Academic Year 2024/25

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Coversheet for Submission:
GV499 Dissertation

1. You must complete all sections of this coversheet for submission and insert it into the front page of your work (i.e. 'Select All' then Copy and Paste this page into your assessment). **You must ensure you upload the correct and most up to date version of your work and keep a copy of it before submitting it.**

2. Your submission should be saved (with this coversheet at the front) as a **Microsoft Word Document (.doc or .docx) or pdf file** and uploaded as **ONE individual file**.

3. Save your assessment using your five-digit **candidate number** followed by your **course number** in the filename (e.g. 78654_GV499.doc).

4. Make sure your five-digit candidate number is included in your document (i.e. in the header or footer). **Your name must NOT appear anywhere in the document.**

5. You must ensure you submit your work with the completed coversheet within the specified deadline. Failure to submit before the deadline could result in the application of late submission penalties

CANDIDATE NUMBER: (**Five digit number** available via LSE for You – this is not the same as the number on your LSE ID card.)	4 2 4 3 3
PROGRAMME TITLE: (e.g MSc Political Theory)	**MSc Political Science & Political Economy**
WORD COUNT:	9639

Please put an X in this box if you are happy for us to use your work as an example for future students. (All identifying features will be removed).	X

Organised Crime, Criminal Violence, and State Capacity

Evidence from Paraguay's Frontier with Brazil[*]

Candidate Number: 42433

Word Count: 9639

Submitted in partial fulfilment of the requirements for the MSc in Political Science and Political Economy

Department of Government, LSE

[*]I am deeply grateful to my supervisor, Dr. Felipe Torres Raposo, for his invaluable guidance throughout the year, and especially for his support in this dissertation. I also wish to thank my family and friends for their unwavering encouragement during this MSc journey.

Abstract

This dissertation investigates how transnational organised crime affects lethal violence under different institutional capacity settings, focusing on the dry border between Paraguay and Brazil. Despite their geographic and demographic similarities, the two countries experience markedly different criminal outcomes along this shared frontier. Using a Difference-in-Differences design, the study finds that the presence of criminal groups like Primeiro Comando da Capital (PCC) and Comando Vermelho (CV) significantly increases homicide rates in Paraguayan border regions, while it decreases violence in comparable Brazilian zones highlighting the role of state capacity in shaping criminal behaviour.

The study makes both causal and substantive contributions. Empirically, it applies a rigorous identification strategy to one of the most violent yet underexplored zones in South America, providing causal evidence on organised crime dynamics in regions with similar geography but contrasting levels of institutional strength. Substantively, the findings reveal the mechanism through which institutional asymmetries shape the strategic behaviour of criminal groups, demonstrating that the issue is not merely one of resource allocation but of the state apparatus's very capacity.

Keywords: Organised Crime, Paraguay, Brazil, Criminal Violence, State Capacity

Contents

List of Figures

List of Tables

Introduction

Organised crime is not merely a consequence of weak governance; it thrives on it. Nowhere is this more evident than in the Southern Cone of Latin America, where transnational criminal organizations have expanded significantly over the past two decades, particularly along fragile and under-governed borderlands (UNICRI 2024). In regions like the dry frontier between Paraguay and Brazil, groups such as the Primeiro Comando da Capital (PCC) and Comando Vermelho (CV) exploit institutional voids to establish key logistical hubs for trafficking drugs, arms, and illicit capital. The fertile ground for criminal expansion in these areas is not defined solely by geography, but by systemic institutional weaknesses, corruption, and a lack of effective state control mechanisms (Martens 2020).

This research seeks to understand how the presence of organised crime groups is associated with lethal violence, and why two nations sharing the same border—Paraguay and Brazil—experience vastly different levels of criminal governance and violent outcomes. Building on causal mechanisms discussed in the literature, the dissertation examines how institutions shape criminal behaviour in border areas that share similar geography, culture, and demographics, yet operate under distinct judicial, political, and institutional systems.

From this, the main research question emerges:

- What is the causal effect of the expansion of transnational criminal groups on lethal violence in the Paraguay–Brazil dry border region?

The analysis relies on regional-level data and employs a Difference-in-Differences (DiD) approach, more specifically, a staggered triple DiD design, to identify the causal effects of organised crime expansion on violence. This design is essential because the phenomenon unfolds along three distinct dimensions: (i) border versus non-border areas, (ii) Paraguay

versus Brazil, and (iii) areas with versus without criminal group presence.

This topic addresses a critical gap in the literature. Most existing studies on organised crime in this region are qualitative, often based on fieldwork or ethnographic analysis. This dissertation offers a complementary quantitative approach, providing causal evidence on criminal dynamics in the Southern Cone, particularly along international borders. Few empirical studies directly compare structural and institutional differences across countries to assess how criminal groups adapt to and exploit governance disparities. In this way, the study contributes valuable new evidence to an underdeveloped but urgent area of research.

The dissertation is organised into four chapters. Chapter 1 provides the historical and institutional context of the study area, tracing the rise of major criminal organizations in the Southern Cone and highlighting the causal mechanism. Chapter 2 details the methodological approach, focusing on the staggered triple DiD design. Chapter 3 presents the main empirical results, including robustness checks and complementary analyses, and discusses their broader policy implications. Finally, Chapter 4 addresses the study's limitations, notably data constraints, the challenges of measuring covert criminal networks, and methodological complexities.

