299***</td>
</tr>
<tr>
<td></td>
<td>(0.100)</td>
</tr>
<tr>
<td>Have gun</td>
<td>-1.287***</td>
</tr>
<tr>
<td></td>
<td>(0.215)</td>
</tr>
<tr>
<td>Injured by a gun</td>
<td>0.393***</td>
</tr>
<tr>
<td></td>
<td>(0.106)</td>
</tr>
<tr>
<td>Age</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
</tr>
<tr>
<td>Men</td>
<td>-0.044</td>
</tr>
<tr>
<td></td>
<td>(0.101)</td>
</tr>
<tr>
<td>Would vote</td>
<td>0.569***</td>
</tr>
<tr>
<td></td>
<td>(0.097)</td>
</tr>
<tr>
<td>Considered buying a gun for protection</td>
<td>-0.952***</td>
</tr>
<tr>
<td></td>
<td>(0.127)</td>
</tr>
<tr>
<td>Robbed</td>
<td>-0.094</td>
</tr>
<tr>
<td></td>
<td>(0.116)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,925</td>
</tr>
</tbody>
</table>

Robust standard errors (in parenthesis). *** p<0.01, ** p<0.05, * p<0.1
Table A3- OLS regression showing the relationship between voting in favor of gun prohibition (dependent variable) and gun-related homicides’ deviation from the historical average.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Vote in favor of the prohibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>gun-related homicides std.</td>
<td>0.622** (0.262)</td>
</tr>
<tr>
<td>Observations</td>
<td>5,505</td>
</tr>
<tr>
<td>Number of Microregion</td>
<td>557</td>
</tr>
</tbody>
</table>

The regression use microregion fixed effects and robust standard errors are adjusted for clusters at the microregion level. It is additionally controlled for women to men ratio, CCT spending per capita, ideology distance to capital, income per capita, number of cattle per rural worker, population, rural population, vulnerability index, drought, land protest, public distribution of agricultural land. *** p<0.01, ** p<0.05, * p<0.1
Table A4 – OLS regression simulating different dates in which the referendum took place

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>gun-related homicides std.</td>
<td>0.622**</td>
<td>0.604**</td>
<td>0.514*</td>
<td>0.438</td>
<td>0.467*</td>
<td>0.310</td>
<td>0.346</td>
<td>0.072</td>
<td>0.089</td>
<td>0.181</td>
</tr>
<tr>
<td></td>
<td>(0.263)</td>
<td>(0.276)</td>
<td>(0.284)</td>
<td>(0.289)</td>
<td>(0.271)</td>
<td>(0.276)</td>
<td>(0.269)</td>
<td>(0.267)</td>
<td>(0.277)</td>
<td>(0.280)</td>
</tr>
<tr>
<td>Observations</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
<td>5,505</td>
</tr>
<tr>
<td>Number of Microregion</td>
<td>557</td>
<td>557</td>
<td>557</td>
<td>557</td>
<td>557</td>
<td>557</td>
<td>557</td>
<td>557</td>
<td>557</td>
<td>557</td>
</tr>
</tbody>
</table>

The regressions use microregion fixed effects and robust standard errors are adjusted for clusters at the microregion level. It is additionally controlled for women to men ratio, conditional cash transfer spending per capita, ideology distance to capital, income per capita, number of cattle per rural worker, population, rural population, vulnerability index, drought, land protest, public distribution of agricultural land. *** p<0.01, ** p<0.05, * p<0.1
Figure F1 – The concealed carry prohibition effects on total homicides, gun-related homicides and non-gun-related homicides

Notes: Figure F1 shows three time-varying functions using a 6 months’ bandwidth and a vertical red line representing the cutoff point (January 2004). The solid line is fitted separately on each side of the threshold, and the dashed line represents the 95% confidence interval. The scatter plots show monthly averages. I regress the predicted residuals after regressing my dependent variables on calendar months, monthly rainfall and temperatures to take seasonality into account.