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Traffic safety or Public safety? The effect of Lei Seca's blitzes

Monografia de Final de Curso

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Declaro que o presente trabalho é de minha autoria e que não recorri, para realizá-lo, a nenhuma forma de ajuda externa, exceto quando autorizado pelo professor tutor.

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Abstract

This paper examines the impact of Lei Seca Operations on crime deterrence in Rio de Janeiro, Brazil. Utilizing a quasi-experimental design, we analyze the effect of increased police presence, specifically through Lei Seca blitzes, on the occurrence of shootings. We explore the spatial and temporal dynamics of crime in relation to police interventions by leveraging geographical data of Lei Seca Checkpoints and armed shootings in the Rio de Janeiro State area. Our findings indicate that the presence of Lei Seca Operations does not significantly reduce the probability of shootings within 100, 500, or 1000 meters from the operation points. These results suggest that certain types of policing, even those not directly aimed at crime deterrence, may not effectively influence criminal activity in specific contexts. This study highlights the importance of tailored policing strategies and the need for further research into the interaction between different forms of police presence and various types of crimes.

Keywords

Crime, Deterrence, Economics, Policing, Public Safety, Crime Prevention, Law Enforcement, Spatial Analysis, Temporal Analysis

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1 Introduction

There is a growing global discussion towards public safety, more specifically if Policing actually increases it from the average citizen point of view, and also the consequences of elevated crime rates towards weaker, poorer economies. This discussion is exacerbated in a country like Brazil, which “boasts” the unfortunate title of having the higher total number of homicides in the world, with 47502 homicides in the year of 2023 alone, according to the Homicide Monitor from ([Igarapé Institute, 2024](#)).

In this article I utilize a new quasi-experimental change in policing, the Lei Seca Operations, to try and isolate the true effect of Police presence in crime. Notably, a rather big part of the deterrence literature uses quasi-experiments to infer the impact of a growing police presence in crime. This approach faces a well-known challenge that an increase in policing is usually driven by a previous increase in crimes, resulting in a cyclic chain of mixed effects between those two that serves as confounding factors. This paper also highlights an addition problem that is pertinent to any study on quasi-experimental inference of the police’s criminal deterrence capability: some policing-allocations destined to combat less violent crimes, like drunk-driving, may avoid extremely violent areas, what induces a reverse causality issue when dealing with those type of crimes.

The literature regarding the effect of augmented policing on crime is scarce, as the context basically forces researchers to look for quasi-experiments in order to confidently isolate the estimated impact. Even though this is a limitation per-se, the papers that do get confident results point that any government intervention, not only policing, leads to a local decrease in crime occurrences (([CHALFIN; MCCRARY, 2017](#)),([TELLA; SCHARGRODSKY, 2004](#)),([LEVITT, 1997](#)),([CHALFIN et al., 2021](#))), following the theory formalized in the pioneering and renowned contribution of **Gary Becker’s** seminal work, titled “Crime and Punishment: An Economic Approach” ([BECKER, 1968](#)). The results in this paper indicate that not all crimes are affected negatively or at all by public place interventions. On the other hand, this paper presents a new quasi-experiment situation towards increased policing and, more generally, state presence, specially at night, which are rare in Rio de Janeiro.

In order to assess the impact of policing in crime in an exogenous manner, I analyze a program called “Lei Seca Operation”, designed to enforce a federal Brazilian law that explicitly prohibits driving if any alcohol was consumed by the person. The program is concerned as extremely successful, specially in the State of Rio de Janeiro, and has a specific modus-operandi focused on harsh penalties, planning, secrecy of place allocation and perceived “randomness” of driver selection within

those that pass through the Operation. Since those harsh penalties include prison and car forfeiting in some cases, a group of police officers is designated to every Lei Seca Operation, independently from there having a police patrol near the place or not.

I gather two databases, both establish the geographical locations of the two sets of events used in my paper: Lei Seca Operations and armed shootings. Firstly, I explored an X (ex-Twitter) page's website which uses public contributions to promote the written locations of Lei Seca Operations every day since August, 2020, I then pin down their exact location by using a geolocation by string service from Google Maps. On the other way, I used an already ready database of all the reported shootings in Rio de Janeiro, along with news and official Government records (all gathered by a Brazilian NGO focused in bringing awareness to armed violence in Brazil's metropolis) to gather information on crimes.

I first show that the Lei Seca Operations are quite frequent over the last years, being a regular, constant presence in the Rio de Janeiro State. For example, within the sample, I was able to identify over 4600 unique addresses in which a Lei Seca Operation happened, with most of them having repeated observations over time. The number of observations per address varies greatly in this sample, ranging from 1 to 47 operations in the same address, and the spacing (in days) between each repetition and the next is virtually impossible to define precisely. I then show that Lei Secas are roughly balanced through each day of the week as well, while the organization obviously favors slightly Fridays and the weekend. All this leads us to believe that Lei Seca Operations placement are not motivated by any other crime-type but drunk-driving while also having police presence, thus representing an adequate quasi-experiment environment.

Then, I explore the main crime source we have, shootings, and define that they are concentrated among neighborhoods and among certain spots within those neighborhoods, with just 788 localities experiencing over 18760 (approximately 50% of the accumulated total) shootings from 2017 until 2023. Besides that, I also comment that, even though shootings are rarer than other less violent and attention-grabbing crimes, they are quite frequent in the State of Rio de Janeiro due to its violent context of territorial dispute between the Government, Drug Trafficking Organizations and Paramilitary Groups. This dispute also affects many other public services and human capital formation as argued by (MONTEIRO; ROCHA, 2017) and (CAVIGIAS; BRUCE; MELONI, 2023).

Employing an Ordinary Least Squares (OLS) approach, I estimate the effect of policing (via Lei Seca Operations) on the probability of shootings occurring within

100m, 500m, and 1000m from an address, comparing days with and without Lei Seca operations. Since Lei Seca Operations are not designed to combat other crimes, this study offers a model for exploring exogenous variations in policing relative to most crimes, with potential extensions to neighboring blocks or subsequent days. The limitations of this empirical strategy include the lack of granular official crime data, preventing its application to street-level crime, which is most affected by police presence at night. Additionally, the potential reverse causality between shootings near Lei Seca spots and Lei Seca operations could bias results, as operation planners may avoid active shooting areas to ensure safety.

The result suggest the presence of increased policing does not affect the probability of a shooting happening in any small or medium distance from the spot. None of the results were either economically or statistically significant or different from zero. Although not what was expected, these null results can tell us much about crime behavior. Not all crime is affected by increased police presence, some modals of targeted interventions have not effect on certain types of crimes. Lei Seca Operations do not aim to combat drug trafficking, for example, they have lots of civilians working and care to make the driving context in Rio de Janeiro safer. This divergence underscores the necessity for tailored policing strategies that address the unique crime dynamics of different areas. The results imply that interventions need to be context-specific and highlight the limitations of generalized policing measures. Furthermore, these findings prompt a deeper investigation into the types of crimes that are more susceptible to deterrence through visible police presence and those that require more specialized law enforcement tactics.

The main contribution of this paper is the introduction of a new quasi-experimental design using Lei Seca Operations to explore exogenous variations in policing and government presence. By leveraging the unique operational characteristics and geographical dispersion of Lei Seca checkpoints, this study provides a robust framework for understanding the broader impacts of non-crime-targeted police interventions on crime rates. The findings of this research have significant implications for public policy and urban safety strategies, suggesting that certain types of policing, even those not directly aimed at crime deterrence, can influence criminal activity in complex ways. Additionally, this study underscores the importance of considering spatial and temporal factors in the allocation of police resources, advocating for more nuanced approaches to crime prevention. Future research could build on these insights by exploring the interplay between various forms of police presence and different types of crimes, potentially informing more effective and targeted law enforcement strategies. This research also opens avenues for examining the socio-economic impacts of

policing policies, contributing to the broader discourse on public safety, governance, and urban development.

2 Literature Review

Despite the numerous contributions to the literature on crime deterrence, a pervasive challenge lies in securing variations in crime-fighting policies that are not confounded by external factors. This predicament is characteristic of the economic discipline, where achieving exogenous shifts in crime combat policies remains a formidable task.

The crux of the matter resides in the reactive nature of crime-reduction public policies, predominantly responsive to criminal incidents rather than proactively designed for prevention.

To illustrate, a seemingly straightforward regression model:

$$CrimeOccurrences_t = \beta_0 + \beta_1 \cdot Crime\ fighting\ Policy_t + u_t \quad (2.1)$$

is inherently flawed due to simultaneity bias. This arises from the influence of the variable $CrimeOccurrences_{t-1}$ on both the dependent and independent variables in the model.

However, the focus of this paper is not specific towards conventional crime-fighting policies, such as increased police presence. I pretend to explore how crime responds to subtle, unexpected alterations in the environment.