The findings have direct relevance for policy debates on border security, judicial reform, and the institutional role in combating organised crime. Leveraging the triple DiD design, the analysis shows that the presence of groups such as the PCC and CV significantly increases homicide rates in Paraguayan border regions, while reducing violence in comparable Brazilian zones. These contrasting effects underscore how differences in state capacity translate into divergent criminal outcomes.

Historical Context

Transnational organised crime has expanded hand-in-hand with economic globalization, embedding itself most deeply in emerging markets with limited state oversight and the Southern Cone of the Americas is no exception.(Ceballos 2018).

In recent years, this region has become a vital corridor for multiple illicit markets, including the trafficking of marijuana, cocaine, arms, and contraband goods. These illegal economies are no longer limited to domestic or regional actors; instead, they have become increasingly intertwined with global criminal supply chains. According to reports by the UN Interregional Crime and Justice Research Institute (UNICRI), certain criminal organizations in Latin America have developed operational ties with groups linked to terrorism, using arms and drug trafficking to fund insurgent or violent activities (UNICRI 2024). Similarly, the United Nations Office on Drugs and Crime (UNODC) highlights how access to international arms smuggling networks has enhanced the operational capacity of drug traffickers in the region, facilitating their expansion into transcontinental routes including those leading to Europe and West Africa (UNODC 2024).

Transnational Actors: Primeiro Comando da Capital and Comando Vermelho

According to InSight Crime, a non profit organization specializing on organised crime and corruption in Latin America, the growing presence of these illicit markets has facilitated the deepening penetration of transnational criminal organizations, particularly in Paraguay's border regions with Brazil. Among the most prominent actors are the Primeiro Comando da Capital (PCC) and Comando Vermelho (CV), whose expanding influence has raised serious concerns regarding public security, violence, and the erosion of state capacity. Both groups have made concerted efforts to consolidate territorial control over the dry border zone between Paraguay and Brazil (InSight Crime 2021*c*).

Comando Vermelho (CV) or Red Command, is one of Brazil's oldest criminal organizations. It emerged in the 1970s inside Rio de Janeiro's prisons, during the country's military dictatorship, as a coalition between common criminals and leftist political prisoners. Poor prison conditions fostered cooperation, which evolved into an exchange of knowledge on criminal structures and resource networks. By the 1980s, the group had entered the cocaine trade, working with Colombian cartels. Although its power declined after 2016, the CV remains influential and has served as a model for other criminal groups across Brazil. (InSight-Crime 2021*a*)

Primer Comando da Capital (PCC) is considered one of the most successful criminal prison gangs in the world. Founded in Brazil's prison system in the early 1990s, it has since expanded to over 30,000 members across 27 countries . Inspired by the structure of the Comando Vermelho (CV), the PCC gained strength throughout the 2000s and consolidated its presence in Paraguay and Bolivia, particularly after breaking ties with the CV in 2016.(InSight-Crime 2020)

While these groups began to explore the "Paraguay project" in the early 2010s, their full territorial consolidation came later. A key turning point was the orchestration of what remains the largest heist in Paraguayan history: the 2017 robbery of Prosegur[1], in which approximately USD 10 million were stolen in a single operation involving high caliber weapons and explosives (BBC 2017).

This was followed in 2020 by one of the country's most dramatic prison breaks, when more than 70 inmates most of them confirmed as members of the PCC escaped custody through a tunnel system allegedly built with internal support (Guardian 2020).

[1]The assault targeted the headquarters of Prosegur, a company specialized in transporting large volumes of cash.

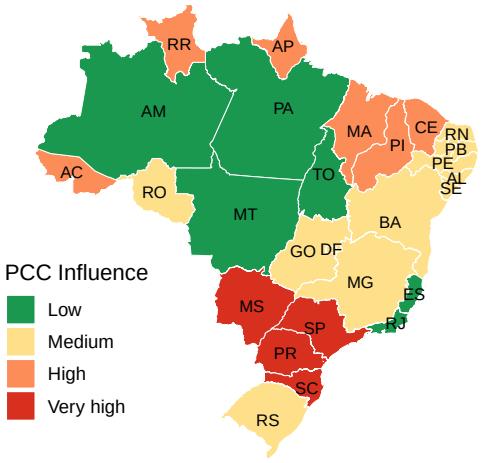


Figure 1: The influence of the PCC in Brazilian states
Source: Re-adaptation in English - 'A Guerra – A Ascensão do PCC e o Mundo do Crime no Brasil' by Camila Nunes Dias & Bruno Paes Manso. Map base: geobr

Organised Crime in Brazil

For decades, Brazil has suffered the consequences of organised crime, largely due to its vast territory and unique geographic position. The country shares borders with ten South American nations, including Paraguay one of the world's top marijuana producers and three of the main global cocaine producers: Colombia, Bolivia, and Peru (InSight-Crime 2023*a*). These conditions have turned Brazil into a strategic hub for multiple criminal economies, including arms trafficking, cocaine and marijuana smuggling, human trafficking, and the export of illicit goods to regions such as Europe, Asia and Africa (*Centre of Excellence for Illicit Drug Supply Reduction* 2021).

