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Turf Wars in Rio de Janeiro

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Trabalho apresentado ao Programa de Pós-graduação em Economia do Instituto de Economia da Universidade Federal do Rio de Janeiro como requisito parcial para obtenção do grau de Mestre em Economia.

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Morro do Dendê é ruim de invadir
Nós, com os Alemão, vamos se divertir
Porque no Dendê eu vou dizer como é que é
Aqui não tem mole, nem pra DRE
Pra subir aqui no morro até o BOPE treme
Não tem mole pro Exército, Civil, nem pra PM
Eu dou o maior conceito para os amigos meus
Mas Morro do Dendê também é terra de Deus

—MC CIDINHO E MC DOCA (Rap das Armas, 2009)

Resumo

Violência urbana ocasionada por grupos criminais é um dos maiores problemas urbanos nas Américas no século XXI. Este trabalho estuda guerras por território nas favelas do Rio de Janeiro, uma cidade com milhares de favelas e controlada por quatro grupos criminais principais. Este estudo tem três principais contribuições. A primeira delas, a criação de uma medida de guerra entre grupos criminais, que permite diferenciar disparos de armas de fogo aleatório de conflitos mais intensos. Segundo, formalizamos disputas entre grupo criminosos com um modelo teórico que explora o papel da proteção territorial e exploração de mercado. Por fim, documentamos novos fatos estilizados sobre a distribuição e dinâmica de guerras por território no espaço e no tempo. Usando dados do Disque Denúncia, uma linha direta para reportar crimes, construímos um novo painel de dados para mapear e caracterizar as guerras entre grupos criminais. Nossos resultados sugerem que a proteção territorial tem um efeito ambíguo, enquanto o mercado consumidor tem um papel essencial em disputas por territórios. Encontramos que há heterogeneidades entre grupos criminosos. Pelo que sabemos, este é o primeiro estudo que investiga guerras entre grupos criminais no Rio de Janeiro.

Palavras-chave: Competição, Crime, Grupos Criminais, Favelas, Violência, Urbana

Abstract

Urban violence caused by criminal groups is one of the most prominent concerns of the 21st century. This paper studies turf wars between criminal groups in favelas in Rio de Janeiro, a city with hundreds of favelas and controlled by four main criminal groups. We make three main contributions towards understanding turf wars between criminal groups. First, we create a measure of a turf war, distinguishing random shooting from intense armed disputes. Second, we formalize conflicts between criminal groups with a theoretical model that accounts for territorial protection and market exploration. Finally, we document new stylized facts about turf wars distribution and dynamics over the territory and time. Using data from a crime hotline called Disque Denúncia, we construct a novel panel dataset to map and characterize turf wars. Our findings suggest that territory protection has an ambiguous effect, while the consumer market plays an essential role in turf wars. We also show that there are heterogeneities between criminal groups. This is the first study investigating turf wars in Rio de Janeiro to the best of our knowledge.

Keywords: Competition, Crime, Criminal Groups, Favelas, Urban, Violence

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CHAPTER 1

Introduction

Violence caused by criminal groups is considered one of the most significant urban and national security challenges of the 21st-century (WORLD BANK, 2011). All over the world, criminal groups, such as gangs in Chicago, mafias in Italy, and rebels in Syria, control vulnerable territories, exerting violent practices. In addition, criminal groups dispute markets, claiming property rights by force. Criminal groups' violence has severe consequences on welfare, harming economic development, reducing human capital investment, earnings, and labor mobility, mainly due to exposure to violence (MELNIKOV et al., 2019; MONTEIRO; ROCHA, 2017; KOPPENSTEINER; MANACORDA, 2016; MICHAELSEN; SALARDI, 2020).

Rio de Janeiro is remarkable by the domain of drug gangs and militias. These groups exert territorial control, use violent practices, exploit illegal economic activities, and dispute market share between them (MONTEIRO; FAGUNDES, et al., 2021). As a result, Rio de Janeiro coexists with gunfights for at least three decades. The shootings are so frequent that the city has two apps to measure its incidence: *Fogo Cruzado* and *Onde Tem Tiroteio*. Between 2008 and 2019, Rio had at least one gunfight between criminal groups reported in 45.4% of the days[1]. These frequent gunfights, however, it is not exclusive to Rio. In 2019, Fortaleza, a Brazilian capital, became the most violent metropolitan region because of a dispute between criminal groups. Mexico and Colombia had similar scenarios in the '00s, with intense conflicts between criminal groups. These intense conflicts between cartels themselves and the State yielded brutal gunfights and high homicide rates. Estimates indicate that around 88% of Mexico's drug-related homicides were among cartels (LESSING, 2013).

Even though conflicts between criminal groups are common phenomena, very little is known about them. Unlike insurgents groups in Civil Wars, criminal groups do not fight to overthrow the state. Instead, they coexist with the State in a duopoly of governance and collision. Criminal groups fight against each other over territories. The control of certain domains gives the criminal group the capacity to smuggle drugs internationally, sell them locally and

[1] Analysis self-conducted based on Disque Denúncia data

extract profits from the illegal trade connected to an assigned territory. The territory has an intrinsic value since it represents a market share, routes to smuggle drugs and illicit goods, and a place to hide from the state and other groups.

In Rio, these places are typically favelas, where the State has little access. With a history of public negligence and located at the city's margins at the hillsides with very tiny streets and lots of houses, access by the State in the favelas is hard. This configuration lets criminal groups hide from the State and protect themselves from the other groups. Thus, these areas are strategic places with valuable territory for illegal activities, such as drug trafficking and legal actions exploited illegally. However, criminal groups do not compete with the same strength for all the favelas. Some of them are more disputed by criminal groups than others. This work aims to answer why some of the favelas in Rio are more disputed by others.

In this paper, we analyze turf wars between criminal groups at favelas in Rio. Between 2008 and 2019, there were 1867 days with shootings in favelas, which corresponds to 94% of the city's gunfights. Measuring gunfights between criminal groups is a hard job since there is no official data about it. In the first part of this work, we build a new measure of a turf war, distinguishing random gunshots from gunfights. We use reports from a hotline, Disque Denúncia, which are classified as shootings between criminal groups, since shooting activity is frequently unreported (CARR; DOLEAC, 2016).

In the second part, we develop a simple, illustrative model for thinking about the turf wars among criminal groups. We model conflicts between criminal groups from the individual decision of engaging in illegal activities and their relationship with territory protection and market income. The territory protection has an ambiguous effect, while market income has a positive impact on turf wars.

In the third part, based on the turf war measure, we quantify and qualify at the time and space of the turf wars. We analyze how turf wars relate to favelas' fixed characteristics and changes in socioeconomic variables. We find that access to markets plays a vital role in conflicts but that criminal groups even desire favelas that are harder to access. We also find that different groups value different territory aspects, in line with the various activities they explore.

This paper is broadly related to economics and social sciences literature that examines how criminal groups interact with each other and the turfs they control. Recent work suggests that violence is a consequence of the turf wars between criminal groups. The existence of criminal groups themselves does not lead to violence. Instead, the dispute between them, that generates

violence. (SOBRINO, 2020; RIOS, 2013; BRUHN, 2021). While the first two argue that cartels fight for revenues, the latter claims that gangs dispute territories that matched their racial/ethnic identity. Along similar lines, Moreno et al. (2020) and Dell (2015) argue that new transportation routes lead to more armed conflicts in Colombia and Mexico once the roads make it possible to produce and shift drugs along with places that were isolated before. Magaloni, Robles, et al. (2020) show that logistical characteristics of the turf might influence the cartel behavior toward the population.

We contribute to a growing body of work on the logic of violence in illegal markets. Recent work has suggested that in the absence of property rights and third-party regulation, on illicit market, revenues are shared between criminal groups using violence (CASTILLO; KRONICK, 2020; NARANJO, 2015; MESQUITA, 2020; CASTILLO; MEJÍA, et al., 2018). Castillo, Mejía, et al. (2018) and Castillo and Kronick (2020) shows that scarcity of drugs, generated by the local government itself or by other countries' governments, and killing kingpins affects the capacity of criminal groups to share profits peacefully. Mesquita (2020) develops a model where rents are endogenous to the territories, suggesting that local shocks can have heterogeneous results according to their proximity to other turfs and to the groups that control it.

This paper also builds on the recent literature in mapping conflicts (LOYLE; MALMIN BINNINGSBØ, 2016; KLOSEK et al., 2020; FJELDE; HÖGLUND, 2021). Criminal activity is frequently underreported and unpredictable (CARR; DOLEAC, 2016; BAZZI et al., 2021). This work produces a georeferenced event dataset on turf wars between criminal groups. By clearing distinguishing random gunshots from intense conflicts, this data allows for empirical evaluation of theories relating to turf wars' timing, location, and dynamics. In addition, the data we use enable us to measure turf wars based on intense conflicts. The other available data source on gunshots does not track if the event was between criminal groups or between criminal groups and the police. Neither allows us to map conflicts since it registers intense and soft gunshots equally.

This paper is organized as follows. Chapter 2 provides background on Rio's criminal groups and favelas. Chapter 3 describes the data used to build the dataset and chapter 4 provides a descriptive analysis of the shooting data. In Chapter 5 we describe the basic model and the main econometric specification. Chapter 6 presents the results, and chapter 7 concludes.

CHAPTER 2

Rio de Janeiro's Background

In 2019, Rio de Janeiro recorded a homicide rate of 28.5 per 100,000 inhabitants. This homicide rate is comparable to countries such as Colombia (25.2), Mexico (27.3), El Salvador (36.4), Nigeria (34.5) , and South Africa (36.5)[1]. This violence in Rio de Janeiro is at least consequence of two factors: (i) the existence of controlled territories by different criminal groups with fragmented power structure and (ii) the occurrence of frequent disputes between those groups, whose objectives are the maintenance and conquest of new territories. When we take a closer look at differences inside the city, the disparities between zones are evident. For example, though the south zone, the richest area, recorded a homicide rate of 13.6 in 2019, the north zone recorded 44.6 per 100,000 inhabitants[2].