From the economics perspective, the best-regarded paper on this subject is (TELLA; SCHARGRODSKY, 2004). The authors argue that extreme and targeted criminal events, such as a anti-Jewish terrorist attack, provoked a exogenous change in policing in certain blocks of Buenos Aires. Most specifically, the blocks with either Jewish or Muslim buildings or institutions received police protection as of a federal government issued-order. Since the geographical distributions of these buildings can be assumed to be exogenous to crime concentration, the authors identified a way to proxy exogenous Police Allocation with the location of those. Therefore, using data on the number of motor vehicle thefts per block for three Buenos Aires neighborhoods, along with the location of every known Muslim or Jewish buildings in this area, the authors were able to successfully estimate the effect of police presence of car theft. Di Tella and Schargrodsky found a negative, significant relationship between those two variables using a diff-in-diff estimator, relative to the control group, car thefts fall by 75% relative to the control group. That being said, the authors find that the effect of police presence is extremely local, police presence did not influence car theft one or two blocks away from the protected building's block. They did not investigate the exact cause of this fact. Another interesting choice by this article was the type of crime investigated, car theft was selected because of two factors: 1- Car insurance as it is requires police intervention to be activated (hence,

under-reporting is not an issue in this type of crime as it is in others, argue the authors) 2- Car theft is expected to be extra-sensitive to police presence, since it requires planning and significant organization by the criminal.

Some articles, specially in the late 1990's and early 2000's tried to tackle this matters using instrumental variables. ([LEVITT, 1997](#)) argues that police presence is affected by electoral cycles, but not the other way around. In his study, the author examines the correlation between electoral cycles and police recruitment, utilizing the timing of gubernatorial and mayoral elections as a determinant for police presence. The analysis spans 59 major U.S. cities from 1970 to 1992. Levitt discovers a significant and negative impact of police on violent crime when using 2SLS (Two Stages Least Squares), notably with murder displaying the largest and only significant coefficient. There are potential concerns about the instrument's validity (specially ([MCCRARY, 2002](#))), which Levitt addresses some by incorporating controls for the unemployment rate and public spending. Nevertheless, he acknowledges that police activities, crime reporting, and hiring may also respond to election timing, especially if the police become subject to political manipulation. Similarly, the behavior of judges and prosecutors might be influenced by elections, potentially leading to a logical reduction in criminal activity during such periods. For most of the papers using instrumental variables, there have been critics and negative comments, as most of them suffer from the high chance of endogeneity in-between their model.

A recent paper approaches crime-fighting in a different way, ([CHALFIN et al., 2021](#)) explores the effect of more subtle changes in the environment ("nudges") over crime. This article is based upon a RCT ran in New York City in which the researchers randomly increased street-lighting in New York City streets. This study, made possible by a unique partnership between the New York City Mayor's Office for Criminal Justice (MOCJ), the New York City Police Department (NYPD), and Housing Authority (NYCHA), offers one of the only experimental piece of evidence on the effectiveness of street lights in controlling street crime. The randomization, as in the article ([TELLA; SCHARGRODSKY, 2004](#)), was made in a block-based unit, with some blocks receiving extra-lighting, and some staying as the control group. Besides this geo-localized date, the result also proxys crime with data from the NYPD criminal complaints from March 2011 through August 2016. The results were encouraging, the authors were able to conclude that, inclusive of potential spillovers, the increase of lighting reduced outdoor nighttime index crimes by 36%. This result is also particularly encouraging due to the nature of the policy applied, the provision of street lighting. The authors argue that this hardly as costly as the

increase of police presence, and could be of substantial importance for the context of this particular thesis, since the Rio de Janeiro State is undergoing a fiscal crisis as of the year os 2016. Public safety was the biggest item in Rio de Janeiro's state budget in 2021, according to Jornal O Globo ([RIO, 2021](#))), but the city is still seen as extremely unsafe for locals and tourists. This affects tourism in a large-scale, as more and more violence is shown to the world, less people want to visit the city, as argued by ([NEUMAYER, 2004](#)). However effective this paper may be, it worth to notice that this is one of the only known RCT's with the objective of studying crime behavior under specific changes to the environment. Cases like this are extremely rare, in part because they require the collaboration of thousands of person, partly because they are not exactly attractive to short-term-thinking politicians, as they don't gather many votes or attention.

There is a common-spread economical sense of how criminals think and act in economics since the publication of ([BECKER, 1968](#)), but very few articles have managed to approach this issue in an appropriate manner. In this paper, I aim to contribute to this literature by studying the effect of a natural experiment in authority presence on crime. Since the Lei Seca Operations are not designed in order to combat street crime, their location won't be affected by the previous street crime rate of a certain location. Crime will be affected because it is of public knowledge that every Lei Seca operation has mandatory police presence. **Consequently, the Lei Seca Operations can affect crime without being affected by its lags, configuring a natural experiment.** Therefore, Lei Seca Operations offer us a rare exogeneity on the study of Police Presence of crime. This exogeneity appears in two ways: time and space. The time feature is expressed on the discontinuity represented by a Lei Seca Operation, which rarely repeat the day of the week they appear at a given place, for this reason, the day is random to the external eye (that being on the eyes of the criminal or the victim). The place feature represents a more traditional approach, which was used by ([TELLA; SCHARGRODSKY, 2004](#)) and ([CHALFIN et al., 2021](#)), as explained above. The location of the Lei Seca Operation varies each day, and the specific site chosen by the authorities remains undisclosed to the public. Consequently, the selection of the location, whether it'll be a particular block or the next one, serves as another source of exogenous change.

3 The Lei Seca Operation

3.1 Context

The term “Lei Seca,” which translates to the “Dry Law” in English, refers to a comprehensive and stringent law enforcement initiative in Brazil aimed at reducing drunk driving and promoting traffic education. The Lei Seca actively establishes a prohibition of driving under the influence of alcohol or any other psychoactive substance that causes dependency in all of Brazilian territory.

Although an instituted law should be followed by all, many of the states governors felt the need to fiscalize the citizens compliance of it via a well-coordinated operation. This operation is primarily conducted by the Brazilian Transport Department (DETRAN) and often involves a multifaceted and multi-institutional approach to address the issue of alcohol-impaired driving. These operations have been organized since Law 11507 ([Congresso Nacional Brasileiro, 2008](#)) was enacted by the National Congress.

3.2 Modus-Operandi

The Lei Seca has been particularly successful since its start in 2009, resulting in a decrease of over 50% in traffic deaths nation-wide. Much of this success is due to its highly efficient *modus-operandi*, which follows as such:

1. **“Random” Alcohol-Checkpoints**

The main (physical) enforcement strategy of the Lei Seca Operation is constant and **strategic sobriety testing**. This testing takes place in **random** checkpoints, where cars are randomly selected by standing personnel (selected DETRAN officers and police officers).

2. **Zero Blood Alcohol Concentration Policy**

At the start of the program, the Lei Seca Operation had a certain tolerance for the selected driver’s Blood Alcohol Concentration (BAC), with a threshold of 0.6 ml/Liter of blood. However, to further ensure street safety, the limit was brought down to just 0.05 ml/Liter, which is virtually zero.

3. **Random and Transitory Personnel-Checkpoint Allocation**

The location where each officer, both from DETRAN and the Police, will be placed is only known in advance by a dozen highly trained and supervised personnel. The rest of the operation only gets to know their allocation 2 to 3 hours before the Lei Seca Operation takes place. This practice ensures that

these operations are not expected by the public, avoiding a sense of “safety” from the checkpoints that could induce people to drink and drive more often if they knew the locations in advance.

4. **Harsh Penalties**

Drivers found to be in violation of the legal limit (which is now **zero**) or driving under the influence of drugs face a range of penalties. These penalties include fines, temporary suspension of driving privileges (from 6 to 24 months), vehicle impoundment, and, in severe cases, criminal charges, potentially leading to imprisonment in case of recurrence, according to ([DETRAN-RJ, 2018](#)).

5. **Data Analysis and Planning**

Every piece of information from each checkpoint is recorded and analyzed in the planning of new operations, to maximize street safety and avoid redundancy. A chapter of this article will be dedicated to explaining more about this data and the process required to access it.

3.3 Focus on Rio de Janeiro

Although the Lei Seca is a federal Law, the Lei Seca Operations are primarily focused at Rio de Janeiro. At its start, there was an attempt to apply to other cities, but the Operations did not manage to actively reduce alcohol-consumption by other state’s drivers, only in Rio.

This was mostly due to the street distribution of the cities. Rio has many roads that can be easily targeted by the Lei Seca Operations since the drivers have no way to “escape”, meaning take other way so they avoid the alcohol-check at the blitz. This was not true in many other cities, like São Paulo, in which the drivers, once knowing where the operation was located, were able to easily divert from that way, ending up in socially and financially frustrating results for the Lei Seca Operations in the city. Since these Operations demand quite some personnel, organization and time, disappointing results ended up in the Lei Seca Operations only being carried on the state of Rio de Janeiro, but most specifically in the state’s capital.

As per its effectiveness in promoting road safety, ([RIO, 2023](#)) showed (using data from ([BRASIL,](#))) that even with the 2nd highest population of the country, the Rio de Janeiro State has the lowest rate of Deaths from traffic accidents related to alcohol use in 2021 per 100,000 inhabitants.

4 Data

In the pursuit of compiling a comprehensive dataset regarding crime and Lei Seca activities in the Federal Unit of Rio de Janeiro, three distinct sources of information were employed. These sources offer invaluable insights into different aspects of public safety within the region, ranging from daily reports on Lei Seca Operations to hourly crime data and firearm shooting incidents. Below are the sources utilized:

4.1 Lei Seca RJ- Twitter/X Page

4.1.1 Data Description

This dataset originates from the administrative website of the "Lei Seca RJ" X (formerly on Twitter) account. The account regularly publishes daily reports detailing the approximate locations where Lei Seca Operations take place.