Brazil now hosts one of the most complex criminal ecosystems in Latin America. Long-standing prison gangs, transnational trafficking networks, and local militias coexist and compete across the country's vast landscape. Major groups such as the aforementioned, PCC and CV have developed sophisticated criminal operations spanning drug, arms, and human trafficking. Meanwhile, regional factions operate in states like Amazonas, Pará, and Mato Grosso do Sul, often controlling key trafficking routes for narcotics and

weapons. Additionally, urban militias some linked to former or current state security forces wield significant territorial influence, particularly in cities like Rio de Janeiro.

Given the scale and fragmentation of Brazil's criminal landscape, this research focuses specifically on the PCC and CV, with particular attention to their operations in strategic border states such as Mato Grosso do Sul and Paraná. These regions serve not only as logistical corridors but also as territorial footholds for these groups, who consolidate power through prison based networks and control of trafficking routes (InSight-Crime 2023*a*).

Organised Crime in Paraguay

Paraguay has, over the past few decades, emerged as a key logistical hub for organised crime in the Southern Cone. This status is not only due to its strategic geographic location at the heart of the South America but also to the flexibility and weakness of its institutions, which have facilitated the rapid expansion and consolidation of illicit activities (InSight-Crime 2018). Insight Crime Organization, drawing on data provide by Paraguay's National Anti-Drug Secretariat (SENAD),estimates that the country was among the world's top cannabis producers in 2019, yielding as much as 40,000 tons of marijuana that year (InSight-Crime 2021*b*).Although the country is involved in various forms of criminal activity, the production and distribution of cannabis remain its main illicit economy. Paraguay is the largest producer of marijuana in South America and the second largest in Latin America, surpassed only by Mexico (UNAV 2021, InSight-Crime 2022).

Paraguay has seen a sharp rise in its ranking on the Global organised Crime Index, moving from 15th place in 2021 to 4th place in 2023. This dramatic shift reflects not only the rapid expansion of illicit markets within the country, but also the state's limited capacity to contain or disrupt these criminal structures. The effects of this criminal entrenchment are particularly evident in border regions with Brazil, where violence, corruption, and

institutional fragility converge (Global Initiative Against Transnational Organized Crime 2023).

Taken together, Paraguay's strategic geographic location, fragile institutions, and high levels of corruption have created a fertile environment for organised crime to thrive. These conditions have enabled transnational criminal organizations to establish themselves in the country and use it as a base to project influence across the region.

Two Countries, One Border, One Criminal Economy

The Paraguay–Brazil border spans approximately 1,367 km, of which 438 km are dry land and the remainder are riverine boundaries. Along this border, illicit activities such as drug and arms trafficking, contraband smuggling, and money laundering prevalent. Two areas stand out in public scrutiny: the Amambay-Canindeyu–Mato Grosso do Sul corridor and the Triple Frontier region where Paraguay, Brazil, and Argentina converge. While both zones exhibit intense criminal dynamics, they differ in actors and illicit markets.(InSight-Crime 2023*a*), (InSight Crime 2021*d*).

This study concentrates on the bilateral corridor, setting aside the trilateral region due to its greater institutional complexity.

Amambay, Paraguay & Mato Grosso do Sul, Brazil

Despite being separated by an international boundary, these two regions operate as deeply integrated borderlands socially, economically, and culturally. These regions, particularly through the twin cities of Pedro Juan Caballero and Ponta Porã, represent a unique case of cross border continuity that enables the study of how differing state institutions affect similar criminal dynamics.

The urban centers of Pedro Juan and Ponta Porã are connected by a dry border; no natural barrier exists between them. Their economies, labor markets, and transportation

networks are fully intertwined. Residents from both sides frequently cross for shopping, schooling, work, and healthcare. Bilingualism is widespread; while Paraguay's population officially speaks Spanish and Guaraní, the local reality includes a high degree of Portuguese fluency and even a hybrid Portuñol dialect (SciELO 2023).

These similarities also extend to demographic structure. Both regions have young populations, with median ages between 26 and 29 years, and low population densities. Culturally, both areas are strongly influenced by the Guaraní heritage and agricultural traditions. Yet, despite this cross-border similarity, they are subject to distinct legal systems, criminal justice institutions, and state enforcement capacity (United Nations Office on Drugs and Crime 2023).