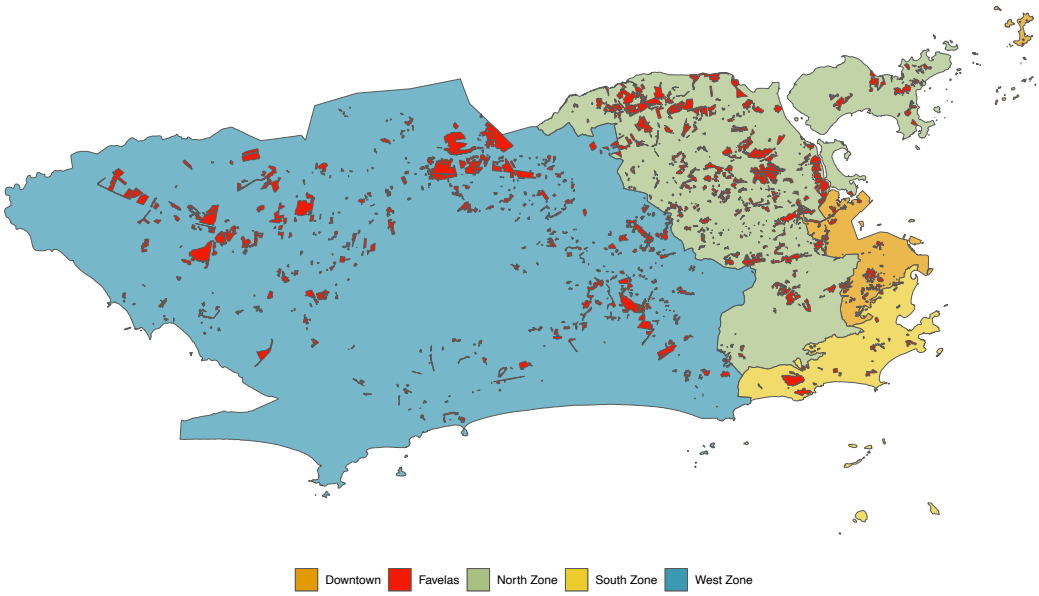
Rio de Janeiro has four main criminal groups in activity: Comando Vermelho (CV), Terceiro Comando Puro (TCP), Amigos dos Amigos (ADA) and Militia. These four groups control territories, most of them favelas, exploit illegal economic activities, and dispute market share between them using violence (MONTEIRO; FAGUNDES, et al., 2021). Most conflicts take place in favelas. Rio de Janeiro's territory is formed by 1,018 favelas and 406 housing complexes, according to Pereira Passos Institute (IPP). Favelas are sets of urban areas with a least 51 houses characterized by high demographic density, illegality, poverty, unhealthiness, and disorder (FERREIRA, 2009). More than one-fifth of Rio de Janeiro's population lives in favelas, according to the Demographic Census of 2010. Figure 2.1 shows the city map with the favelas' locations. The favelas are pretty widespread across the city. The south and west zone have respectively 4.7% and 4.2% of their area with favelas. Still, the north zone is where there are more favelas per area, followed by downtown, with almost 10% of its area covered by favelas.

The first favelas in Rio de Janeiro date from the end of the 19th century. They emerged in

[1] Homicide rates from Homicide Monitor <https://homicide.igarape.org.br>. South Africa homicide rate from 2018

[2] Instituto de Segurança Pública. While the homicide rate in favelas and non-favelas would be a great indicator, there is no official data about it

Figure 2.1 Favelas per zone



Note: This figure presents Rio de Janeiro's and favelas boundaries, divided by city zone. The red polygons are the favelas and housing, and the yellow polygon is the south zone of the city, the orange is downtown, while the green and blue are the north and west zone, respectively.

hillsides due to the end of slavery, rapid urban growth, and removals from noble areas. On the other hand, the housing complexes appeared in the '50s and had their origins in extensive urban reforms that removed favelas from downtown and noble regions. In the favelas and housing, the presence of the State was always weak, with a history of lack of public services provision and infrastructure. It is essential to notice that, even though favelas and housing have high poverty rates, not all inhabitants are poor, and not all poor live in favelas and housing. The average per capita income of a permanent household is 1.5 minimum wages, and the average number of residents per household is 3.1. On average, 66% of young people up to 15 years old are literate. While most permanent families have access to running water, garbage collection, bathroom inside the house, and electricity, less than half have a formal identification number of the house, sidewalk, paved streets, and public lighting in the surroundings. In the past three decades, access to urban infrastructure and public services has improved, especially in the favelas (VIANNA, 2008). Still, until 2010, only 15.6% of the 1,018 were considered urbanized according to IPP.

Drug selling was a well-known phenomenon at the beginning of the 20th century, especially at the favelas. The drug market sold marijuana, mostly in vulnerable areas, since vulnerable people primarily consumed it. The end of the '70s marked the emergence of the leading drug gangs inside the prison system (MISSE, 2011). In the 1980s, Comando Vermelho (CV), the first prominent organized drug gang in Rio de Janeiro (DOWDNEY, 2003), gained control of the already established marijuana trade network to sell cocaine. The high profits of the cocaine trade made the territory control crucial for the well-being of the illegal business and changed its dynamics. Soon began a dispute between gang members, which led to the foundation of Terceiro Comando (TC) in the late 1980s, Amigo dos Amigos (ADA), and Terceiro Comando Puro (TCP) in the '90s (MISSE, 2011). This fragmentation soon led to an arms race between those groups, resulting in the use of heavy weaponry, such as grenades and modern military machine guns (MONTEIRO; ROCHA, 2017). Nowadays, Rio de Janeiro is an essential hub for cocaine exports to Europe and Africa and a regional strategic point for the distribution of cocaine and marijuana (DRUGS; CRIME, 2012).

Rio de Janeiro's criminal groups, especially the drug gangs, do not present a rigid hierarchical structure the way is seen in the Sicilian Mafia (MISSE, 1997; SOUSA, 2001). Drug gangs are seen as networks of independent affiliated actors (DOWDNEY, 2003), formed by young and inexperienced man (BAPTISTA, 2000). So even though some coordination can happen between leaders in the same presidium, each favela has a local leader that commands operations, decides how to defend its territory, and decides if it will attack its rivals or not.

With the rise of the factions in the 80s, the favelas became strategic points for the illegal drug markets. Besides strategic selling points, the favelas are important hubs for the international drug trade, once Brazil is an essential route to smuggle drugs from South America to Europe and Africa (MISSE, 2011). In the 1990s, while drug gangs were fighting with each other, a new actor emerged in the favelas of the west zone: the militias. Inspired by the death squads of the '70s, the militias were also formed by security state agents that offered protection to businesses and inhabitants of the favelas against drug gangs. The arrangement was successful in keeping drug gangs away and maintaining the social order (MISSE, 2011). Soon this model expanded to other territories at the west zone and gained new activities such as illegal transportation, provision of TV, internet services, and cooking gas (MONTEIRO; FAGUNDES, et al., 2021).

In these areas, the monopoly of force does not belong to the State. Instead, it belongs to

three drug gangs (ADA, CV, and TCP) and the militias. Those areas are attractive places to install illegal business due to lack of State presence and the possibility of imposing *de facto* rules. It is worth mentioning that even if criminal groups control the favelas and housing, their inhabitants are not criminals but people with no better living options. Most of them do not support criminal groups but suffer oppression by the police, whose incursions are increasingly lethal.

Rio de Janeiro has two police forces: the Civil Police and the Military Police. The former is responsible for investigating all the committed crimes, while the latter has the duty of doing ostensible policing and preserving public order. Police incursions are a common phenomenon in the favelas. Usually, the police realize operations to make drug seizures or arrest someone. However, over the last few years, police operations escalated violence, killing several innocent civilians. With a history of corruption, they do not always intervene in criminal groups conflicts. When they do interfere, it is because the war reached the public attention.

CHAPTER 3

Data

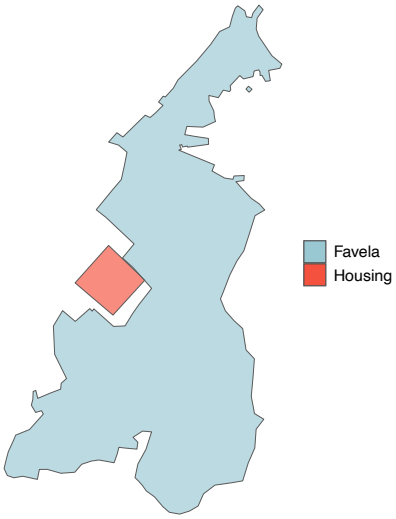
This chapter presents the data used in this work for our inquiry on the drivers to conquer a specific favela by criminal groups. Since we want to understand what drives a favela to be more disputed than others, we need data at the favela level. Therefore, we divided this chapter into three parts. The first part describes the favela data: the favela and housing location, geographic, and socioeconomic data. The second part describes how we handled the shootings data to construct the main variables of this work: shootings at favelas and turf wars. Finally, the last part describes the income and urban infrastructure data.

3.1 Favela Data

In Rio de Janeiro, there are 1,018 favelas and 406 housing complexes. As seen in chapter 2, many housing projects have similar logic to a favela. Some of them are close to favelas or even inside the favelas. Since this work focuses on favelas and housing, the favela and housing data provided by Instituto Pereira Passos (IPP) is fundamental for every process. The shapefiles from IPP provided the favela or housing complex's official name, a popular name, and a polygon. We used the official, and the popular name's to match a given gunshot based on the favela or housing name informed in the report. Sometimes the report had a different popular name than the one informed by IPP because it had more than one popular name. When this happened, we manually googled the given name to find its official or the IPP popular names, to match the report to a favela. In some cases, there was no mention of a favela in the report, so we looked at the address in Google Earth to check whether it was inside a favela or housing.

There are 76 housings totally or partially inside a favela, like figure 3.1. Therefore, we grouped all housing and favelas that are less than 1m of a distance of each other. After grouping the boundaries, we had 1,179 favelas and housing. On average, favelas and housing have an area of 59,747 m^2. We used this shapefile to build the other data we had about favelas and housing.

Figure 3.1 Housing and Favela



Note: The red polygon represents a housing complex and the blue polygon a favela.

We calculated each favela and housing inclination based on that shapefile, using the earth gradient provided by the Shuttle Radar Topographic Mission (SRTM). The SRTM has data for grids of 90m. From the 1,179 favelas and housing, we have data from 964. We do not have data for tiny favelas and housing, where the grids are smaller than 90m. On average, a favela or housing has an inclination of 40.13m. The maximum altimeter at our sample is 500m.

We also have the Demographic Census data from the Instituto Brasileiro de Geografia e Estatística (IBGE) from 2010. The Census does not provide data at the favela and housing level, but it offers at the census tract level. Therefore, based on these tracts, we constructed the favela and housing data. Then, we intersected the tracts with the favelas and housing boundaries to relate which tracts were inside a favela or housing. We noticed that more than one tract formed some favelas and housing, while others were created just by one. Therefore, we weighted the variables for the proportion between the favela and housing area and the total tract area to avoid cases where a favela or housing is smaller than a tract.

For this analysis, we chose variables number of permanent households, the population in permanent homes, access to running water, access to the bathroom inside the house, access to electricity, access to garbage collection, total of residents, young up to 15 literacy, total per capita income of permanent households, percent of permanent households with sidewalks, afforestation, paved streets, public lighting in the surroundings and percent of permanent homes with formal identification. Table 3.1 presents summary statistics for the favelas and housing

Table 3.1 Selected Census Variables

	Ave.	Sd.	Max.
Permanent Household (PH)	226.6	96.3	808.6
Population in PH	699.7	298.2	2,785.3
Population	705.1	299.0	2,785.5
% Afforestation	0.4	0.3	1.0
% of PH with Sidewalk	0.5	0.3	1.0
% of PH with Paved Streets	0.5	0.3	1.0
% of PH with Public Lighting	0.6	0.3	1.0
% of PH with Identification Number	0.5	0.3	1.0
PH Monthly per capita Income	765.7	505.9	4,717.8
Young up to 15 literacy	0.7	0.1	0.8
% of PH with Running Water	1.0	0.1	1
% of PH with Bathroom inside	1.0	0.03	1
% of PH with Electricity	1.0	0.03	1
% of PH with Garbage Collection	1.0	0.05	1

Note: This table presents summary statistics for selected variables at the favelas and housing.

The variables are from the Demographic Census of 2010 (IBGE).

selected variables.

3.2 Shootings

Understanding turf wars requires data at the favela level. Unfortunately, the official data provided by Instituto de Segurança Pública (ISP) does not track information on when and where gunfights between drug factions happen. Instead, it tracks events that were fatal and non-fatal victims. So there are two other sources of data: Disque Denúncia and Fogo Cruzado. To overcome the lack of data available from the police, we built a novel data set based on anonymous reports from Disque Denúncia (DD). DD is a crime hotline open to the public for reporting problems associated with security or public order that require government intervention. They gave us access to all reports classified as a gunfight between criminal groups. We can find an example of the report classified as a gunfight between criminal groups at figure 3.2.