With a substantial following of over 4 million users, this privately-run, not-for-profit Twitter account serves as a platform for citizens to share information about Lei Seca Operations, enabling others to avoid these areas, particularly if they anticipate traffic congestion or have concerns about impaired driving. It's important to acknowledge that these reports primarily rely on user-provided information via X.

The reports are published in a consistent pattern, as illustrated in Figure 1.



Figure 1 – Text circled in red: **Neighborhood**; Text underlined in blue: **informal description of the exact location**

Subsequently, I manually compiled the information from these reports into a database. Following data cleaning procedures, I extracted crucial details such as the weekday, exact date, neighborhood, and informal user-provided descriptions of the operation locations.

However, while informative, this dataset lacked precise geographical coordinates. To address this limitation, I utilized the Google Maps API, successfully obtaining the exact latitude and longitude for up to 97.5% of the 4825 unique addresses provided in Lei Seca Operations reports, spanning from August 2020 to the conclusion of 2023.

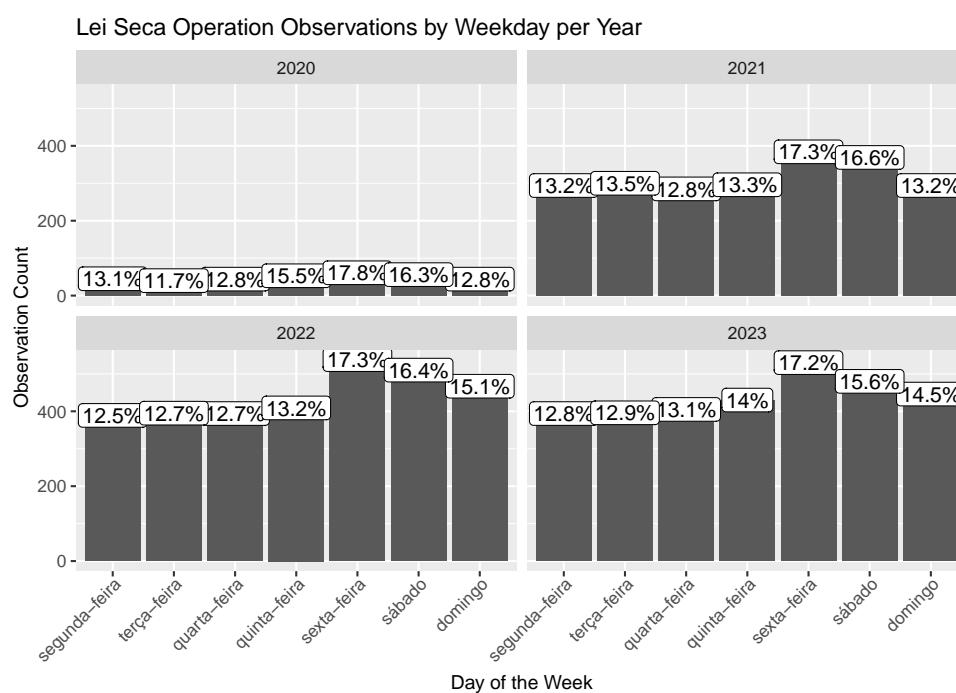
4.1.2 Database Details and Descriptive Statistics

In the analysis of the Lei Seca Operations database generated by the process detailed thoroughly in Section 4.1.1, three noteworthy observations have emerged, illuminating the distribution patterns of Lei Seca Operations.

1. Distribution of Lei Seca Operations by weekdays is constant

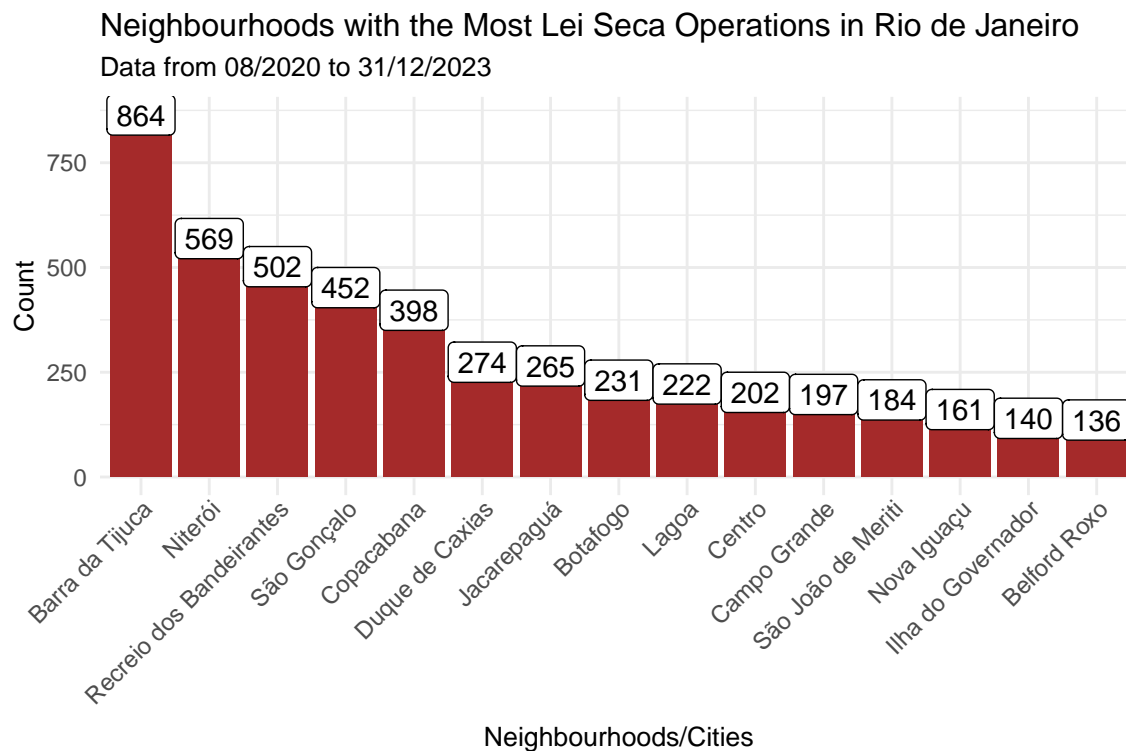
Here it is stated that the number of Lei Seca Operations is constant throughout Friday to Sunday (the most relevant days, considering that people tend to drink and drive more on the weekend) in each year of our sample, as it can be seen in the plot below.

Notably, small daily variance is observed, with the most substantial variations occurring between Wednesday and Thursday, remaining within a range of just four percentage points.



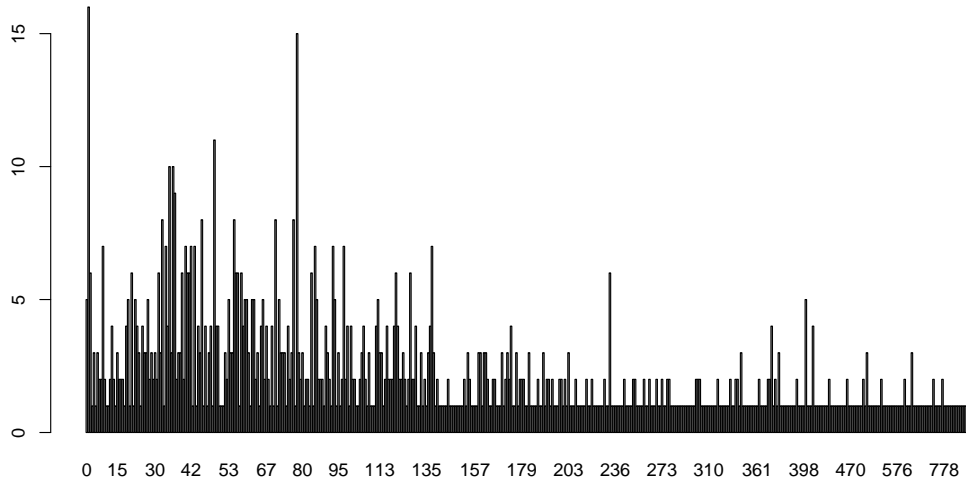
2. LS Operations are concentrated by neighborhood and street

Another fact I was able to spot is that Lei Seca Operations are indeed concentrated in specific neighborhoods (and streets within them). No official government agency publishes the reasons that lead this concentration to happen, but this is a well-known fact for residents of Rio de Janeiro. We can prove this by exploring the distribution of Lei Seca Operations by neighborhood in the histogram below.