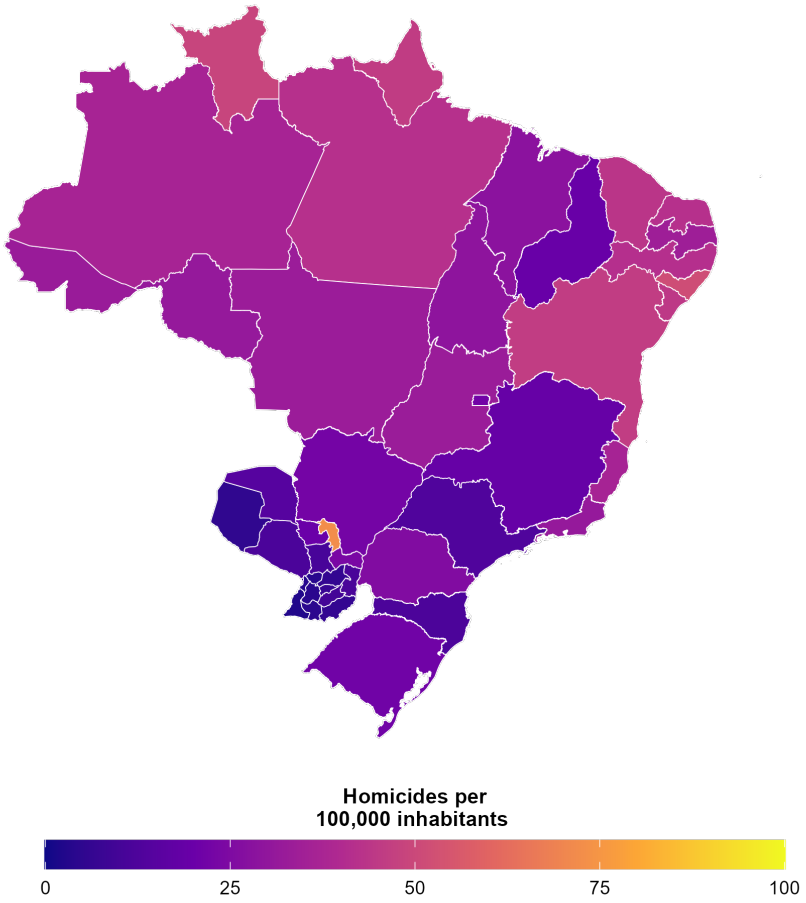


Figure 2: Heatmap of homicides rate per region in Paraguay and Brazil 2010–2023

The region of Amambay is not only one of the most dangerous and violent in the Southern Cone, but it also ranks among the most violent areas globally (United Nations Office on Drugs and Crime 2023). As illustrated in Figure 2, the homicide rate in Amambay reaches approximately 70 per 100,000 inhabitants, while the national average in Paraguay is around 8.8 per 100,000 (World Bank 2022). Even in comparison with neighboring Brazil where the presence of criminal organizations is reportedly stronger (InSight-Crime 2023*a*), the homicide rate in this border area remains at least triple as high as the national average for Brazil. (Global Initiative Against Transnational Organized Crime 2023).

Understanding the divergence in outcomes despite similar social and geographic inputs allows researchers to isolate the impact of state capacity, anti crime policy, and corruption levels on organised crime outcomes.

Looking more closely at national data, the annual average number of contract killings in Amambay nearly triples the national average for Paraguay (Figure 3). This concentration of extreme violence in such a specific and isolated region suggests that there may be other contributing structural or institutional factors at play. As shown in Figure 4, this area is also a major hub for marijuana trafficking, along with other types of illicit activities.

On the other hand, according to investigations by InSight Crime, Mato Grosso do Sul is the main entry point for marijuana into Brazil, as well as one of the largest exit hubs for cocaine and contraband. The area is largely controlled by the Primeiro Comando da Capital (PCC), which has almost hegemonic control over arms and drug trafficking, with Comando Vermelho (CV) exerting some presence in specific cities (InSight-Crime 2023*a*).

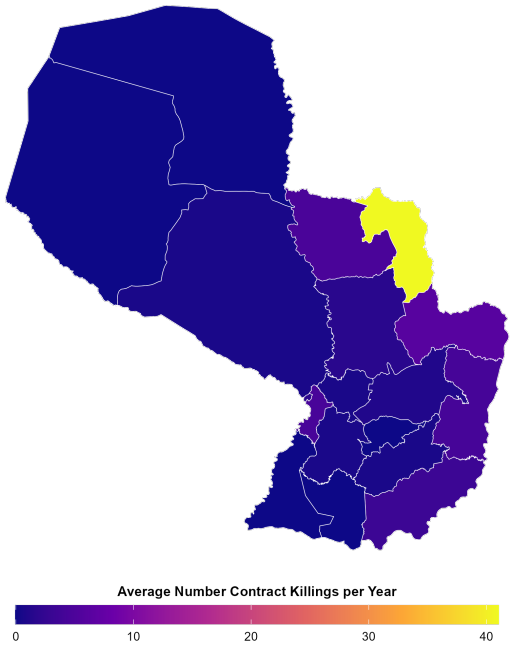


Figure 3: Heatmap of Contract Killings in Paraguay- Average 2019-2023

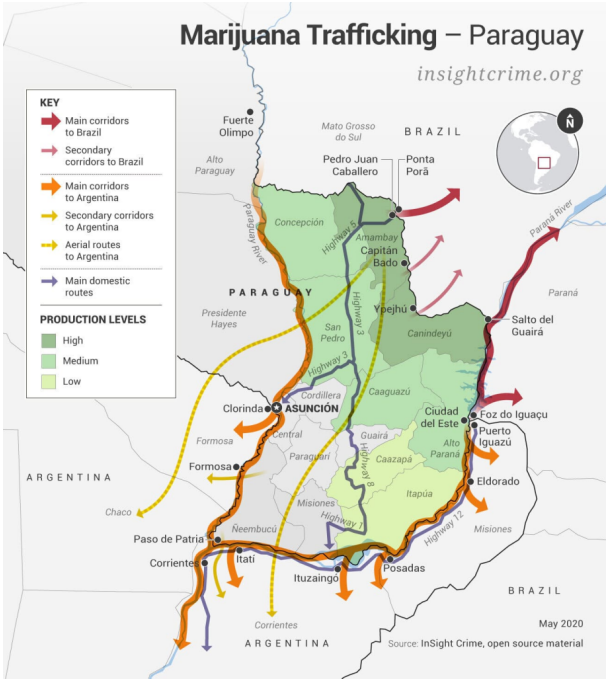


Figure 4: Marijuana Trafficking map. *Source:* Insight Crime (2020).