Figure 3.2 Example of Shooting Reports Contents

"In the aforementioned neighbourhood, close to the Treu factory, is located in Morro do Chaves, where (unidentified) heavily armed traffickers from the ADA faction have allied themselves with (unidentified) traffickers from the Lagartixa, Quitanda and Pedreira, to help them in the war against (unidentified) traffickers of the CV faction, that are trying to take back drug sale points on weekends after 5 am. "Playboy" (not characterized) is the leader of drugs in the locality and promotes a funk ball on Vitorino Freire street, on fridays, from 0:00 am on."

"In the aforementioned street, at number 177 (one hundred and seventy-seven), inside the Cajueiro community, at this moment, there are several (unidentified) drug dealers, heavily armed, preparing for a confrontation with rival drug dealers, who (today, 19/01/14), will try to take over the local drug points."

"Informs that on the street mentioned and its vincinity is happenning a frequent and intense war between rival drug gangs, since the prison of Celsinho da Vila Vintém. At this moment is happenning an intense shooting between factions."

Note: This figure illustrates three report contents. Source: Disque Denúncia

Disque Denúncia is an NGO, founded in 1995, that operates as a call center in a close partnership with the Secretary of State for Security of Rio de Janeiro. Between 2002 and 2020, DD has compiled a dataset of more than 2 million reports registered. All reports are anonymous and forwarded to the civil or military police, which decides if they act and how. Until 2016, the

hotline worked 24 hours per day, seven days a week.

The reports contain a date, call time, address, type of irregularity, and the description of the event, shown in figure 3.2. Citizens may call to make noise complaints, inform against drug selling, or even denounce a fugitive whereabouts. They gave us access to all reports about gunfights between drug gangs from 2008 to 2019. Since the description of the event is very rich in most cases, we read all of them to locate the event best and make sure the circumstances were, in fact, gun fighting between drug gangs. We also corrected the date of the event since people made some callings after the shootings started. Some of the events mentioned more than one place, so we duplicated this event with multiple locations. Other events have an address that does not match the area mentioned in the description, so we corrected the address based on the report.

Based on the Instituto Pereira Passos (IPP) list, we coded the favelas' names, attributing them to a given code by IPP. However, some reports did not have a favela name, so we looked at Google Earth if this street was inside a favela or housing complex, based on shapefiles from IPP. Appendix A describes the detailed process. We matched 92.3% of the reports to a favela or a housing complex. From 406, only 22 had at least one report, which corresponds to 4.6% of the shooting report.

This work aims to measure turf war, which is different from shootings and firearm discharge. To identify turf wars, however, we need to look at the shootings. What we want are events with the rapid escalation of violence and with a particular frequency. To distinguish random gunshots from intense conflicts, we only considered frequent events. Since conflict duration can vary greatly (MONTEIRO; ROCHA, 2017), we built two different variables to measure the extreme circumstances. The first one is the days with gunfights in a given year. The second one is a dummy when there are at least two days in a week with shootings. Table 3.2 provides descriptive statistics about the different treatments and the number of favelas and housing that were treated. Column 2 shows the number of days with shootings, and Column 3 the amount of housing and favela per year with shooting at least one day. Column 4 presents the number the turf war events per year. The variable at this column is the dummy equals one when there are at least two days in a week with shootings, our turf war definition. When a favela or housing has this variable equals one, we count it as one event of a turf war. Important to say that this column is not bounded to 52 weeks. If two favelas have a turf war in the same week, we count as two events. Column 5 shows the number of favelas with turf wars. The last

Table 3.2 Conflicts - Summary Statistics

Year	Days With shooting	N favelas 2 or with shooting	Turf Wars	N favelas with turf wars
2008	192	89	25	18
2009	223	108	61	27
2010	151	88	19	11
2011	207	98	35	20
2012	199	87	30	18
2013	116	69	21	13
2014	176	99	34	20
2015	142	76	20	15
2016	103	76	7	5
2017	118	83	12	9
2018	149	103	20	16
2019	95	72	14	10
Total	1670	328	298	99

Note: This table presents summary statistics for the shooting data for each year at our sample. In column 2 we have the days in that year where there was at least one shooting in at least one favela. Column 3 presents the number of favelas and housing that had at least one day with shooting. In column 4 we use the turf war variable we built. The variable is a dummy equals one when there is two or more days with shootings in a favela or housing, in a week. When a favela have this dummy equals one, we count as one turf war event. Notice that in this column, the weeks are not bounded to 52. This means that, if two favelas have a turf war in the same week, we count two turf wars. Column 5 presents the number of favelas with turf wars. The total of favelas with turf wars and shootings are not the sum of the columns, since one favela can have turf wars and shootings in more than one year.

line presents the total for the years. The total favelas with shootings and turf wars are not the sum of the favelas for each year since a favela can appear in more than one year. As we can notice, there are fewer favelas with turf war than favelas with shootings. Also, the events are

less frequent when we compare to days with shootings. Figure A.1 in Appendix A presents the spatial distribution of gunfights across years. Appendix B validates the variables with a case study.

3.3 Criminal Groups Data

Besides the gunfights between criminal groups, we also use DD as a data source about the presence of criminal groups. Once again, there is a lack of official data about it. Intelligence agencies have this information, but they do not record it over time, neither disclose this kind of information. Instead, they only register how the criminal groups are located at present. To overcome the lack of historical data, we got access to all reports that mention the name of a criminal group in the event description. The keywords searched on the DD database were *CV; comando vermelho; ada; amigos dos amigos; tcp; terceiro comando; terceiro comando puro; milicia; melicia*. From 2008 to 2019, there were 39,456 reports about criminal groups. Figure 3.3 shows the yearly distribution by criminal group. As we can notice, the total of reports varies mostly because of militias reports. Reports about other criminal groups are mostly stable over time.

This data follows DD shooting data structure, containing an address, date, hour, and an event description. Figure 3.4 brings examples of the reports. The reports can be about any subject as can be seen in figure 3.4. While panel (a) describes a drug-selling event where shoot randomly guns, figure (c) describes a frequent and heavy event. On the other hand, figures (b) and (d) reports tax extortion respectively from *milicianos*[1], and internet, and telephone cut off by drug dealers from TCP. These reports refer to 145 different types of illegal activities.

[1] *Milicianos* are how the members of militias are called.

Figure 3.3 Number of Reports about Criminal Group Presence by Year (2008-2019)

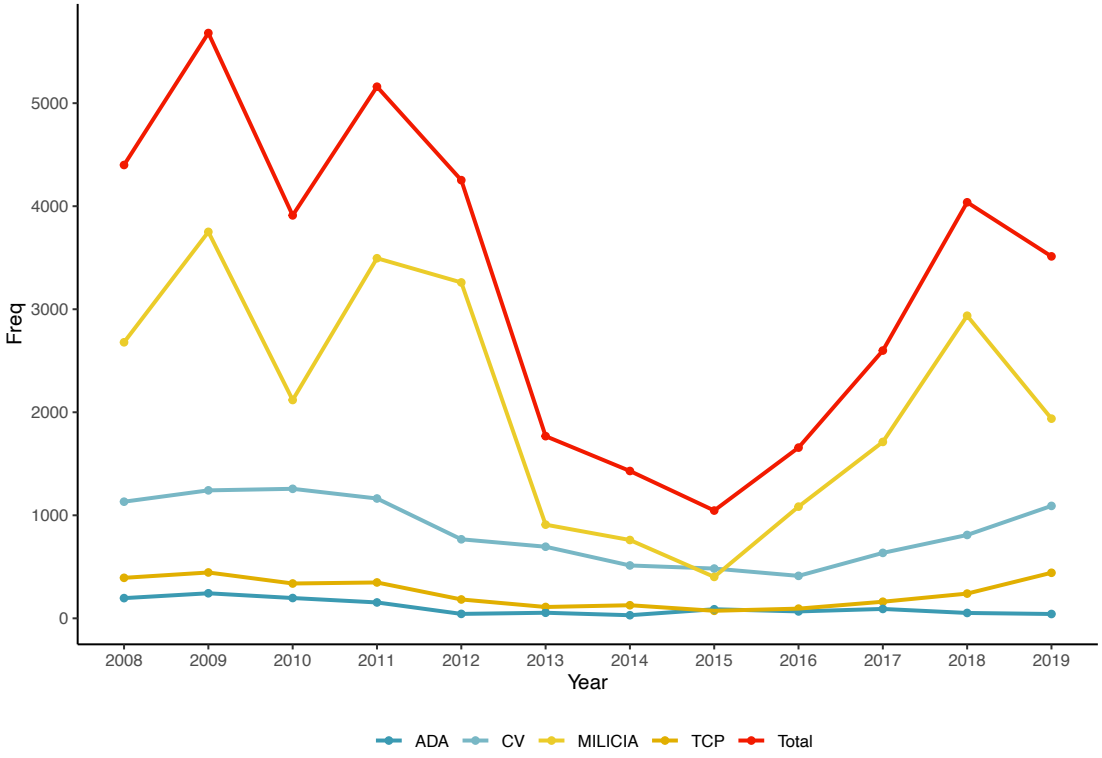


Figure 3.4 Example of Criminal Group Presence Reports Contents

(a)

On the mentioned outside, near Rua Florentina Rangel, it has been operating all day, every day, from 6 pm on, drug traffickers (not identified), from the Amigos dos Amigos criminal faction, armed with fuzzes, selling cocaine and maconha. They shoot at random. They come from the community known as Rua da Feira.

(b)

At the beginning of the road mentioned, near the Valqueire market, near the Chacrinha community, at this moment, there are about ten militiamen (unidentified) armed with rifles and pistols, following on foot in increasing numerical order, extorting residents and merchants.

(c)

On the third street, near the Assembleia church, for approximately four days, at night, drug dealers "Diego" aka "Dengo" and "Feijão" and other drug dealers (unidentified) from the Red Commando, heavily armed, meet to try to take over the neighborhood, which is currently dominated by the Third Commando. At this moment there is an intense shootout. It is reported that the traffickers (unidentified) are using several motorcycles with no license plate and a black auto siena with no known license plate.

(d)

To attribute the presence of an armed group inside a favela or housing complex, we geocoded the address with the HERE API, a geocoder API that allows you to obtain coordinates for addresses. That is, we submit an address to request the corresponding geocoordinates. With the coordinates in hand, we used the shapefiles from IPP to calculate distances from these points and the favelas and housing complexes. For this analysis, we consider a distance of 200m as evidence of criminal group presence. We allow some distance because many vulnerable places do not have good geocoding besides the exact address. Without presence criterion, 60% of the reports can be associated uniquely with a favela or housing project. Table 3.3 presents descriptive statistics.

Table 3.3 Criminal Group Presence - Descriptive Statistics

Year	Total	Ave.	Sd.	Max.
2008	2805	3.7	6.2	79
2009	3336	4	6.7	106
2010	2330	3.3	5.6	65
2011	3092	3.9	7.2	74
2012	2448	3.8	6.9	84
2013	1115	2.5	3.3	29
2014	878	2.5	3.1	26
2015	682	2.1	2.1	20
2016	968	2.7	3.5	37
2017	1572	3.2	5.1	59
2018	2206	3.8	8.8	126
2019	2136	3.6	7	116
Total	23568	3.4	6.2	126

Note: The table presents summary statistics for criminal group presence.