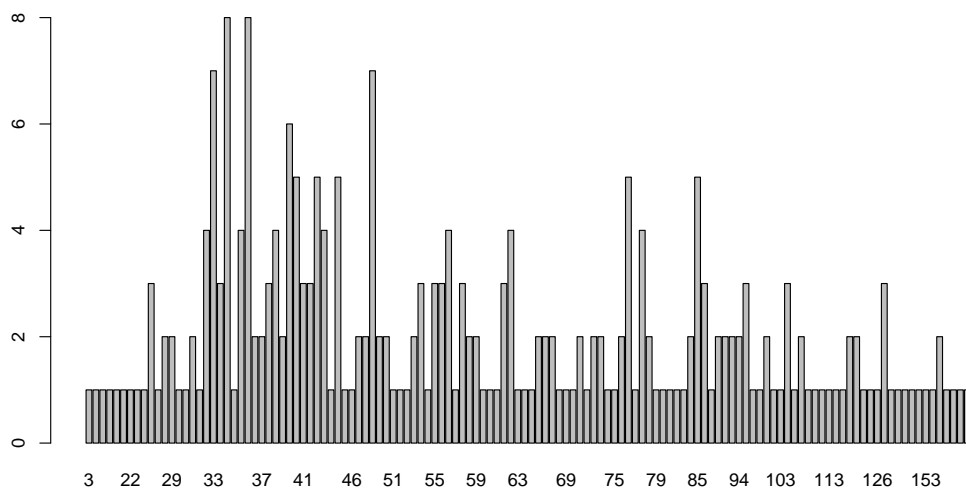


3. The Day a LS Operation will happen in a certain address is unpredictable

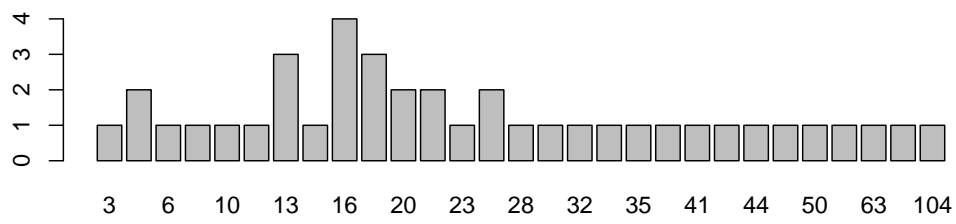
Lastly, it is noticeable that the distribution of the days interval between two Lei Seca Operations in the exact same address is highly disperse, although skewed towards the interval between the 7 and 90 days interval. As we can see on the frequency tables below, this can be observed when we use data from 3 different sub-samples:



(a) The whole state of Rio de Janeiro



(b) Only the top quartile of addresses with the most LS operations in the State



Frequency count- Day intervals in the top LS location in Rio de Janeiro- 08/20-12/23

(c) The location with the most Lei Seca operations ever

Figure 2 – Days between Lei Seca operations

4.2 Firearm Shooting Incidents - Fogo Cruzado NGO

4.2.1 Data Description

This dataset comprises firearm shooting incidents that occurred in the State of Rio de Janeiro from 2017 until the end of 2023.

In addition to receiving notifications directly from users via the Fogo Cruzado mobile application and social media platforms, the data management team at Fogo Cruzado receives direct information from partners (those which they do not elucidate on) operating in the field. These partners include local collectives, communicators, and residents who are actively engaged in the community. The Fogo Cruzado team also aggregates information collected from press sources and official police channels into their databases. Fogo Cruzado makes all their data available via an API, which is how I collected the data for all the recorded shootings in Rio de Janeiro in the 2017-2023 period, most including latitude, longitude, date and exact time of the report.

4.2.2 Database Details and Descriptive Statistics

While analysing this database, a series of topics and unique characteristics surrounding the type of crime studied (firearm shootings), their implications and its hotspots. It is important to say that the results were generated for the **full sample (shootings reported from 01/2017 till 12/2023)** and the **Sample used in the model, which fitted the Lei Seca Database timeline (shootings reported from 08/2020 until 12/2023, named Regression Sample)**.

1. Shootings are quite frequent in Rio de Janeiro

Shootings are a violent crime, if one is charged with that, the person will be facing multiple years in prison and other mild penalties in addition, specially if the armed shooting is part of another crime as robbery or murder for example, which is mostly the case, as it can be observed in table 1 below:

Table 1 – Police Presence and Number of Occurrences by Reason of Shooting

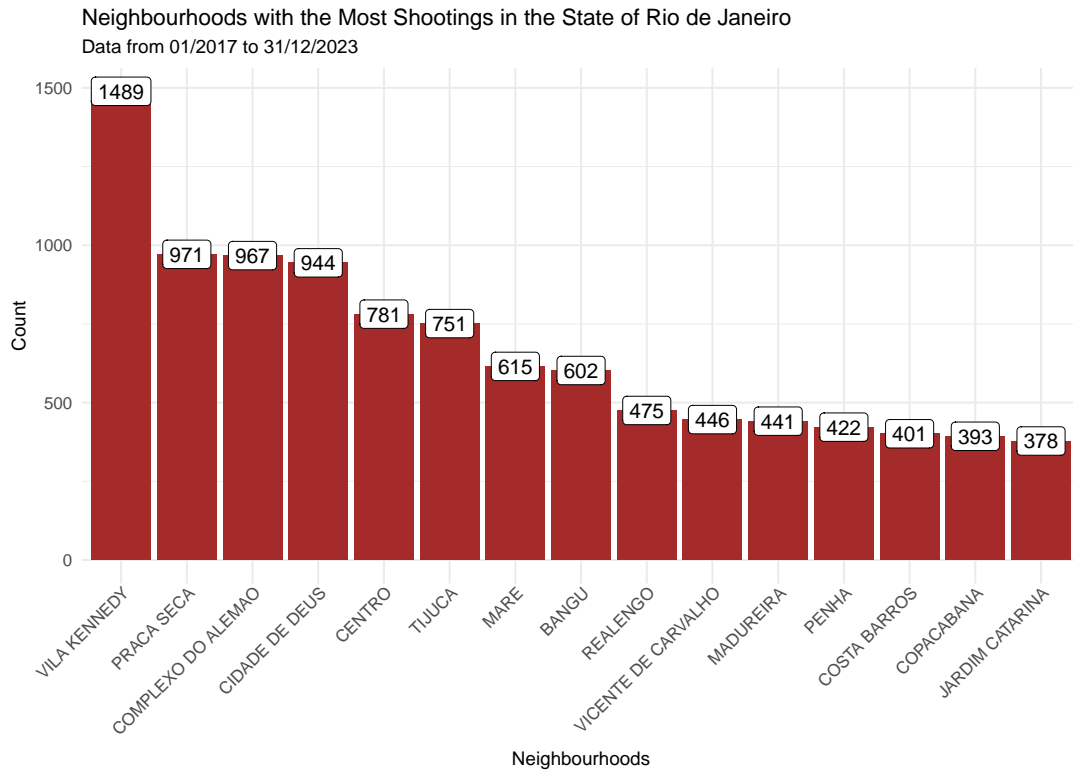
Reason for Shooting	Presence of Government Agents	Number of Occurrences
Police action	100%	6074
Police operation	100%	3344
Homicide/Attempt	13.65%	2381
Attempted robbery	64.7%	1997
Dispute	11.44%	708
Fight	43.03%	251
Arrastão	60.76%	79
Attack on civilians	10.29%	175
Random shooting	12.6%	127
Attempted cargo robbery	85.92%	277
Accidental discharge	17.65%	17
Torture	16.22%	37
Attempted bank robbery	73.91%	69
Kidnapping/Hostage situation	69.05%	42
Other	20%	15
Suicide	100%	6
Rebellion/Escape of prisoners	100%	1

Shootings, typically rare and significant, are frequent in Rio de Janeiro due to ongoing conflicts between Drug-Trafficking Organizations, Paramilitary Groups, and the Police Force (as defined by (CAVGIAS; BRUCE; MELONI, 2023)). Corruption and territorial battles exacerbate daily shootings in impoverished neighborhoods, endangering lives and disrupting services (as exemplified in (MONTEIRO; ROCHA, 2017)). The table below shows this, with an average of over twenty daily shootings from 2017 to 2019, with a sustained high average of over nine daily shootings post-COVID-19.

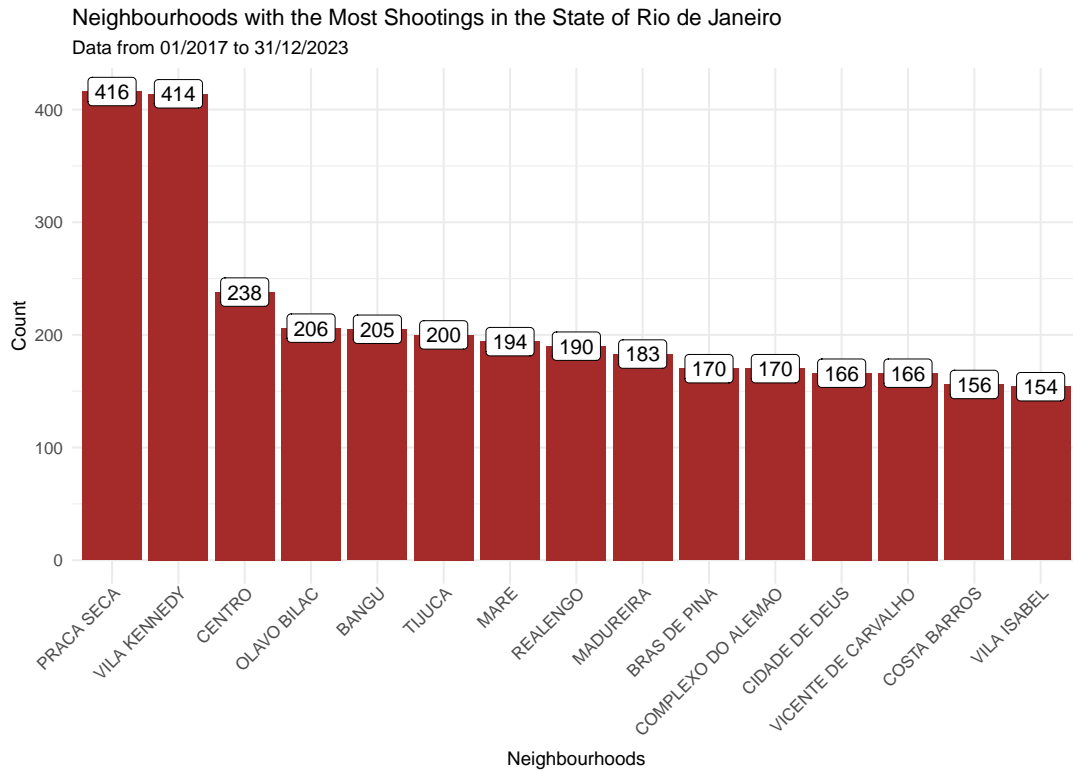
Table 2 – Shootings Database - Numbers used in the Regression Sample