In this state, according to information from the Brazilian Ministry of Justice and Public Security, multiple criminal economies are active, including weapons trafficking, cocaine, cannabis, environmental crimes (especially exotic animal and wildlife trafficking), human trafficking, and smuggling (*Centre of Excellence for Illicit Drug Supply Reduction* 2021).

Despite the scale of the criminal economy operating in the region, the average homicide rate is nearly four times lower approximately 19 deaths per 100,000 inhabitants than that of the neighboring Paraguayan side (Amambay). Moreover, this rate is even lower than the national average across other Brazilian states, which stands at approximately 22.8 per 100,000 inhabitants (World Bank 2022, SciELO 2023).

Institutionalism and Governance in Critical Zones

One of the dominant theoretical frameworks for explaining the establishment of organised crime in Latin America is grounded in institutionalist theory. According to North (1990), institutions both formal (laws, bureaucracies) and informal (norms, practices) shape the

incentives and constraints within which actors operate. When institutions are weak or captured, they create governance vacuums that can be exploited by non-state actors such as organised criminal groups. Building on this view, Acemoglu & Robinson (2012) argue that states with limited extractive and enforcement capacity often experience parallel systems of authority, where criminal organisations fill roles of service provision, dispute resolution, and informal governance. Similarly, Soifer (2015) emphasises that variations in subnational state capacity particularly in borderlands and rural zones explain why some regions become havens for organised crime while others resist criminal penetration.

Although corruption and institutional strength data are limited at the regional level, national indicators provide useful proxies. According to Transparency International's Corruption Perceptions Index (2023), Paraguay ranks 149 out of 180 countries, placing it among the most corrupt in Latin America only behind Venezuela. Brazil, while still struggling, ranks 104, suggesting comparatively stronger (though far from robust) institutional integrity.[2] Likewise, the Worldwide Governance Indicators compiled by the World Bank show Paraguay scoring significantly lower than Brazil in "Control of Corruption", "Rule of Law", and "Government Effectiveness" (World Bank 2023). These national discrepancies likely reflect broader structural weaknesses that influence local governance conditions in border areas such as Amambay and Mato Grosso do Sul.

Institutional weakness is especially visible in judicial and penal systems, not only in crime suppression but also in reintegration. A robust literature connects prison conditions with the expansion of organised crime: prison gangs frequently originate and consolidate inside penitentiaries before projecting power externally (Lessing 2016, Fondevila 2024). The World Prison Brief reports that Paraguay has a prison population rate of approximately 250 prisoners per 100,000 population, with an occupancy level near 183% indicating severe overcrowding. Brazil's rate is approximately 390 per 100,000, with occupancy at 136% (World Prison Brief 2025).

[2]In the CPI, a lower rank indicates lower perceived public sector corruption, while a higher rank reflects greater perceived corruption.

Exclusive reporting by GloboNews and G1 reveals that the Primeiro Comando da Capital (PCC) has established a transnational presence in at least four continents. Paraguay emerges as the country with the largest PCC membership outside Brazil, with 699 identified members 341 incarcerated and 358 at liberty. This pattern underscores the strategic role of prisons as operational bases for recruitment and coordination: more than half of PCC members abroad are imprisoned, reflecting the group's deliberate infiltration of penitentiary systems to consolidate power, expand trafficking networks, and launder illicit proceeds (Fuentes 2025). Evidence suggests that many PCC members prefer to be detained in Paraguay rather than in Brazil's high-security prison system, owing to weaker oversight and looser internal controls that allow continued operations while incarcerated (InSight Crime 2023*b*).

In both countries, prison systems have historically served as incubators for criminal networks, but the degree of state control differs sharply. In Brazil, the PCC's franchise model built across prisons and reinforced by bribery and inter prison mobility allowed it to extend territorial control into Mato Grosso do Sul and beyond (Lessing 2016, Berg 2021). In Paraguay, overcrowded facilities with under resourced staff create permissive environments for gang governance, recruitment, and cross border coordination.

Theoretical mechanisms: Institutional Moderators of Criminal Violence

The institutional disparities described above constitute the fundamental causal mechanism through which identical criminal organisations produce divergent violence outcomes across the Paraguay–Brazil frontier. Building on Lessing (2016)'s framework of criminal governance, I argue that transnational groups exploit institutional arbitrage opportunities that create differential incentive structures for violent versus non-violent strategies depending on state capacity.

Following Snyder & Durán-Martínez (2009*a*)'s typology of state sponsored protection

rackets, groups operating in Brazilian border regions face credible enforcement threats from federal task forces and specialised courts. This high capacity environment fosters what Magaloni et al. (2020) term "competitive clientelism", where violence becomes strategically counterproductive because it triggers enforcement responses that threaten trafficking networks (Arias 2006). As a result, these groups substitute overt violence with corruption based territorial control.

Conversely, in Paraguayan border regions, limited enforcement capacity generates what could be characterized as a "competitive violence equilibrium". Without credible institutional enforcement, violence serves as the primary mechanism for market signalling and dispute resolution. The absence of effective courts makes violence a cost effective tool for asserting dominance.