According to our knowledge, almost all favelas and many housing complexes in Rio are controlled by criminal groups. However, as seen in (MONTEIRO; FAGUNDES, et al., 2021), people tend to call to report when there is something unusual going on. 921 favelas and housing project appears to have a presence of a criminal group at least in one point of time between

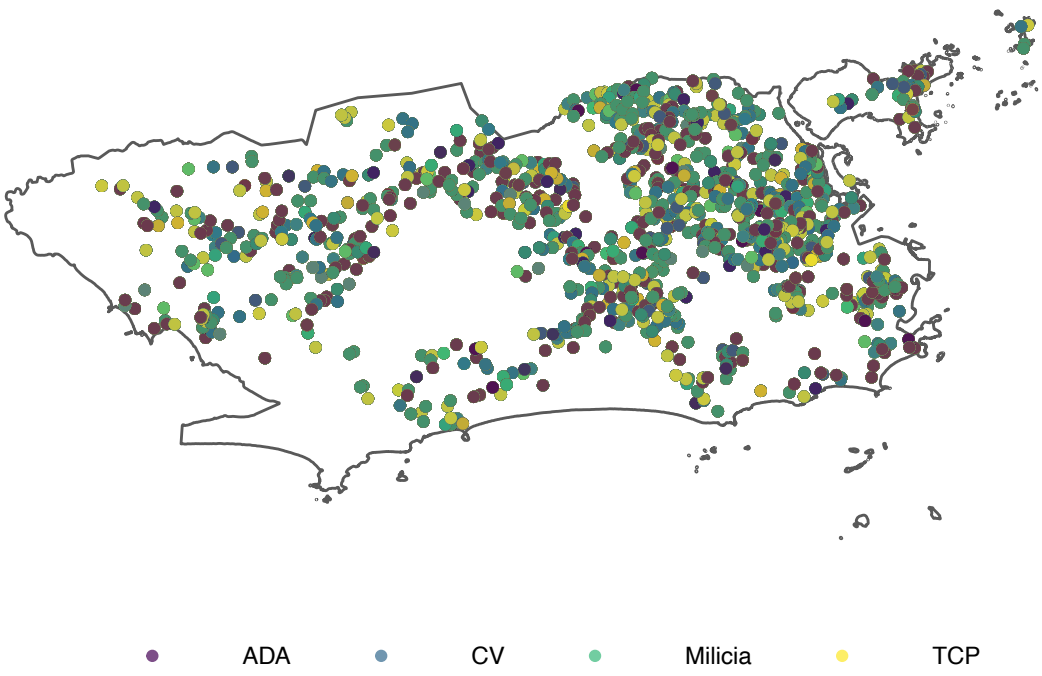


Figure 3.5 Criminal Group presence spatial distribution 2008-2019

2008-2019. Once again, the presence of criminal group tends to be stable for almost all groups, but to the militias. It is important to remember that it is possible that the number of the militias is stable, but people stopped calling because nothing unusual was going on, and this data captures badly the presence of criminal group, but captures better unusual activities of criminal groups. Even though there is a degree of uncertainty on the precision of reports individually, we argue that the combination of numerous reports represents a unique source of data in understanding criminal dynamics in the state. (MONTEIRO; FAGUNDES, et al., 2021). Figure 3.5 plots the spatial distribution of the criminal groups between 2008 and 2019.

3.4 Income and Urban Infrastructure Data

To test our hypothesis, we need income data that varied on time. To overcome the lack of variation of the Census data, we chose to proxy it by the income of the formal job market.

The *Relação Anual de Informações Sociais* (RAIS), from the Economic Ministry, discloses information on firms' and workers' characteristics. Instituto Pereira Passos (IPP) provides wage bills from RAIS by neighborhood. We use this variable to create a proxy of consumer market

Table 3.4 Wage Bill (R$) - Summary Statistics

Ave.	Max.	Min.	Sd.
41,562,718	797,357,515	136,760	71,200,429

Note: The table presents summary statistics for the wage bill in reais (R$) variable from RAIS.

income for each favela and housing. First, we calculated distances between favelas and housing and the neighborhoods. The average distance between a favela and housing to a neighborhood centroid is 16 km. Next, we calculated a matrix where the lines were neighborhoods and columns favelas and housing. Then we got a value of 1 if the distance between them were at least 1km. Finally, we weighted the wage bill for each favela and housing according to the neighborhoods at least 1km away. In table 3.4 we have summary statistics for the wage bill data.

Besides the income data, we have urban infrastructure data from the Municipal Secretary of Transport. The data contains Rio's main streets and highways. We calculate the distance of each favela and housing projects to the streets and highways. There are 34 main streets in Rio[2], where three are considered highways: Linha Amarela, Linha Vermelha and Avenida Brasil. On average, main streets are 19 km away from the favelas and housing. There are 729 favelas within 1km of distance to main streets, which represents 62% of the favelas and housing.

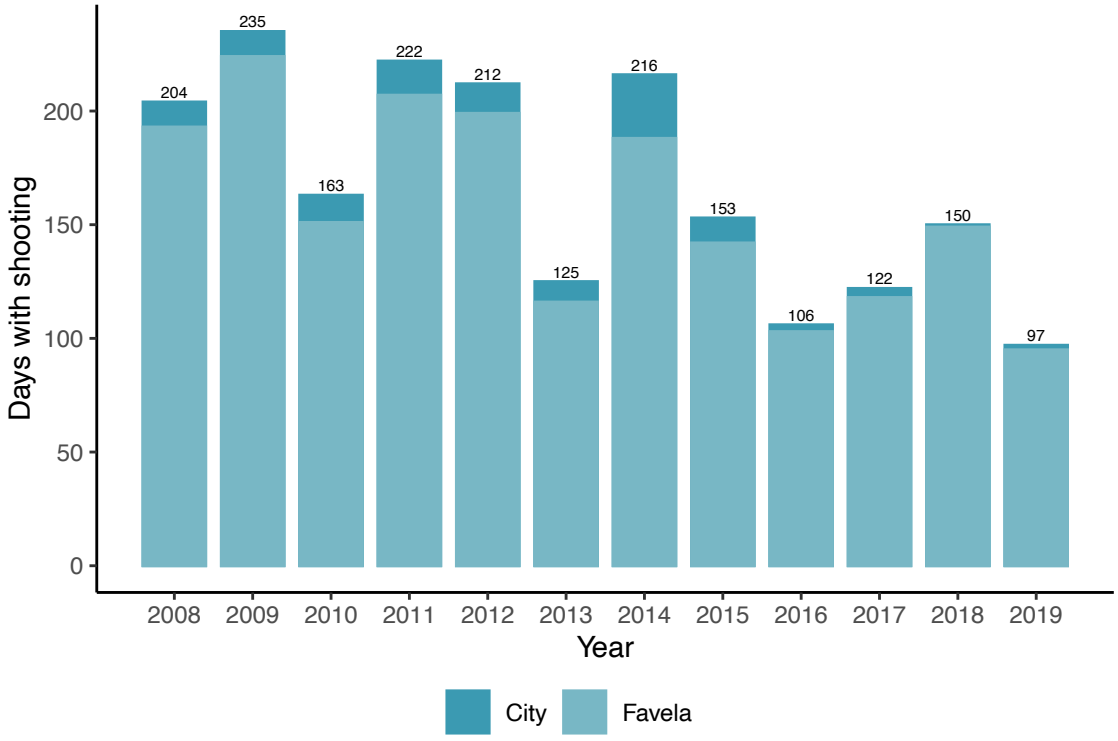
[2] Av. Infante Dom Henrique, Av. Pastor Martin Luther King Jr., Av. Francisco Bicalho, R. Senador Câmara, Av. General Justo, Av. Brasil, Av. Sargento de Milícias, Av. Armando Lombardi, Est. da Pedra, Av. Presidente João Goulart, R. Felipe Cardoso, Av. Atlantica, Av. Lauro Sodré, Av. Prefeito Mendes de Moraes, Av. das Américas, Av. Dom João VI, Av. Niemeyer, Av. Delfim Moreira, Av. Ministro Ivan Lins, Tn. do Pasmado, Av. Presidente Vargas, Av. Presidente Kubitschek, Autoestrada Lagoa Barra, Av. Vieira Souto, Av. Princesa Isabel, Av. Rio de Janeiro, Av. das Nações Unidas, Av. Ayrton Senna, Av. Rodrigues Alves, Vd. Engenheiro Freyssinet, Av. Rio Branco, TransOlímpica, Av. Governador Carlos Lacerda, Av. Paulo de Frontin

CHAPTER 4

Data Description

This chapter focuses on the gunfights data, explaining how the conflicts behave and their relationship with the other variables also defined in chapter 3. We conduct an exploratory analysis of the data and document some statistics regarding the favelas.

Figure 4.1 Days with shooting per year in Rio



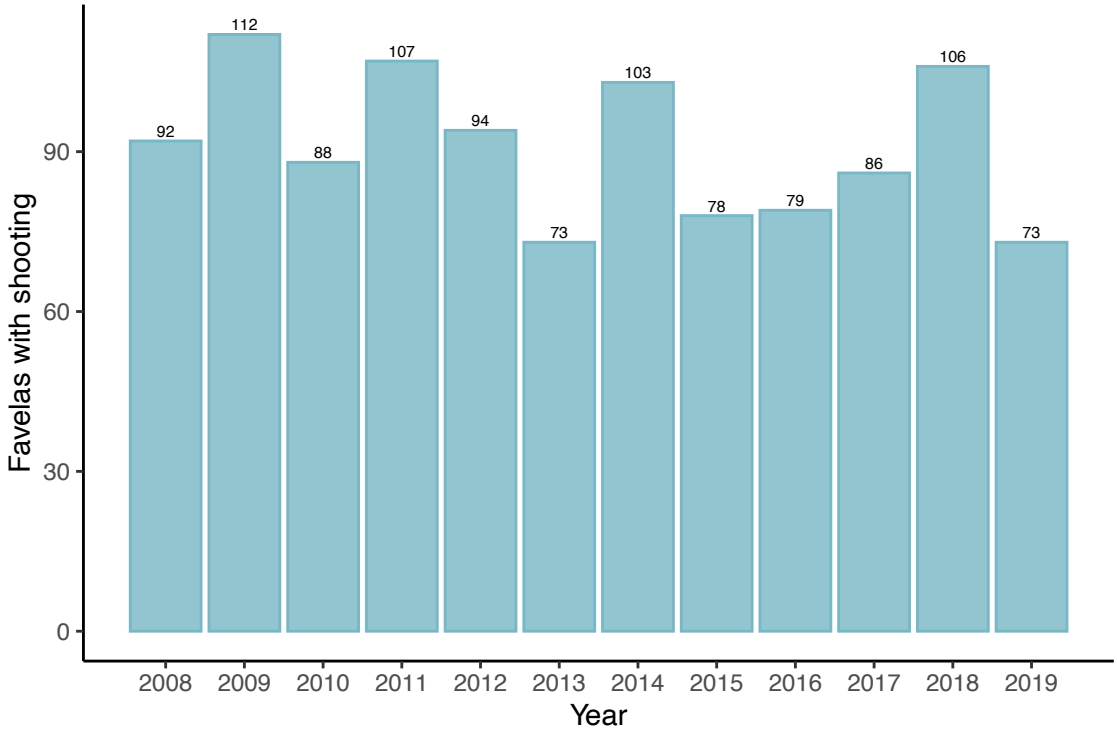
Note: The vertical axis is the number of days with shootings, and the horizontal axis is the year. The lighter blue is the shooting at favelas, while the darker blue is shootings at the whole city. The labels on the top of the bar are the days with shooting in the entire town.