Year	Total Yearly Shootings	Shootings per Day (mean)	Percentage Change
2017	5444	14.92	
2018	9633	26.39	+76.95%
2019	7368	20.19	-23.51%
2020	4585	12.56	-37.77%
2021	4651	12.74	+1.44%
2022	3589	9.83	-22.83%
2023	2952	8.09	-17.75%

2. Shootings are strongly concentrated within certain neighborhoods



(a) Full Sample



(b) Regression Sample

3. Shootings are strongly concentrated within certain locations

To show the strongly unbalanced distribution of shootings per location in Rio de Janeiro, we plot a Lorenz Curve (as defined in (LORENZ, 1905)) of all the shootings per unique combination of Latitude and Longitude we could pull from the shootings database.

Even though this range of locations does not grasp all the locations in a city as large as Rio de Janeiro, which has millions of addresses and thus is a biased distribution of geographical points, we observe in figure 4 that just 6.51% of the geographical points gather 50% of the armed shooting occurrences in the full sample (for the restricted sample, this number increases to approximately 12.34%, as seen in figure 5).

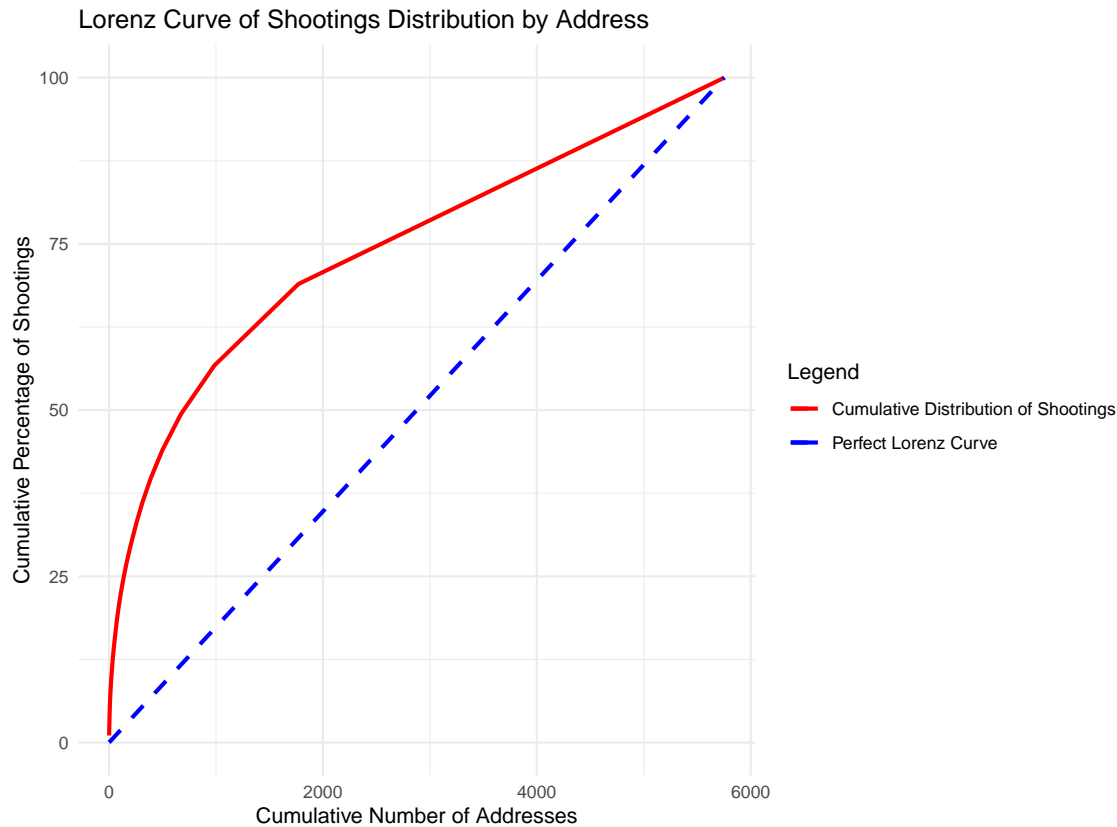


Figure 4 – Lorenz Curve of Shootings per Location (Full Sample)

Cumulative distribution of the shootings per address in the State of Rio de Janeiro
Over 50% of the shootings happened in only 6.51% of the addresses from 2017 till 2023

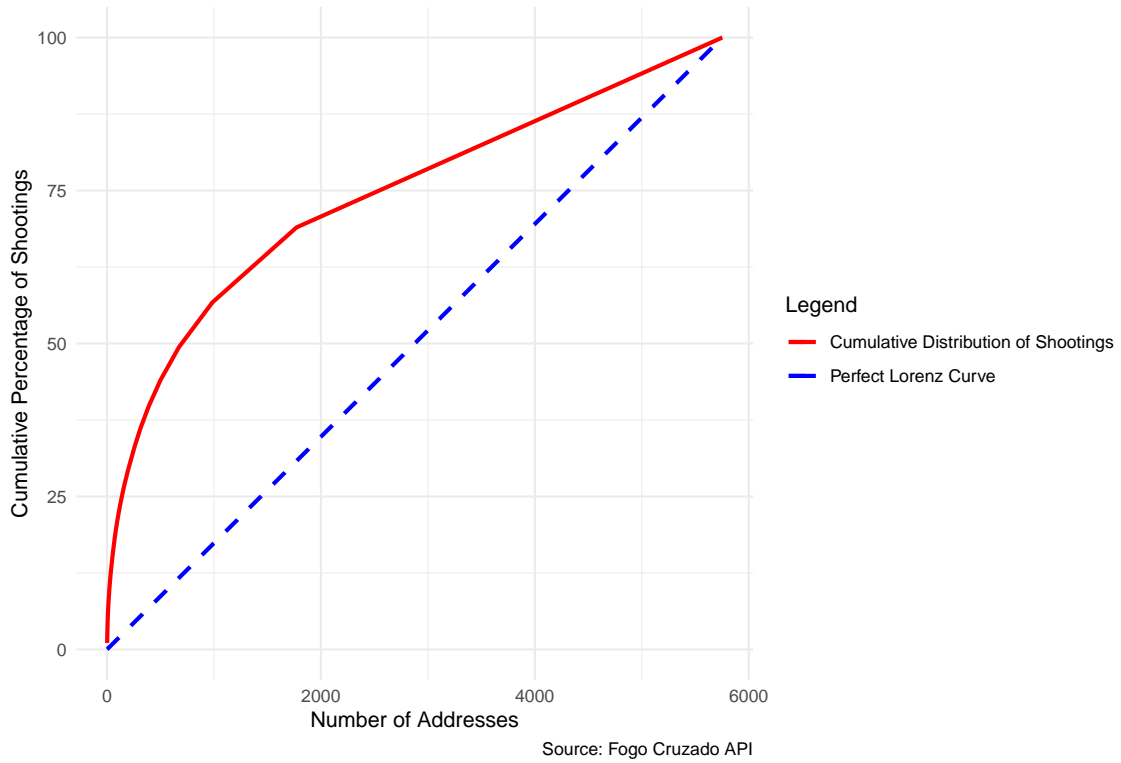


Figure 5 – Lorenz Curve of Shootings per Location (Regression Sample)

5 Empirical Strategy

5.1 Model

In order to explore the relationship between Lei Seca Operations and Crime Deterrence, I'll develop an empirical model based on geo-referenced data for both crimes (in this case, firearm shootings) and Lei Seca Checkpoints, using multi-variate regressions. I plan to explore the role of a (supposedly) random Lei Seca Checkpoint in crime activity, and explore criminal behavior when dealing with authority presence.

I obtain the OLS estimator for the effect of Authority Presence on the Probability of a Crime occurring in a certain address using the following model:

1. OLS Model

$$CrimeOccurrences_{w;t}^k = \beta_0^k + \beta_1^k \cdot LeiSeca_{w;t} + \boldsymbol{\alpha} \cdot \mathbf{X}_t^k + u_{w;t}^k \quad (5.1)$$

In this model, $CrimeOccurrences_i$ is our variable of interest, which will be a measure of criminality given by could be the amount of shootings reported near a certain Lei Seca Operation taken place in day t from within a radius of w meters.