Prison based networks, as documented by Lessing (2016), facilitate this cross border coordination: Brazilian factions operate from Paraguayan territory to exploit institutional weaknesses while maintaining logistical infrastructure in higher-capacity environments. This framework yields a clear empirical expectation

Hypothesis (H1): The expansion of PCC and CV will **increase** lethal violence in Paraguayan border regions but **reduce** it in comparable Brazilian regions, as violence is "exported" to low capacity areas while high capacity ones favour covert governance.

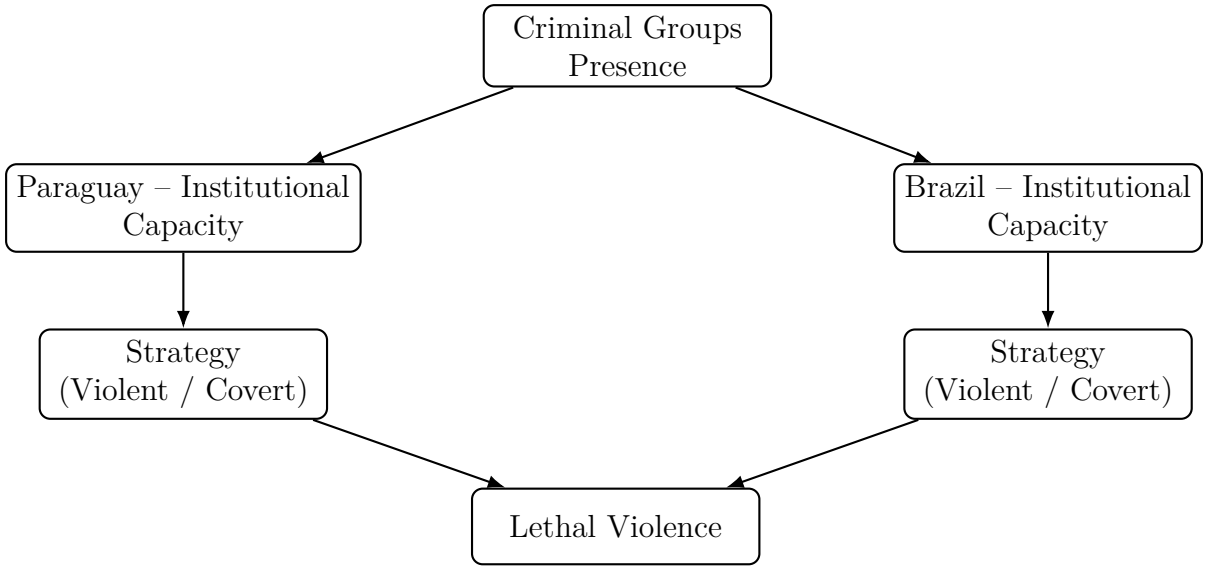


Figure 5: Institutional capacity moderates how criminal-group presence translates into violent vs. covert strategies and, ultimately, lethal violence.

Research Design and Methodology

This research aims to test the causal effect of organised criminal group presence on homicide rates, which serve as a proxy for violence . In addition to the main estimation, the empirical strategy integrates a series of robustness checks to strengthen the credibility of the findings. These include placebo estimations set in pre-treatment years with no documented presence of major criminal organisations, sensitivity tests using alternative specifications, and a moderation analysis to see how the criminal groups interacts with different indicator between countries.

Effect of Organised Crime in Border Violence

I employ a Difference-in-Differences (DiD) approach given that treatment exposure varies along three dimensions: country (Paraguay versus Brazil), border status (border versus non-border areas), and the presence or absence of organised criminal groups. Moreover, the expansion into Paraguayan territory occurred at different points in time, which moti-

vates a staggered specification across these dimensions. This results in a Staggered Triple Difference-in-Differences design.

A standard DiD could account for two of these dimensions but would risk conflating the third with broader country-level or temporal trends. By interacting all three, the triple DiD isolates the net effect of organised crime expansion in border regions, relative to their non-border counterparts, while explicitly accounting for institutional differences between the two countries.

Conceptually, a Triple Difference (DDD) estimator is the difference between two DiD estimates across a third dimension, such as location, country, or policy context (Olden & Moen 2022).

In this case the DDD represents the difference between the DiD estimate for Paraguay (DiD 1) and the DiD estimate for Brazil (DiD 2)

$$\widehat{DDD} = \underbrace{\left[(\overline{Y}_{\mathrm{PY},B,1} - \overline{Y}_{\mathrm{PY},NB,1}) - (\overline{Y}_{\mathrm{PY},B,0} - \overline{Y}_{\mathrm{PY},NB,0})\right]}_{\textbf{DiD 1 (Paraguay)}} - \underbrace{\left[(\overline{Y}_{\mathrm{BR},B,1} - \overline{Y}_{\mathrm{BR},NB,1}) - (\overline{Y}_{\mathrm{BR},B,0} - \overline{Y}_{\mathrm{BR},NB,0})\right]}_{\textbf{DiD 2 (Brazil)}} \tag{1}$$

Where the dimensions are:

- Regions with and without criminal group activity,
- Border and Non-Border Regions
- Regions located in Paraguay versus Brazil.