Between 2008 and 2019, Rio de Janeiro had 3,748 shootings, corresponding to 2005 days with at least one shooting. 94% were in a favela or housing complex, which corresponds to 1,885 days having at least a gunfight. The yearly distribution is shown in figure 4.1. The year 2009 was the most violent one, with 235 days of shootings in the city, while 2019 was the least, with 97 days. Since 2016, the difference in shootings between city and favelas is getting

smaller, with 2018 being the year where almost all shootings occurred in favelas and housing.

While most of the shootings and conflicts happen in favelas, not all favelas are constantly under dispute (MONTEIRO; ROCHA, 2017). Even when a criminal group controls a favela, this control is not stable. The local chief's power is systematically questioned by members of the same group or rivals. Because of the fragmented power structure, violence is the primary conflict resolution mechanism. Only 30% of the favelas (346) reported shootings between 2008 and 2019, where 5.7% (22) are housing complexes and 94.7% are favelas. However, the number of favelas with at least one day of shootings varies across years, as seen in figure 4.2. 2009, 2011, 2014, and 2018 were the most widespread regarding favelas and housing with shootings. While the first three were also the more days with gun fires, 2018 did not have that many days.

Figure 4.2 Favelas with shooting per year in Rio

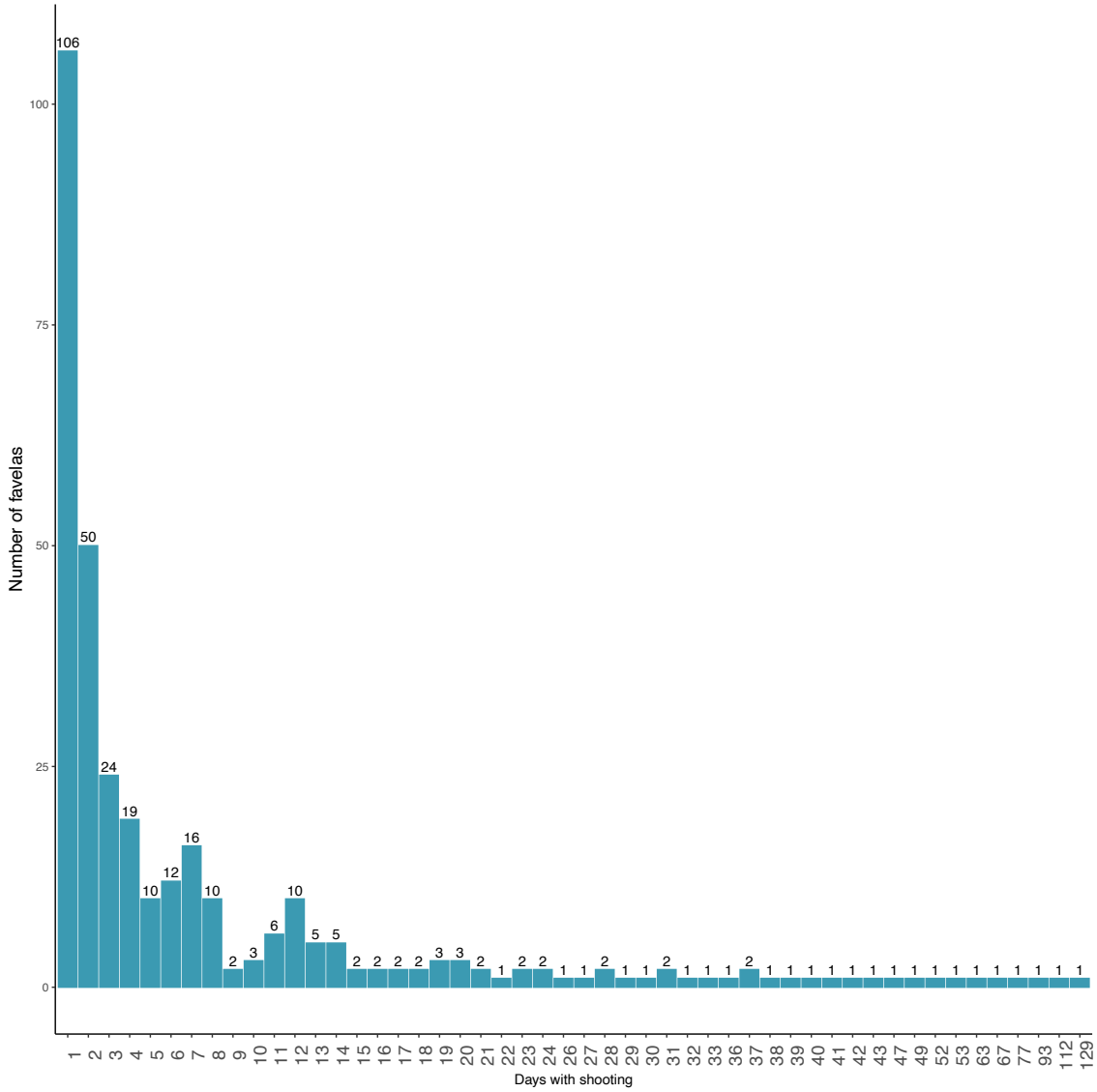


Note: The horizontal axis is the year, and the vertical axis is the number of favelas that had at least daily with shooting. The labels on the top of the bars are the number of favelas with at least one shooting in the given year.

Even when a favela or housing has shootings, 31% of them have only one day with gunfights between 2008 and 2019. Half of the housing complexes have only one shooting during the whole period. The favela with the most days with shooting is Morro do Juramento, with 129 days between 2008 and 2019, followed by Vila Kennedy, with 112 days. Figure 4.3 shows the distribution of days with shooting per favelas and housing from 2008 and 2019. The p50 of

this distribution is 3, p75, and p90 are 9 and 22 days with shooting. There are 85 favelas and housing at the p75 and 34 at p90.

Figure 4.3 Number of favelas by total days with shooting: 2008-2019

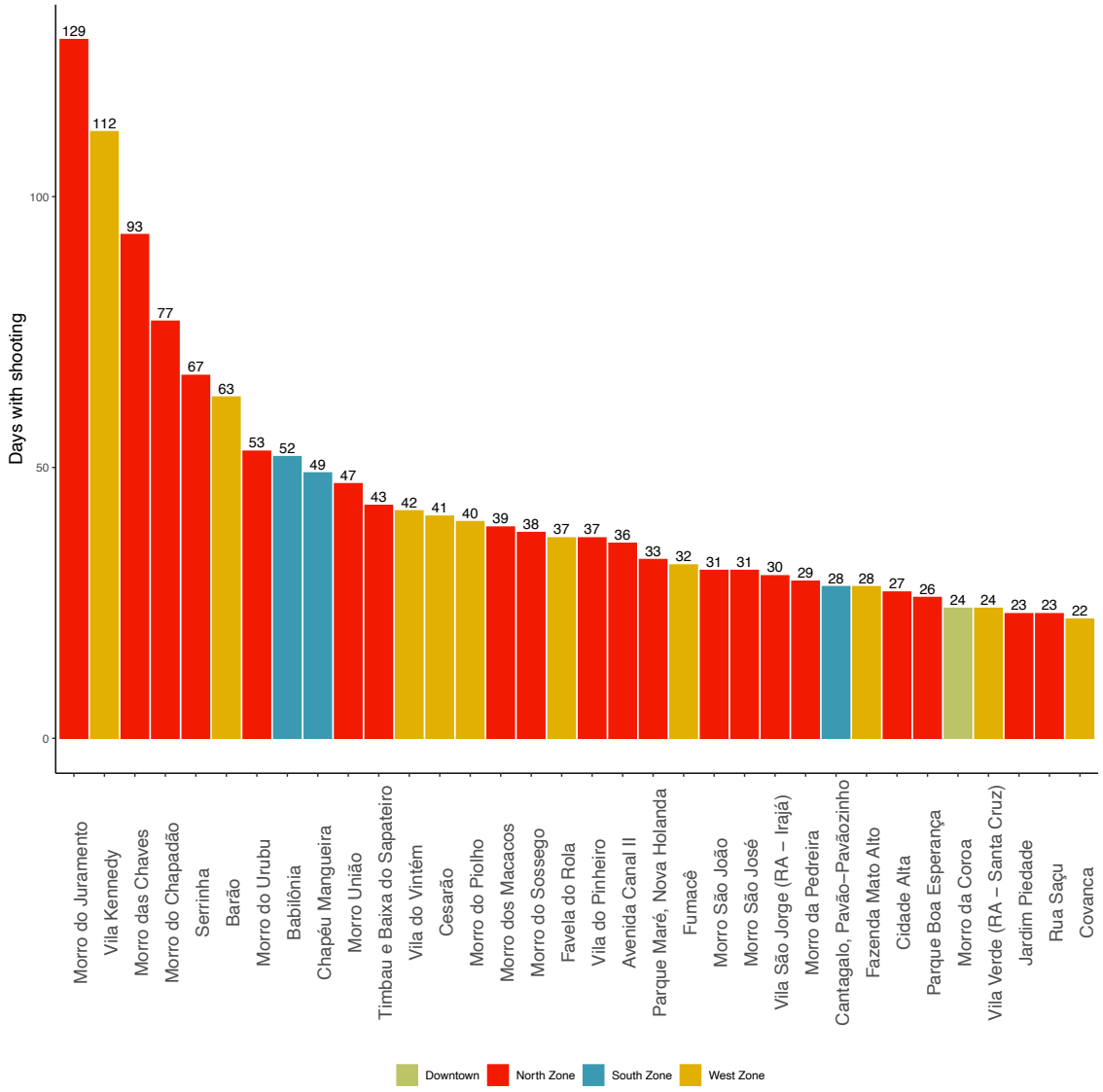


Note: The vertical axis is the number of favelas, and the horizontal axis is the number of days with shootings between 2008 and 2019. The labels on the top of the bars are the number of favelas with a certain amount of shootings.

Zooming in at favelas in p90, which have 22 or more days with shootings, we notice variations in the number of favelas and housing with shootings during the years. We see that not all of them have shootings all over the years. Thirty of them had at least a day with gunfights in 2011, while only 18 had a gunfight in 2016 and 2017. This presents evidence that even when criminal groups dispute a favela or housing, this dispute is not constant through time. Only one of them have gunfights all of the years: Morro do Juramento, the most violent favela.

Figure 4.4 plots the most violent favelas and their days with shooting between 2008 and 2019 per zone. This figure also shows us that the most disputed favelas are not in the south zone, as common sense usually says. They are primarily in the north zone. So even when a dispute is motivated by the drug profits generated by the external markets, this is not the primary motivation. Around 58% are in the north zone, a third are in the west zone, while three are in the south zone and only one downtown.