The main Parameter we aim to calculate is β_1^k , which measures the effect that a random Lei Seca Operation has on crimes of type k within a certain radius of w meters. Furthermore, I aim to include vector \mathbf{X}_t^k as a multi-covariates control which includes year, neighborhood and day of the week fixed-effects. Where:

- $CrimeOccurrences_{kw;t}$ is the number of shootings reported within the radius of w meters from a Lei Seca operation on day t .
- $LeiSeca_{w;t}$ is a dummy variable indicating the presence of a Lei Seca operation within radius w of the selected location on day t .
- $X_{k;t}$ is a vector of control variables, including fixed effects for year, month and day of the week.
- $u_{k;w;t}$ is the error term.

Therefore, this chapter outlines the approach I intend to use in order to analyze criminal behavior in our observed context. I employed econometric methods, specifically fixed effects OLS models in order to try and define the relationship between

Crime Occurrences and Policing in an exogenous manner. The choice of those is driven by the need to isolate the genuine impact of crime deterrence from potential confounding factors. These models offer a robust framework for retrieving exogenous effects and providing valuable insights into the dynamics of crime and authority presence within a broader context.

A key aspect of our empirical exercise is that the geographical allocation of police forces (which are mandatorily present in Lei-Seca operations) induced by the Lei-Seca operations framework (described in chapter 3) is exogenous to the distribution of crime. Officers are placed in those blocks to prevent drinking-and-driving, not in response to levels of common crime. Thus, the Lei-Seca Operations provide a natural experiment that breaks the simultaneous determination of crime and police presence similar to the context in (TELLA; SCHARGRODSKY, 2004). A critical aspect to consider in this analysis is the potential issue of reverse causality. Specifically, Lei Seca operations are typically not conducted in or around favelas, which are known hotspots for firearm shootings in Rio de Janeiro due to them being home to strategic bases of Drug trafficking organizations, as it is explained richly in (CAVIGIAS; BRUCE; MELONI, 2023). This geographic avoidance could explain the lack of significant findings in areas with high shooting rates. As a result, the observed deterrent effect of Lei Seca operations may be understated due to the exclusion of these high-crime areas from the intervention zones. Future studies should account for this potential bias by incorporating spatial analyses that explicitly consider the geographic distribution of both Lei Seca operations and shooting incidents.

5.2 Limitations

It is important to acknowledge several factors that could impose limitations on the estimation exercise.

The first limitation is the scarcity of crime data. In Rio de Janeiro, crime data is managed by the Civil Police Secretariat, which holds all the occurrence reports and is responsible for investigating every crime in the state. Although the data exists, the official government policy is to only share aggregated crime statistics for each neighborhood and month of the year. Given that neighborhoods can be quite large (for instance, the neighborhood of Guaratiba spans approximately 139 km²), the lack of more detailed, daily crime data would limit the precision of the analysis if we were to use official government data. Our model depends on having at least daily crime observations and more accurate proxies for the locations of occurrences. While we relied on available data that should be reliable, occasional inaccuracies were found, such as crimes being incorrectly geolocated. However, such discrepancies were rare in the examined observations.

Additionally, the Lei Seca operations are typically not conducted in or around favelas, which are known hotspots for firearm shootings due to their association with drug trafficking organizations, as elaborated by (CAVGIAS; BRUCE; MELONI, 2023). This geographic avoidance could result in an underestimation of the deterrent effect of Lei Seca operations, as high-crime areas are excluded from the intervention zones. Future studies should account for this potential bias by incorporating spatial analyses that explicitly consider the geographic distribution of both Lei Seca operations and shooting incidents.

Overall, while these limitations present challenges, they also highlight areas for potential improvement and further research to better understand the impact of Lei Seca operations on crime deterrence in Rio de Janeiro.

6 Results

It is expected, coming from a logic cited in multiple articles, such as (LEVITT, 1997), (TELLA; SCHARGRODSKY, 2004) and (CHALFIN; MCCRARY, 2017), that a bigger, more observable presence of Police in a certain area tends to bring crime down.

I expect this effect not to come only from *crime reallocation* (the criminal, observing the police allocation, decides to commit the crime in a different place) but also from a deterrence effect, observed in most of the articles cited above, which comes from the logic that the criminal, when observing the new police/authority allocation, decides it is not worth it committing the crime there (and also not in another place, since he'd have to incur in other costs such as transportation and bigger incarceration risk), therefore, the criminal decides to just not commit the crime.

Therefore, I expect: $\beta_1 < 0$ in model 5.1, it's value can and should vary concerning the type of crime Occurrence examined and the police allocation. The expected effect tends to be higher to more visible and attention-catching crimes, such as armed street theft and muggings, according to (TELLA; SCHARGRODSKY, 2004) and (CHALFIN et al., 2021). I chose to work with close and middle range deterrence, using 3 distances: 100, 500 and 1000 meters, what resulted in 3 estimations (one for each value of "w" in model 5.1).

To provide a practical understanding of these distances, Figure 7 illustrates a Lei Seca operation point with circles of 100, 500, and 1000 meters radii.

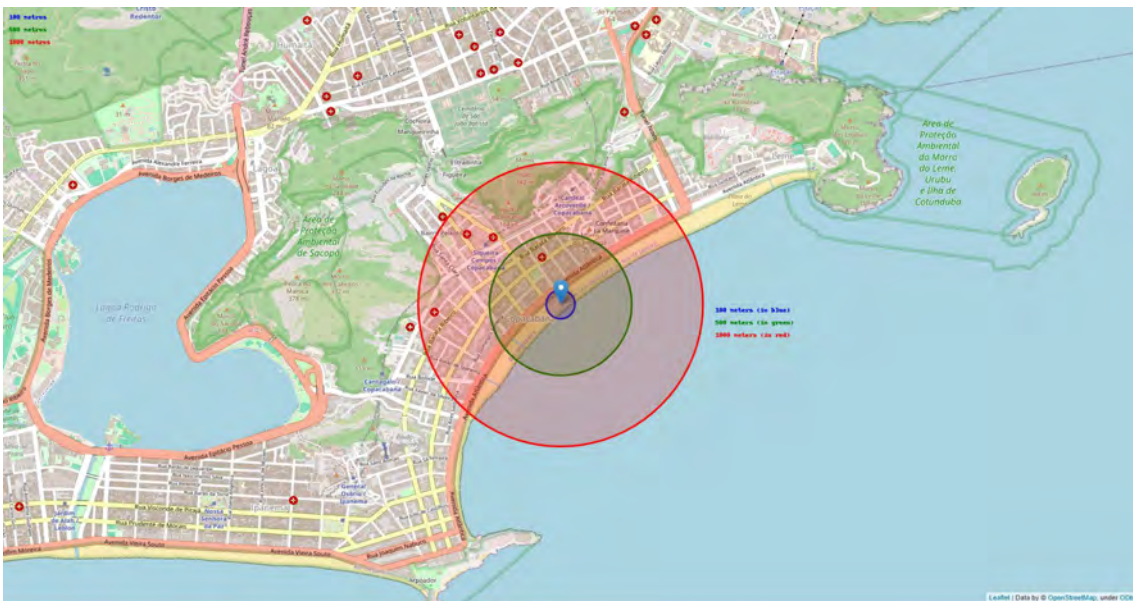


Figure 6 – Map showing a Lei Seca operation point with 100 (blue), 500 (green), and 1000 (red) meter radii¹

6.1 Model Database Descriptive Statistics

Table 3 – Control and Treated Groups Comparison

Variable	Description	Obs. Type		
		Overall	Treated Group	Control Group
Shootings	≤ 100 meters from location	2	0	2
	≤ 500 meters from location	3	0	3
	≤ 1000 meters from location	7	1	6
Number of Obs.		1277199	7632	1269567

6.2 Regression Results

Table 4 – Model Summary for Fixed Effects Regressions

Dependent Variable:	Prob. of Shootings Within		
	100 meters	500 meters	1000 meters
Did a Lei Seca Happen?	-0.0000020 (0.0000012)	-0.0000031 (0.0000021)	0.0001278 (0.0001367)
Num.Obs.	1257993	1257993	1257993
R2 Adj.	0.000	0.000	0.000

Note: Standard errors are clustered by day of the week. All regressions were run with fixed effects for day of the week, year, and month included. 19,206 observations were dropped pre-estimation because of missing values.

Table 5 – Model Summary for Fixed Effects Regressions

As it can be seen, none of the estimated coefficients were statistically different from zero, meaning having a Lei Seca Operation happen does not affect the probability of a armed shooting happening in my any random location (that has had a LS before or after).

6.3 Discussion

The lack of statistically significant findings in this analysis could be attributed to several factors. One critical aspect is the issue of reverse causality. Lei Seca operations are typically not conducted in or around favelas, which are known hot

¹ The circles represent 100, 500, and 1000 meter radii from the Lei Seca operation point at Copacabana Palace.

spots for shooting incidents. This geographic avoidance could explain the lack of significant findings in areas with high crime rates. As a result, the observed deterrent effect of Lei Seca operations may be understated due to the exclusion of these high-crime areas from the intervention zones. The figure below illustrates this factor in a more visual manner, having the shooting occurrences and the Lei Seca Operations occurrences in the neighborhood of Tijuca both plotted in a single map.