This identification strategy helps isolate the impact of criminal groups from country specific trends, regional heterogeneity, and temporal shocks, and is therefore especially useful when the parallel trends assumption may not hold uniformly across the two main dimension, in this case Paraguay and Brazil, and provides a way to net out residual confounding

trends.The logic is that if both Difference-in-Differences estimators share the same bias, their difference will cancel out that bias, resulting in an unbiased estimate (Olden & Moen 2022). The triple interaction between criminal group presence, border location, and country allows for controlling unobserved confounders by leveraging spatiotemporal heterogeneity. The inclusion of the country dimension is essential to capture institutional and policy differences between Paraguay and Brazil, especially when examining twin cities and border regions.

The outcome derived from this method is the Average Treatment Effect on the Treated (ATT), which, in practical terms and given the triple interaction, can be interpreted as the effect of the presence of criminal organizations in border areas between Paraguay and Brazil, focusing specifically on the Paraguayan side.

Data

To measure violence, I use the homicide rate per 100,000 inhabitants as a proxy. This indicator is widely accepted for capturing lethal violence and insecurity, particularly in Latin America, where underreporting of other crimes is common (UNODC 2019). It reflects the most extreme form of violence and is often closely linked to organised crime and drug trafficking dynamics (Calderón et al. 2020).

In regions such as Amambay - Canindeyu (Paraguay) and Mato Grosso do Sul (Brazil), where drug trafficking and contract killings are widespread, homicide rates capture the most severe manifestations of insecurity and are among the most consistently reported indicators at the municipal level.

Outcome (homicide rate per 100,000 inhabitants): For Brazil, data were compiled from three main sources. From 2000 to 2009, figures were manually constructed using raw intentional homicide data from the Brazilian Institute of Geography and Statistics (IBGE),

divided by the regional population. For 2010 to 2012, data were extracted from the Brazilian Public Security Statistical Yearbook. From 2013 to 2023, data were obtained from the Atlas da Violência, produced by the Institute for Applied Economic Research (IPEA).

For Paraguay, homicide data were drawn from two main sources. From 2010 to 2014, data came from the Atlas de Violencia produced by the National Council for Science and Technology (CONACYT). From 2015 to 2023, the data were obtained from the National Institute of Statistics (INE).

Treatment (presence of criminal groups): I created binary indicators based on administrative intelligence reports, media sources, and public datasets signaling the presence of PCC or CV criminal organizations by region and year. Regions are coded as treated (1) starting from the first recorded and attributed attack by these groups.

Border Indicator: A dummy variable indicates whether a municipality lies adjacent to the international border, capturing spatial discontinuities in institutional frameworks and criminal operations.

Dependent Variable : Homicide rate per 100,000 inhabitants at a regional level

Independent Variables: Dummy for PCC or CV presence: 1 if confirmed presence of organised crime in that year and region.

As a result, I constructed an unbalanced panel dataset with 863 observations. [3]

Estimation

The following model implements the triple Difference-in-Differences design to estimate the impact of criminal group expansion in lethal violence

[3]All constructed and utilized datasets are documented in the appendix, along with the complete list of events marking the "entry" of organised groups into the respective zones

$$
\begin{aligned}
Y_{it} = \alpha + \beta_1 \cdot \text{Criminal Presence}_t + \beta_2 \cdot \text{Border}_i + \beta_3 \cdot \text{Paraguay}_i \\
+ \delta \cdot (\text{Criminal Presence}_t \times \text{Border}_i \times \text{Paraguay}_i) + \gamma_i + \lambda_t + \varepsilon_{it}
\end{aligned}
\tag{2}
$$

Where:

- Y_{it}: Homicide rate (or another outcome) in regional i and year t.
- $CriminalPresence$: Indicator variable equal to 1 after the entry of criminal groups; 0 otherwise.
- $Border_i$: Dummy variable equal to 1 if the region is located in a border region; 0 otherwise.
- $Paraguay_i$: Dummy variable equal to 1 if the region is located in Paraguay; 0 otherwise.
- γ_i: Regional fixed effects, controlling for time-invariant characteristics.
- λ_t: Year fixed effects, capturing shocks common to all municipalities in a given year.
- δ: **The main coefficient of interest**: This coefficient captures the additional effect of organised criminal presence in Paraguayan border states, compared to the baseline of non border states without criminal activity in Brazil .

First, I estimate the full model using a three-way fixed effects (Triple DiD) specification with the triple interaction across the three dimensions described above, which constitutes the main causal framework. I then implement country-specific difference-in-differences models as robustness checks, using alternative estimators to assess identification assumptions and evaluate the stability of the results

Key Findings

	Criminal Groups	PCC	CV
Criminal Group Presence (Baseline: Brazil × Non-Border)	9.96**		
	(3.17)		
Criminal Group × Border (Brazil)	−17.24***		
	(3.05)		
Criminal Group × Paraguay (Non-Border)	−14.02***		
	(3.24)		
Paraguay × Border × Criminal Group	12.01**		
	(3.92)		
PCC Presence (Baseline: Brazil × Non-Border)		3.80	
		(4.77)	
PCC × Border (Brazil)		−13.87**	
		(4.31)	
PCC × Paraguay (Non-Border)		−8.27	
		(4.71)	
Paraguay × Border × PCC		8.66	
		(4.98)	
CV Presence (Baseline: Brazil × Non-Border)			10.56**
			(3.21)
CV × Border (Brazil)			−20.13***
			(3.47)
CV × Paraguay (Non-Border)			−14.49***
			(3.40)
Paraguay × Border × CV			16.04***
			(3.87)
Num. obs.	863	863	863
Num. groups: Region	45	45	45
Num. groups: Year	23	23	23
R^2 (full model)	0.80	0.79	0.80
R^2 (proj model)	0.12	0.05	0.11
Adj. R^2 (full model)	0.78	0.77	0.78
Adj. R^2 (proj model)	0.11	0.04	0.11

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 1: Triple Difference-in-Differences Estimation Results

Interpretation of Key Coefficients.