Figure 4.4 Most violent favelas by zone

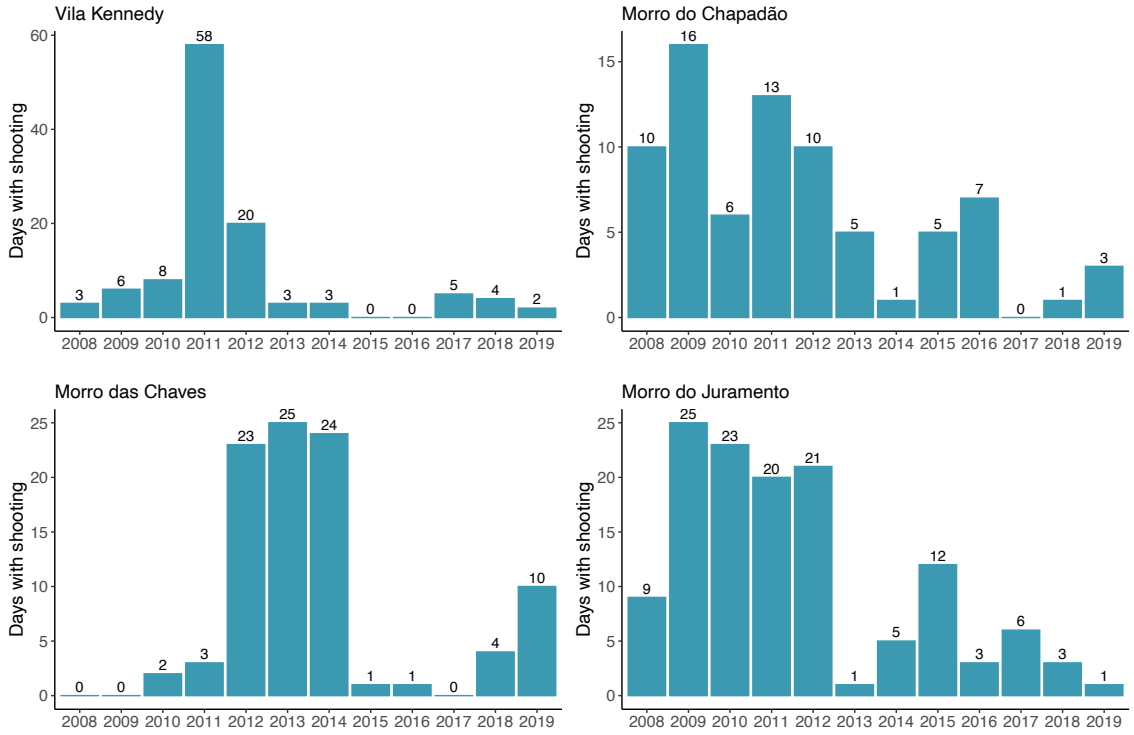


Note: The vertical axis is the days with shooting between 2008 and 2009. The horizontal axis is the favelas in p90. The colors represent a different zone of the city.

As seen in the figure 4.4, the top 6 most violent favelas have a more considerable difference of days than the other 28. The average number of days with shooting to this group is 44.3 days, with a standard deviation of 25.2 days. Figure 4.5 shows how the disputes vary across

years to the four most violent favelas. While Morro do Juramento and Morro do Chapadão have gunfights between criminal groups almost every year, Vila Kennedy had two very violent years: 2011 and 2012. Also, Morro das Chaves had the years of 2012 to 2014 very violent, and it seems that since 2018 conflicts came back to the fore.

Figure 4.5 Selection of four most violent favelas



Note: The horizontal axis is the years, the vertical axis the days with shooting. The labels on the top of the bars are the days with shooting in each year.

CHAPTER 5

Theoretical Framework

This chapter examines the effect of changes in the value of territories on the disputes among criminal groups in Rio de Janeiro's favelas. First, we formalize the relationship between the increase in the value of certain territories and their conflict. Second, we introduce the main econometric specification of the effect of socioeconomic and geographic variables on the probability of having a turf war.

5.1 Turf War

We propose a model in which turf war among criminal groups is a function of territory protection and markets. The model's motivation is to show how conflicts vary in time and space. Criminal groups aim to conquer territory to sell drugs, explore illegal activities, such as security fees and services supply (tv, internet, etc.), and protect themselves from the police and other groups.

Criminal groups seek to monopolize territory because it increases the share of the market that they can supply and explore. Since illegal markets face a lack of formal mechanisms and systematic rules to deal with disputes and disagreements between criminal groups, the competition between groups is unstable, and it is based on armed confrontations (RIOS, 2013; MISSE, 2011). The easier is to hide from the police and protect from other groups, the greater the territory protection this favela offer, the more desirable it is. Also, the bigger the market, the more desirable the favela is. Since different aspects influence the conflict for a favela, we aim to clarify how these aspects interact with this model.

Model

Consider a city with I favelas (potential places where a criminal group can be installed). Each I favela has territory protection, α_i, such as inclination, distance to other favelas, etc. Each favela also has a market, ω_i, where the group explores illegal activities, like drug selling,

extortion, security fees, etc. This market ω can be separated into β, close external markets, and γ, the local market. α_i is fixed in time, while β_i and γ_i vary in time. In this city, there are different criminal groups. The distribution of favelas controlled by them is given. The model predicts three outcomes: always peace, always turf wars, and periods of peace interspersed with periods with turf war. By now, we will only analyze the outcome that there are always turf wars. We do not make distinctions between criminal groups for the time being, even though each of them has its particularities. We only assume that the entrant criminal group has mobility advantages to move its men across the city's favelas very fast. Neither do we take into account the direct role of the police and the internal structure of criminal groups in turf wars.

Individuals in illegal activities

Individuals have different payoffs based on illegal activities, according to their territory characteristics. They can either be part of a criminal group that is an incumbent or an entrant. The only difference between incumbents and entrants is that incumbents have lower mobility[1] across territories than the entrants. Individuals engaged in illegal activities tend to be young and uneducated men, reflecting evidence that drug gang members are mainly males between 11 and 24-year-old, with an average age of 16-year-old, provided Carvalho and Soares (2016). Based on this evidence, we suppose they have difficulties finding formal jobs and that the informal jobs pay meager wages, so we assumed their outside option is shallow.

Decision

When an individual at an incumbent territory engages in illegal activities, he has a payoff equals to ω_i^T that is a function of α_i, β_i, γ_i. This is typically what he gets when their criminal group is successful in defending its territory. When this same individual at an incumbent domain engages in illegal activity, but the entrant defeats their criminal group, he gets zero. On the other hand, an individual at the entrant group has a payoff equals to ω_i^M that is a function of α_i, β_i, γ_i. He also gets a gain zero if he does not win the conflict.

The game is model as a Stackelberg game: the entrant moves first and decides the level of violence, M, and the incumbent moves after and decide their level of violence, A_i. We model the level of violence as a discrete decision, where the group can choose either the lowest level,

[1] At the two territory model (under development), the mobility differences matter for the outcomes. By now, the mobility differences do not play an essential role.

zero, or the highest level, one. The criminal group has a linear cost of applying the chosen level of violence.

Game

The Incumbent

In $t = 2$ the incumbent criminal group chooses A_i. Its expected utility can be written as:

$$u^e_{Ti}(A_i) = \alpha_i \frac{A_i}{M} \omega_i^T - A_i \tag{5.1}$$

Where α_i is a parameter for the natural protection at favela i, A_i can be interpreted as the number of men in the incumbent group in favela i, M can be interpreted as the number of men in the entrant group. ω_i^T is the income has in favela i. It is worth noting that A_i increases the incumbent benefit to fight but also imposes a linear cost.

The criminal group chooses $A_i \in [0,1]$, that is low violence or high violence. When it chooses $A_i = 1$, high violence,

$$A_i = 1 \iff \frac{\alpha_i}{M} \omega_i^T > 1 \tag{5.2}$$

So,

$$M < \alpha_i \omega_i^T \tag{5.3}$$

From equation 5.3 we got that the incumbent only chooses the high level of violence when $\alpha_i \omega_i^T > M$.

The Entrant

In $t = 1$ the entrant chooses M. Its expected utility can be written as:

$$u^e_{M,i}(M) = \begin{cases} \omega_i^M - M, & \text{if M} \geq \alpha_i \omega_i^T \\ \left(1 - \frac{\alpha_i}{M}\right) \omega_i^M - M, & \text{if M} < \alpha_i \omega_i^T \end{cases} \tag{5.4}$$

Its optimal choices can be written as:

- if $M^* \geq \alpha_i \omega_i^T$, then $M^* = \alpha_i \omega_i^T$: upper bound
- if $M^* < \alpha_i \omega_i^T$, then $M^* = \arg\max_m \left(1 - \frac{\alpha_i}{M}\right) \omega_i^M - M$

$$FOC: \quad \frac{\alpha_i}{M^2}\omega_i^M = 1 \Rightarrow M^* = \sqrt{\alpha_i \omega_i^M} \tag{5.5}$$

Where 5.5 is the first-order condition of the incumbent problem.

$$u^e_{M,i}(M^*) = \begin{cases} \omega_i^M - \alpha_i \omega_i^T, & \text{if} \quad \sqrt{\alpha_i \omega_i^M} < \alpha_i \omega_i^T \\ \left(1 - \frac{\alpha_i}{\sqrt{\alpha_i \omega_i^M}}\right) \omega_i^M - \sqrt{\alpha_i \omega_i^M}, & \text{otherwise} \end{cases} \tag{5.6}$$

Where 5.6 is the value function of the entrant problem.

Impact of α on Turf Wars

From the first line from equation 5.6, we have:

$$\alpha_i \omega_i^M < \alpha_i^2 (\omega_i^T)^2 \tag{5.7}$$

$$\frac{\omega_i^M}{\omega_i^T} < \alpha_i \tag{5.8}$$

If 5.8 holds, then $A_i = 1$ and there is conflict. Otherwise, $A_i = 0$, and there are no conflicts.

Proposition 1:

When α_i increases, $\frac{\omega_i^M}{\omega_i^T} < \alpha_i$ holds for a larger set of parameters values, which means more conflicts.

Lemma 1:

When $\frac{\omega_i^M}{(\omega_i^T)^2}$ decreases, $\frac{\omega_i^M}{\omega_i^T} < \alpha_i$ holds for a larger set of parameters values, which means more conflicts.

Impact of β on Turf Wars

From lemma 1, when we differentiate[2] $\frac{\omega_i^M(\beta)}{(\omega_i^M(\beta))^2}$ with respect to β, we have:

$$\frac{\omega_i^{M'}}{\omega_i^{T'}} < \frac{2\omega_i^M}{\omega_i^T} \tag{5.9}$$

Which is the condition for $\frac{\omega_i^M}{(\omega_i^M)^2}$ to be decreasing in β.

[2] See Appendix C for more details.

Proposition 2:

Hence, because of lemma 1,
$\frac{\omega_i^{M\prime}}{\omega_i^{T\prime}} < \frac{2\omega_i^M}{\omega_i^T}$, is the condition for conflicts to be increasing in β.

In short, from propositions 1 we have that territory protection, measured by α_i has a positive effect on turf wars. From proposition 2 we got that a bigger consumer market increases turf wars for these markets. In the next section, we relate these parameters to observed variables.

5.2 Empirical Strategy

To test how socioeconomic and geographic characteristics affect turf war in Rio de Janeiro's favelas, we estimate OLS regressions. The purpose of this analysis is to identify if the most disputed favelas have a specific geographic or demographic profile. We estimate the following OLS specifications:

$$Y_{it} = \beta_0 + {}_1 X_{it} + {}_2 Z_i + {}_3 Q_{it} + \varepsilon_{it} \tag{5.10}$$

Where Y_{it} is either the number of reports, days with shooting, or a dummy that measures turf wars in favela i, on year t. β_0 is a constant, X_{it} is a vector with proxies for the consumer market, Z_{it} is a vector with favelas' characteristics. Q_{it} is a vector of favelas' controls and ε_{it} is an error term. In vector X_{it} we have the average wage bill yearly, the average distance to highways, the favela population in 2010, the favela area in 2019, and population density. Vector Z_i contains variables such as average distance to other favelas and average inclination of favela i. We use the percentage of paved streets, percentage of public lighting, a dummy for UPP presence in a given year as controls.