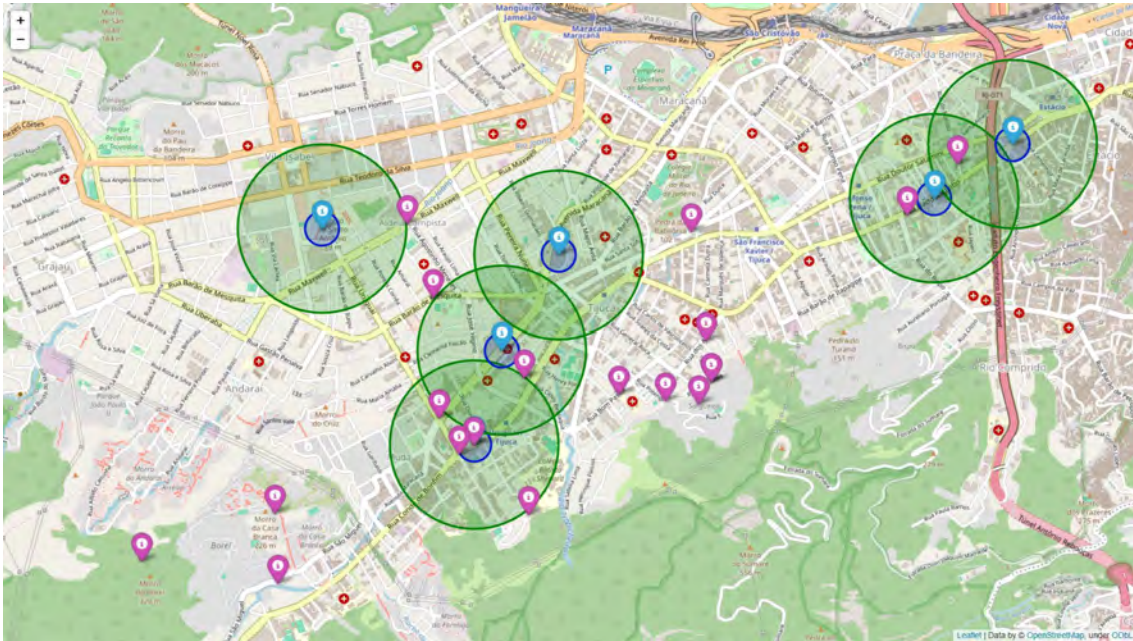


Figure 7 – Map showing Lei Seca Operation points (blue markers) and radii of 100 (blue circle), 500 (green circle) and shootings (purple markers)²

Although in this map the Lei Seca's seem concomitant, most of the favela-concentrated shootings (with tend to be the ones closer to the green patterns in the map, which are the mountains and Tijuca Forest) are far away from the Lei Seca Operations. This map is also gathering a small sample of shootings (17 observations from an universe of 751 over 6 years) and Lei Seca Operations (5 observations from an universe of 83 of 2 and a half years) for better visualization, the pattern follows on when we scale the estimations. Additionally, the Lei Seca operations are primarily designed to combat drunk driving and are not specifically targeted at reducing firearm violence. Therefore, the observed lack of significant impact on shooting incidents might reflect the limited scope and objectives of the operations.

Overall, the findings suggest that while Lei Seca operations may have benefits in terms of reducing drunk driving, their impact on firearm violence is not significant, possibly due to the operational focus and geographic targeting of the interventions. What can also be concluded from these estimations is that not all forms of policing affect crime in general, one cannot expect that crime deterrence will come from an

increase in overall policing, instead, policing should be increasingly more focused, with specific operational methods being used to combat each type of crime.

7 Conclusion

In this paper, I have analyzed the impact of the Lei Seca Operations on the incidence of firearm shootings in Rio de Janeiro. The primary aim was to determine whether these operations, primarily designed to combat drunk driving, had any significant effect on reducing violent crimes such as shootings.

The results suggest that increased policing through Lei Seca Operations does not significantly affect the probability of shootings within the studied distances of 100, 500, and 1000 meters from the operation points. Although these null results were unexpected, they provide important insights into crime behavior, indicating that not all crimes are deterred by increased police presence. Lei Seca Operations, focused on traffic safety, do not target the deterrence of other criminal-activity, they may very well be placed in “secure” locations, avoiding those with an abundance of shootings and murders, for example. Consequently, the lack of significant findings may reflect the limited scope and objectives of these operations.

The main contribution of this paper is the identification of a novel quasi-experimental design using Lei Seca Operations to investigate exogenous variations in policing and government presence. By utilizing the distinctive operational characteristics and geographical distribution of Lei Seca checkpoints, this study offers a robust framework for understanding the wider impacts of police interventions not specifically aimed at general crime reduction. This innovative approach can serve as a model for future research investigating the effects of various policing strategies on different types of criminal activity.

This study also advances the literature on criminal deterrence by revealing the nuanced effects of police presence on a certain crime type: shootings. It emphasizes the need for targeted interventions and customized policing strategies to effectively address specific criminal activities. The results suggest that a uniform policing approach may be inadequate for deterring all forms of crime, especially in areas plagued by issues such as drug trafficking and gang violence. Moreover, the paper highlights a potential reverse causality concern, as Lei Seca Operations are generally not conducted in or near favelas, which are known hotspots for shootings. This geographic avoidance may lead to an underestimation of the operations’ deterrent effect, given that high-crime areas are excluded from the analysis. Future research should incorporate spatial analyses that consider the geographic distribution of both Lei Seca Operations and shooting incidents to mitigate this limitation.

Overall, while Lei Seca Operations have proven effective in reducing drunk driving and enhancing traffic safety, their impact on violent crime, specifically shoot-

ings, appears limited. Policymakers should recognize the need for diversified and context-specific policing strategies to combat various criminal activities effectively. This study provides a framework for future research to explore the nuanced effects of police and governmental presence on different crime types, thereby contributing to a more comprehensive understanding of crime deterrence mechanisms.

Bibliography

BECKER, G. S. Crime and punishment: An economic approach. *Journal of Political Economy*, University of Chicago Press, v. 76, n. 2, p. 169–217, 1968. ISSN 00223808, 1537534X. Disponível em: <http://www.jstor.org/stable/1830482>.

BRASIL, M. d. S. *Banco de dados do Sistema Único de Saúde-DATASUS*. Disponível em: <http://www.datasus.gov.br>.

CAVGIAS, A.; BRUCE, R.; MELONI, L. Policy enforcement in the presence of organized crime: Evidence from rio de janeiro. *Journal of Development Economics*, Elsevier BV, v. 162, p. 103071, maio 2023. ISSN 0304-3878.

CHALFIN, A. et al. Reducing crime through environmental design: Evidence from a randomized experiment of street lighting in new york city. *Journal of Quantitative Criminology*, Springer Science and Business Media LLC, v. 38, n. 1, p. 127–157, jan 2021.

CHALFIN, A.; MCCRARY, J. Criminal deterrence: A review of the literature. *Journal of Economic Literature*, v. 55, n. 1, p. 5–48, March 2017. Disponível em: <https://www.aeaweb.org/articles?id=10.1257/jel.20141147>.

Congresso Nacional Brasileiro. *LEI Nº 11.705, DE 19 DE JUNHO DE 2008*. 2008. https://www.planalto.gov.br/ccivil_03/Atos2007-2010/2008/Lei/L11705.htm.

DETRAN-RJ. *SUSPENSÃO DO DIREITO DE DIRIGIR*. 2018. Disponível em: https://www.detran.rj.gov.br/_documento.asp?cod=5805.

Igarapé Institute. *Homicide Monitor - Igarapé Institute*. 2024. Disponível em: <https://homicide.igarape.org.br/>.

LEVITT, S. D. Using Electoral Cycles in Police Hiring to Estimate the Effect of Police on Crime. *American Economic Review*, v. 87, n. 3, p. 270–290, June 1997. Disponível em: <https://ideas.repec.org/a/aea/aecrev/v87y1997i3p270-90.html>.

LORENZ, M. O. Methods of measuring the concentration of wealth. *Publications of the American statistical association*, Taylor & Francis, v. 9, n. 70, p. 209–219, 1905.

MCCRARY, J. Using electoral cycles in police hiring to estimate the effect of police on crime: Comment. *The American Economic Review*, American Economic Association, v. 92, n. 4, p. 1236–1243, 2002. ISSN 00028282. Disponível em: <http://www.jstor.org/stable/3083311>.

MONTEIRO, J.; ROCHA, R. Drug Battles and School Achievement: Evidence from Rio de Janeiro's Favelas. *The Review of Economics and Statistics*, v. 99, n. 2, p. 213–228, 05 2017. ISSN 0034-6535. Disponível em: https://doi.org/10.1162/REST_a_00628.

NEUMAYER, E. The impact of political violence on tourism - dynamic econometric estimation in a cross-national panel. *Journal of Conflict Resolution*, v. 48, n. 2, p. 259–281, April 2004. Available at SSRN: <https://ssrn.com/abstract=533043>.

RIO, G. *Alerj aprova orçamento do RJ para 2021 e projeta déficit de R20bilhões.2021*. Disponível em :

RIO, G. *Lei Seca 15 anos: mistura de álcool com direção causa 8,7 internações e 1,2 mortes por hora no país em 2021*. 2023. Disponível em: <https://g1.globo.com/saude/noticia/2023/06/19/lei-seca-15-anos-mistura-de-alcool-com-direcao-causa-87-internacoes-e-11-mortes-por-hora-no-pais-em-2021.html>.