We relate variables from vector X_{it} to the β parameter from section 5.1, the consumer market, and vector Z_{it} to territory protection, the α_i parameter also from section 5.1.

CHAPTER 6

Results

In this chapter we establish novel facts regarding turf wars based on OLS estimations. The hypothesis behind this descriptive analysis is that favelas represent a source of monopoly for their explorer, serve as bunkers to hide illegal goods, and hide from the state and other criminal groups.

6.1 Empirical Results

Following the specifications from chapter 5, we estimate the regressions and show the coefficients in table 6.1. Each column at table 6.1 presents estimates for different dependent variables. For example, column 1 shows the estimation for the number of reports, column 2 for the days with shooting, column 3 for the number of turf wars in a year, and column 4 for the turf war dummy. The idea is that when we move from column 1 to column 2, we have a dependent variable that captures more violent conflicts, and the same with columns 2, 3, and 4.

Consistent with the prior literature, the first fact we document is that the more a favela is distant from another favela, the fewer conflicts it has. A one km increase in the distance to other favelas decreases the number of reports by 0.02, on average. This translates into a decrease of 8.3% in the number of reports. The effect is smaller when we look at days with shootings: a one km increase in the distance to other favelas decreases the shootings by 5% on average. However, when we move to the turf war variables, the effect is larger: a one km increase in the distance to other favelas decreases the number of turf wars and its probability by 10% and 0.1 pp. on average respectively. This fact goes in line with Bruhn (2021), where violence in Chicago is mainly driven by the proximity of rival gangs but not by gangs' existence. The average inclination affects only the probability of having a turf war. A one km increase in the average inclination increases, on average, increases in 3.5% the number of turf wars. This means that more inclined favelas have more turf wars, however, the inclination only affects really violent events.

The average distance to highways does not have a statistically significant effect on the turf war variables. However, an one km increase in the distance to highways decreases the reports by 0.01 on average. This translates into a decrease of 4% on reports on average and 0.5% on the days with shooting

Table 6.1 OLS Estimates

	Dependent variable:			
	Reports	Days with shooting	Turf wars	Turf war dummy
	(1)	(2)	(3)	(4)
Distance to other favelas (km)	-0.02^{***}	-0.01^{***}	-0.001^{***}	-0.002^{**}
	(0.01)	(0.004)	(0.0004)	(0.001)
Ave. inclination (km)	0.32	0.42	0.07^{**}	0.03
	(0.43)	(0.31)	(0.03)	(0.06)
Av. distance to highways (km)	-0.01^{**}	-0.01^{***}	-0.0003	-0.001
	(0.005)	(0.003)	(0.0003)	(0.001)
Ave. wage bill (ln)	-0.05^{***}	-0.03^{***}	-0.003^{***}	-0.01^{**}
	(0.02)	(0.01)	(0.001)	(0.002)
Population Density (ln)	0.28^{***}	0.22^{***}	0.01^{***}	0.03^{***}
	(0.01)	(0.01)	(0.001)	(0.002)
Observations	11,532	11,532	11,532	11,532
R^2	0.05	0.06	0.02	0.03
Average	0.24	0.2	0.02	0.01

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

on average. A one-unit increase in the population density increases by 0.28 the reports on average. This means an increase of 1.16% on the reports, 1.1% increase in the days with shooting, 0.5% increase in turf wars, and 3 pp. increase in the probability of having a turf war. These results are following our conflict model that the consumer market plays a positive role in turf wars.

In opposition with our model, where the external consumer market have a positive effect on conflicts, the average wage bill of the surroundings have a negative effect on conflicts. A one-unit increase in the average wage bill decreases the reports in 0.05. This means a decrease of 0.2% on the reports, a 1.1% decrease in the days with shooting, a 0.15% decrease in turf wars and a one pp. decrease in the probability of having a turf war. These results also go in contrary with the common sense and local press, that the disputed favelas are the ones located in rich neighborhoods.

In short, more inclination, more proximity to other favelas and to highways and a greater population density have a positive correlation with disputes between criminal groups. On the other hand, favelas with greater average wage bill of its surroundings have a negative correlation with conflicts.

To verify if the effects vary across criminal groups, we restrict the sample to criminal groups. Table 6.2 presents heterogeneous estimates for Comando Vermelho (CV), Terceiro Comando Puro (TCP), and Milicia. We excluded Amigo dos Amigos (ADA) from this analysis due to the lack of observations. We only estimate regressions for the turf war dummy as a dependent variable.

The distance to other favelas is statistically non-significant for turf wars in favelas controlled by CV, TCP and Militias. A one km increase in the average inclination increases by 0.44 on average the probability of turf war in favelas controlled by Militias. This translates into an increase of 22 pp.

In favelas owned by CV, a one-unit increase in the average wage bill of its surroundings decreases, on average, the probability of having a turf war in 0.01. This translates into a decrease of 0.2 pp. A one-unit increase in the population density in CV favelas increases, on average, the probability of having a turf war in 0.03. This translates into an increase of 0.6 pp. on average.

In favelas owned by Militia, a one km increase in the distance to highways decreases by 0.001 on average the probability of turf wars, which represents a decrease of 0.05% on the probability of turf wars. In favelas controlled by Militias, a one-unit increase in the population density increases by 0.01 on average the probability of turf war, which means a 0.5 pp. increase.

In short, the main differences across criminal groups are that turf wars in CV favelas' are negatively correlated to the average wage bill and positively correlated to the population density. In TCP favelas' turf wars do not seem to be related to any of these variables, but it its possibile that these results are driven by a small sample, since it only have 216 observations. Finally, in Militias' favelas, turf wars are positively related to the favelas' inclination and population density, and negatively correlated to the distance to highways and favela area. These differences can be related to different types of economic ac-

Table 6.2 Heterogeneous Effects - Turf War dummy

	Armed Group:		
	CV	TCP	Militias
Distance to other favelas (km)	−0.003	−0.01	0.001
	(0.003)	(0.004)	(0.001)
Ave. inclination (km)	0.22	−0.07	0.44***
	(0.18)	(0.28)	(0.11)
Av. distance to highways (km)	0.003	0.004	−0.001*
	(0.003)	(0.003)	(0.001)
Ave. wage bill (ln)	−0.01*	−0.001	−0.001
	(0.01)	(0.01)	(0.003)
Population Density (ln)	0.03***	0.01	0.01***
	(0.01)	(0.01)	(0.002)
Observations	1,248	216	3,035
R^2	0.05	0.05	0.04
Average	0.05	0.02	0.02
Note:	*p<0.1; **p<0.05; ***p<0.01		

tivities these groups explore: while CV and TCP explore mainly drug selling, Militias explore securities fees, TV and Internet, Cooking Gas, etc (MONTEIRO; FAGUNDES, et al., 2021).

CHAPTER 7
Conclusion

This paper uses data from Disque Denúncia and Instituto Pereira Passos over 12 years to build a new dataset on turf wars in Rio de Janeiro. We document new stylized facts regarding the distribution and dynamics of turf wars. First, we create a measure of a turf war to distinguish random gunfire from intense conflicts and find that turf wars are not a common phenomenon through all the favelas in Rio. Second, we formalize territory disputes between criminal groups with a theoretical model for territorial protection and market exploration. Finally, based on OLS estimates, we document new stylized facts about turf wars distribution and dynamics over the territory and time and heterogeneities between criminal groups.

From these data, we learned that shootings vary a lot across time and space, even in the most violent favelas. In general, our results show that criminal groups dispute areas that serve as hideouts from other criminal groups and the police and explore illegal economic activities. However, these variables are mostly fixed in time and do not explain the time variation in turf wars. More work is needed to further deepen the time variation in turf wars.

In line with previous literature, the proximity with other favelas have is positively related to turf wars. However, the different sources of territory protection have different effects, so the general protection effect is ambiguous, in line with our theoretical model. Also, according to common sense, the external consumer market, which can be proxied by wage bill and distance do highways, empirically is negatively correlated with turf wars. On the other hand, the local consumer market, proxied by population density, is empirically a fundamental determinant of turf wars.

Yet, criminal groups present differences in values of these determinants. When we look at heterogeneities between them, we notice that the main differences across criminal groups are that turf wars in CV favelas' are negatively correlated to distance to other favelas and negatively correlated to the distance to highways. In TCP favelas' turf wars do not seem to be related to any of these variables. Finally, in Militias' favelas, turf wars are positively related to the favelas' inclination, favela population, and population density and negatively correlated to the distance to highways and favela area.

These findings are essential for two reasons. First, mapping turf wars are necessary for any rational policy response that seeks to weigh the costs and benefits of various criminal group interventions. Second, the results help shed light on the limitations of standard economic theories of competition as a tool for understanding illegal markets. Understanding the types of crimes, settings, and institutions,

where traditional economic theories do not apply to illegal markets, is important for future work. Also, identifying the causes of violent events might be decisive in designing effective interventions to reduce criminal groups' violence.

An important limitation of this study is its inability to provide causal evidence regarding the impact of socioeconomic and geographic changes on turf wars. Nevertheless, this paper is a first step towards understanding the triggers of turf wars between criminal groups. It is possible that others facts, such as changes in the criminal group's internal structure and the role of police operations, also play an essential role in turf wars. However, developing this richer, complete view of the causal effect of criminal group structure and police operations is left for future work. In addition, a better understanding of the specific favela-level factors that produce such environments should be a critical goal for subsequent empirical work.

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APPENDIX A

Disque Denúncia Shooting Data

This appendix presents how we used the Disque Denúncia (DD) callings data to build our shooting measure. We first gathered all the reports between 2008 and 2019 classified as "gunfights between criminal groups." There is an excellent variety in the report's content, but we could extract the date of call, a location reference, and an event description in all of them. Most of the reports are simple, as we can see below:

> *"On the aforementioned avenue, after the blue bridge, there is an intense gunfight between traffickers from rival factions."*

Others have a great wealth of details, providing crucial information for the police, such as a drug dealer location, and show how these conflicts are violent:

> *"At the address mentioned, in front of the botafogo road, near the br gas station, in the interior of the Morro da Pedreira, there is a house where ""Cleusemar"" lives (not characterized), who is the mother of the drug dealer alias "Dedo Nervoso" (not characterized) and receives money from the drug trafficking that operates in the community, to hide under the floor of his residence, a large amount of weapons. According to information, on today's date (01/03/2016), the traffickers from the aforementioned favela will get all their arsenal from the place where it's hidden and will head for the favela Para Pedro, in Irajá, where they will attack rival traffickers, to dominate their territory."*

Although DD always asks for the complete address (street, number, and zip code), people don't always give it details. In some cases, only the name of the favela was given. The exact location of some confrontation can be more challenging to identify since the person can frequently mention a complex of favelas. To deal with this type of problem, a combination of the reported addresses, the name of the favela (when it was mentioned), and the content of each report was used to identify where the described confrontation took place. Based on this information, each report was associated with a favela in the city via the file made available by the Instituto Pereira Passos (IPP) that contains Rio's territorial configuration and favela and housing complex boundaries. In some cases, this association was not immediate for three reasons. First, often no favela name was mentioned in the complaint. Given this

difficulty, we used the IPP files on Google Earth, adding the address or other information given in the complaint. Second, if the address was within a favela or housing or close to its boundary, the report was associated with that favela or housing. Addresses far from a favela or housing were classified as "asphalt" and excluded from the sample.