TELLA, R. D.; SCHARGRODSKY, E. Do police reduce crime? estimates using the allocation of police forces after a terrorist attack. *The American Economic Review*, American Economic Association, v. 94, n. 1, p. 115–133, 2004. ISSN 00028282. Disponível em: <http://www.jstor.org/stable/3592772>.

A Future Research Strategies

A.1 Neighboring-unit Model

$$\begin{aligned} CrimeOccurrences_{w;t}^k &= \beta_0 + \beta_1^k \cdot Lei\ Seca_{w;t} + \beta_2^k \cdot Neighbor\ Block-LS_t \\ &+ \boldsymbol{\alpha} \cdot \mathbf{X}_t^k + u_{w;t}^k \end{aligned} \quad (\text{A.1})$$

In this model expressed by the equation A.1, we aim to analyze the criminal's reaction to authority presence within a certain range. The criminal, when confronted with an adverse location, tends to either give up on committing the crime or commit it in another location to minimize the chance of getting caught (maximizing the crime's expected utility). I aim to capture this possible **crime displacement** by adding the dummy variable *Neighbor Block-LS* to model 5.1. With this addition, the parameter β_2^k represents the change in Crime Occurrences (of a crime of type k) in a certain block when a Lei Seca Operation is being carried on at a neighboring block. After this change, the resulting model is represented by equation A.1.

In the model articulated by the equation A.1, our objective is to scrutinize how criminals respond to the presence of authority within a defined range. When faced with a policed location (the block where the Lei Seca Operation is going on), criminals may choose to either give up on committing the crime or do it elsewhere, in order to minimize the risk of apprehension (maximizing the expected utility of the crime).

To capture this potential phenomenon of **crime displacement**, I introduce the dummy variable *Neighbor Block-LS* into the model described by A.1. With the addition of *Neighbor Block-LS*, the parameter β_2^k assumes a crucial role, representing the alteration in Crime Occurrences (of type k) within a specific radius w when a Lei Seca Operation is underway in a neighboring spot.

A.2 Lagged Model

In this Lagged Model expressed by the equation A.2, I explore the impact of Lei Seca operations not only in the current time period (t) but also in the previous time period ($t - 1$). The equation is given by:

$$\begin{aligned} CrimeOccurrences_{w;t}^k &= \beta_0 + \beta_1^k \cdot Lei\ Seca_{w;t} + \beta_2^k \cdot Lei\ Seca_{w;t-1} \\ &+ \boldsymbol{\alpha} \cdot \mathbf{X}_t^k + u_{w;t}^k \end{aligned} \quad (\text{A.2})$$

In this context, β_1^k represents the immediate effect of a Lei Seca operation in the current time period, within the radius of w meters. β_2^k captures the lagged

impact of a Lei Seca operation in a certain block. This lagged specification allows us to investigate whether the influence of a Lei Seca operation on crime occurrences persists over time. This model can be escalated to even earlier time periods such as (t-2), (t-3), etc.

The coefficients α and $u_{w;t}^k$ retain their interpretations from the previous models in [A.1](#) and [A.2](#).

B Lei Seca Operations- Descriptive Statistics

B.1 Plots from section 4.2.2 in higher resolution

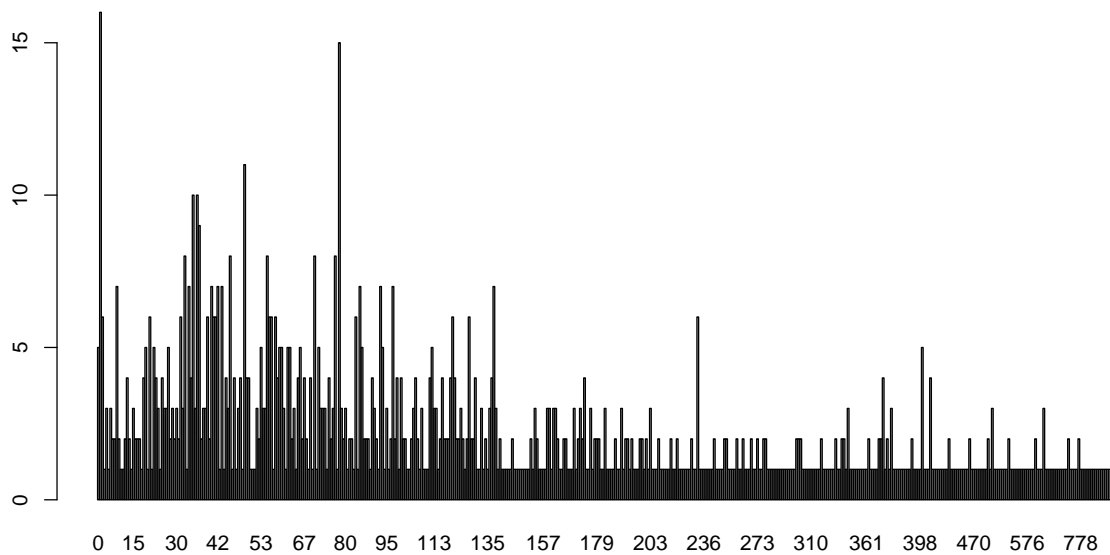


Figure 8 – Plot (a)

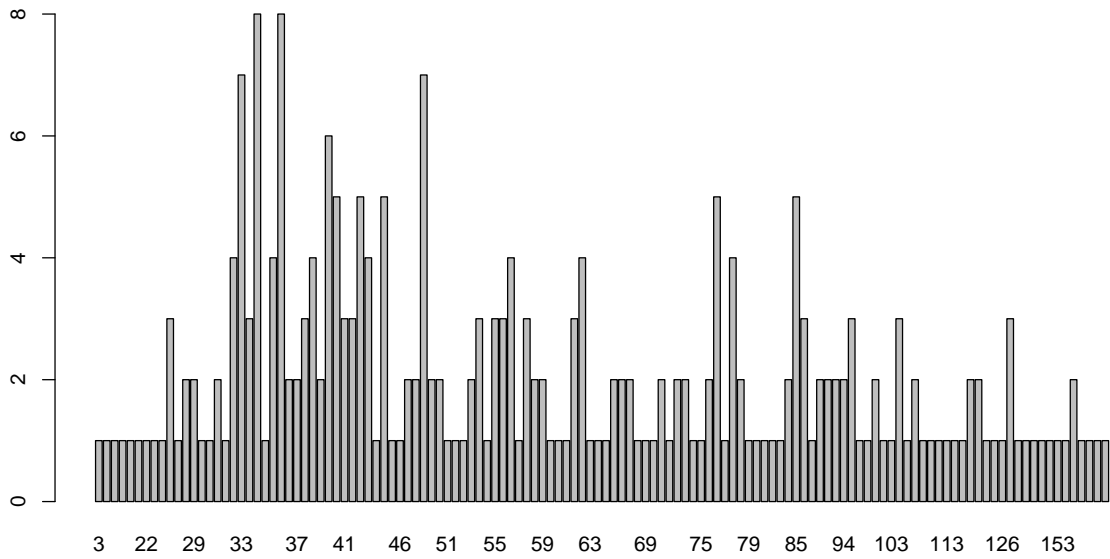
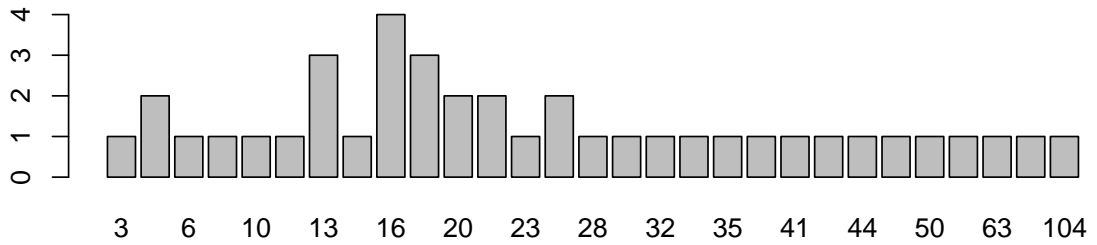


Figure 9 – Plot (b)



Frequency count– Day intervals in the top LS location in Rio de Janeiro– 08/20–12/23

Figure 10 – Plot (c)

B.2 Additional info to section 4.1.2

1. Overall summary of the database
2. Weekdays with the most Lei Seca Operations per year

Table 6 – Summary Statistics- Lei Seca Operations

Variable	Value
Number of neighborhoods	266
Days between Lei Seca Operations - All Observations - Mean	167.23
Days between Lei Seca Operations - All Observations - Median	99.5
Days between Lei Seca Operations - Regular Spots - Mean	63.92
Days between Lei Seca Operations - Regular Spots - Median	55

Table 7 – Top 3 days with the most LS Operations per Year

ano	dia_da_semana	Freq	Porcentagem
2020	sexta-feira	61	17.78426
2020	sábado	56	16.32653
2020	quinta-feira	53	15.45190
2021	sexta-feira	384	17.28173
2021	sábado	369	16.60666
2021	terça-feira	300	13.50135
2022	sexta-feira	538	17.34365
2022	sábado	510	16.44101
2022	domingo	467	15.05480
2023	sexta-feira	530	17.20221
2023	sábado	480	15.57936
2023	domingo	446	14.47582