Another challenge is the fact that people use different names to refer to the same favela or housing. Furthermore, the name of the favela used by IPP is not always the same as the most commonly used by the population. For example, the favela popularly called Parada de Lucas or just Lucas is registered in the IPP as Parque Jardim Beira Mar. IPP also reports the list with alternative names, making it possible to make the names used by the population compatible with the names used in the IPP file. However, IPP does not report the popular name in housing complexes, so we had to google it. Most of the time, we were able to find some news where there were the official and popular names, like in the case of Fumacê, which official name is Conjunto Água Branca. We also added other possible popular names to this file when the favela had more than one.

In this effort to standardize the addresses, the content of each report was read to ensure that each report reported a gunfight that happened at the location and on the date reported. Consequently, reports that mentioned a potential shooting, some threat of a confrontation at the location were excluded, and reports with the location of corpses and drug dealers did not mention that an armed confrontation occurred at that place and date. In addition, some reports informed one address but referred to a confrontation that took place elsewhere. In this case, the address was changed to ensure that it referred to the actual location of the confrontation.

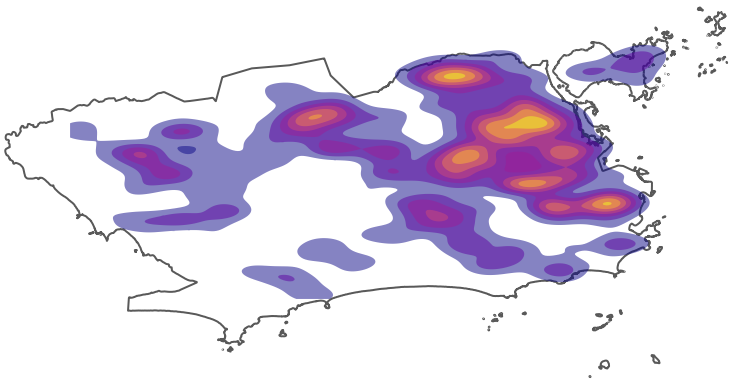


Figure A.1 Gunfights distribution between 2008-2019

A similar adjustment was needed for dates. For example, sometimes, people would call in and report that an armed confrontation had occurred three days earlier, and the DD would record the day

of the call. The dates were then corrected to ensure that they referred to the date that the confrontation actually occurred.

This procedure finally generated a list of favelas and housing containing the dates on which armed confrontations took place in the city. Figure A.1 plots the spatial distribution of gunfights. In the analysis, the primary measure used is a dummy equals one when the number of days on which at least one report was made in a week is equal or greater than two. This variable distinguishes random shootings from a turf war since it captures the more frequent and violent conflicts between criminal groups.

APPENDIX B

Validating Disque Denúncia Data

Using Disque Denúncia data brings some concerns. The decision to report an illegal activity supposes some trust in the police system and hopes to take some action. The biggest challenge for our analysis is that some city areas report more than others or that some events affect people's willingness to report overtime differently. While there is no data to indicate how the population's trust in DD varies across different city areas and over time, this session presents a range of evidence to indicate that a DD-based measure of turf wars is at least as good as existing alternatives.

The first concern about DD is that people do not call them because they are afraid of being identified. However, Cano (2008) stresses that DD is an essential source for types of crimes that are not usually reported officially, either because of fear of the whistleblowers or disbelief in the system. The calls to DD do not need the person who called to identify itself, and it can be made from anywhere, for example, home or work. Calling DD involves a low personal and time cost compared to the traditional form, where the person needs to go to a police station, etc.

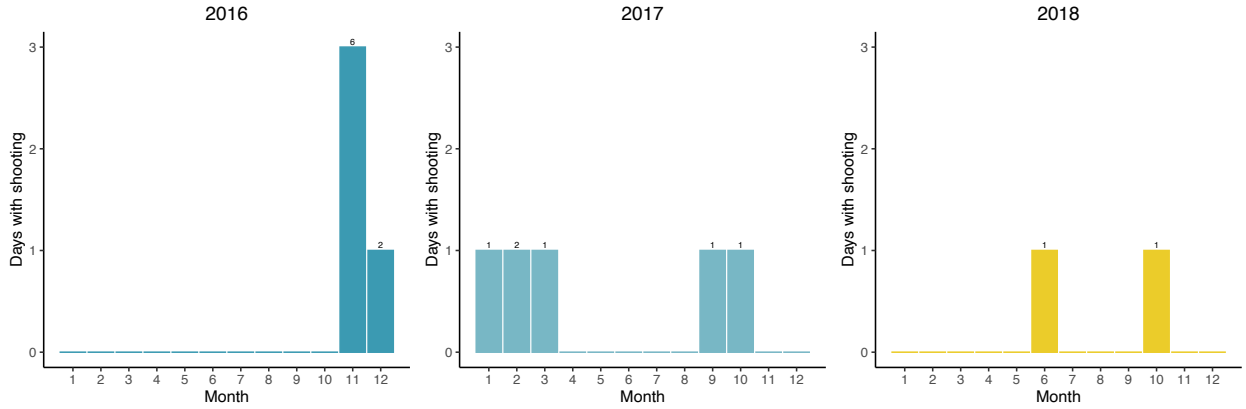
The second concern is that people do not call when the events are common, which is more outstanding in more violent places. For example, if a place has shootings every day, possibly this turns into routine events and does not motivate people to call. They would only call when there is sometimes unusual going on. Since we would also like to get the frequent events, this can cause measurement errors in our variable. In this case, this measurement error can make the variables downward biased. If we have a downward bias in our main variables, the findings we made are the lower bound of the effects, which does not affect our work that much.

To validate this data, we build upon Chaves (2021), a case study about Peixão, a drug dealer. Peixão is one of the Terceiro Comando Puro (TCP) leaders in Rio de Janeiro. It is notable for being Pentecostal and chasing practitioners of Afro-Brazilian regions in its domains. He usually denominates their group as Aaron's troop. He built a complex known as Complexo de Israel in the last few years by taking close favelas and housing. He was originally from Parada de Lucas, a favela in the north zone. Nowadays, the Complexo de Israel is formed by Vigário Geral, Parada de Lucas, Cidade Alta, Pica-Pau, Cinco Bocas, Quitungo and Guaporé. Figure B.1 shows the locations on a map.

Figure B.1 Complexo de Israel

Source: Chaves (2021)

Figure B.2 Shootings in Cidade Alta



Note: The horizontal axis is the months, the vertical axis is the number of days with conflicts in a month, and the labels on the top of the bars are the number of reports in a month.

According to Chaves (2021), in November 2016, his troop invaded Cidade Alta, a CV territory, with the help of a former CV member. In June 2018, Aaron's troop took Pica-Pau, with drones and police support. In May 2019, his troop killed eight people in Cinco Bocas. In November 2019, he was part of a police incursion in Complexo da Penha, a favela that belongs to a rival group, Comando Vermelho (CV). In May 2020, Peixão allied with Guaporé and Quitungo, and in June 2020, he invaded Cinco Bocas.

Since our data go until 2019, we focus on the early events driven by Peixão: the invasion of Cidade Alta in November 2016. We begin by looking figure B.2 the days with a conflict between 2016 and 2018. The horizontal axis is the months, the vertical axis is the number of days with conflicts in a month, and the labels on the top of the bars are the number of reports in a month. We can notice that in November 2016, there is a spike in reports and days with reports. In November 2016, there were three days with shootings. When we look at our variable of turf wars, a dummy equals one when there are two or more days with shootings in a week, we notice that it takes value one. In fact, when we look at the date of these reports, we observe that the calls were made for three days in a row, during the same week. This event is exactly what we wanted to get from our turf war measure.

Above, we list the report's contents about the Cidade Alta invasion in November 2016 to gain more confidence about this visual inspection.

- Call at November 16th, 2016: "In the aforementioned street, accessed from Avenida Brasil, in the community of Cidade Alta, at this moment, armed traffickers from the communities of Para Pedro and Parada de Lucas can be found, who are invading the area and exchanging fire with local traffickers."

- Call on November 16th, 2016: "In the aforementioned street that accesses the community of Cidade Alta, where at this moment an intense exchange of fire is taking place between rival

factions of traffickers (not identified). Members of the CV faction (Comando Vermelho) are trying to retake control of this community, which is currently controlled by the TCP faction (Terceiro Comando Puro)."

- Call on November 17th, 2016: "On the aforementioned street, which accesses the community of Cidade Alta, where an intense exchange of fire is currently taking place between rival drug trafficking factions. The invading drug traffickers are also being covered by military police armored car number 51-0005, which is transporting the invaders to the interior of Cidade Alta. The aforementioned armored car is still in the upper city."

- Call at November 17th, 2016: "At the aforementioned street in the community of Cidade Alta, at this very moment, the "caveirão" can be seen, prefix 51-0005, where military police officers from the 16th BPM are giving support to rival drug dealers and helping them invade the area. Calls for urgent measures, as there is already an intense shootout."

- Call on November 18th, 2016: "In the aforementioned community (Cidade Alta), specifically in Divinéia and Avilã, there are currently traffickers from the TCP, who are hiding inside homes and taking residents hostage. He added that the military police are not acting in defense of the residents, who are cornered."

- Call on November 18th, 2016: "In the aforementioned street, near the Rede Economia market, you can see, at this moment, more than ten (unidentified) individuals armed with rifles, members of the CV, exchanging fire with (unidentified) traffickers from the TCP. The aforementioned are terrorizing residents."

By reading the reports, we can notice that, in fact, Peixão was attacking Cidade Alta. The visual inspection of figure B.2 goes in line with what we read in the reports. By the dates and the variables we use to measure turf wars, we can get violent and frequent events using this data.

APPENDIX C

Model Details

In this chapter we present step-by-step the result in equation 4.9.

$$\frac{\partial}{\partial \beta} \frac{\omega_i^M(\beta)}{(\omega_i^T(\beta))^2} = \tag{C.1}$$

$$\frac{\omega_i^{M'}(\omega_i^T)^2 - 2\omega_i^T \omega_i^{T'} \omega_i^M}{(\omega_i^T)^4} < 0 \tag{C.2}$$

$$\omega_i^{M'}(\omega_i^T)^2 < 2\omega_i^T \omega_i^{T'} \omega_i^M \tag{C.3}$$

$$\omega_i^{M'} \omega_i^T < 2\omega_i^{T'} \omega_i^M \tag{C.4}$$

$$\frac{\omega_i^{M'}}{\omega_i^{T'}} < \frac{2\omega_i^M}{\omega_i^T} \tag{C.5}$$

We also illustrate it with a linear example. Let $\omega_i^M(\beta) = r\omega_i^T(\beta), \forall \beta, r > 0$.

Them,

$$\omega_i^{M'} = r\omega_i^T(\beta) \tag{C.6}$$

$$\frac{\omega_i^M}{\omega_i^T} = r = \frac{\omega_i^{M'}}{\omega_i^{T'}} \tag{C.7}$$

Since $r < 2r$ for $r > 0$, condition 4.8 holds.