The triple interaction term δ, represented as *Criminal Group × Border × Paraguay*, which estimates the differential effect of criminal group presence on the outcome in Paraguayan border regions relative to other groups. In Paraguayan border states, the presence of criminal groups leads to a 12.01 point increase in homicide rates (significant at the 5% level), capturing the localized effect of organised crime in frontier areas our main coefficient of interest.

In contrast: **Criminal Group × Border (Brazil)**: In Brazilian border regions, criminal group presence is associated with a 17.24 point **decrease** in homicide rates, suggesting a strategic reduction in violence near sensitive borders.

Criminal Group Presence (Baseline: Brazil × Non-Border): The presence of criminal groups is associated with a 9.96 point increase in the homicide rate in non border areas of Brazil (significant at the 1% level).

Criminal Group × Paraguay (Non-Border): In non border areas of Paraguay, criminal group presence is associated with a 14.02 point reduction in homicide rates, potentially reflecting reduced conflict or alternative criminal strategies.

Similar interpretations follow for subgroup estimations using the presence of specific criminal groups like : PCC and CV separately. Notably, CV's presence is associated with a significant increase of 16 points in Paraguayan border areas, while it decreases violence in Brazilian border regions, possibly due to strategic behavior.

The analysis reveals differentiated effects of criminal group presence on homicide rates across country border combinations. In Paraguayan border regions with PCC presence, the evidence is weaker, the homicide rate increases by 8.7 points, although this effect is not statistically significant, providing no reliable evidence of impact in this specific context.

In contrast, the presence of CV (Comando Vermelho) is associated with more pronounced and statistically significant effects. In non border Brazilian regions, CV presence leads to a 10.6 point increase in homicide rates ($p < 0.05$), indicating that CV's activities are associated with greater violence in these areas. However, this relationship reverses in Brazilian border municipalities, where CV presence is linked to a 20.1 point reduction in homicides ($p < 0.01$), possibly reflecting strategic behavior by the group to avoid drawing attention in sensitive frontier zones.

Substantive Significance

To assess whether the findings are not only statistically significant but also substantively meaningful, I calculate effect sizes by expressing the main coefficients in terms of standard deviations (SD) of the dependent variable. Following the conventional thresholds proposed by Cohen (1988) 0.2 SD = small, 0.5 SD = medium, and 0.8 SD = large, I classify results as substantive when they are at least 0.5 SD. Table 2 summarises the effect sizes and their substantive interpretation.

Table 2: Substantive significance of triple interaction effects

Triple Interaction Term	**Coefficient**	**Effect Size (SD units)**	**Substantive?**
Paraguay × Border × Criminal Group	12.01	0.73	Yes (Medium–Large)
Paraguay × Border × PCC	8.66	0.53	Yes (Medium)
Paraguay × Border × CV	16.04	0.98	Yes (Large)

Note: Effect size calculated using SD of dependent variable = 16.38.

Robustness Checks

Placebo Test

To further examine the robustness of the main findings, I implement a series of placebo estimations in which the treatment is artificially assigned to occur six, seven, and eight years before the actual intervention. These placebo periods are defined relative to each treated region's actual year of entry, shifting the treatment indicator six, seven, or eight years earlier. Official reports, judicial records, and contemporary press coverage confirm that these earlier periods show no evidence of PCC or CV presence in the treated regions. This design ensures that the placebo falls within a time window when the emergence of these criminal groups was implausible, allowing the test to assess whether the estimated effects are driven by spurious pre-existing dynamics rather than the actual expansion of organised crime. Table 3 presents these results. The null hypothesis of no systematic differences between treated and control areas in these pre-intervention periods cannot be rejected. Across all placebo windows, the estimated coefficients for the triple interaction term are markedly smaller than in the main specification and statistically insignificant. Taken together, this evidence reinforces the credibility of the main results, although it cannot entirely rule out the possibility that the observed effect is a false positive.

Table 3: Placebo tests

	Placebo (-6)	**Placebo (-7)**	**Placebo (-8)**
criminal_groups_placebo	3.00	1.60	−0.08
	(2.50)	(2.70)	(3.10)
criminal_groups_placebo × Border	−9.30**	−6.80*	−3.20
	(3.10)	(3.30)	(3.30)
criminal_groups_placebo × Paraguay	1.90	4.10	2.80
	(2.90)	(3.10)	(3.30)
criminal_groups_placebo × Border × Paraguay	4.60	−3.30	−13.20
	(6.00)	(7.30)	(9.30)
Fixed Effects:			
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	598	553	508
R^2	0.8386	0.8445	0.8569
Within R^2	0.0294	0.0220	0.0308

Notes: Standard errors in parentheses are clustered at the region level.

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Placebo models shift the treatment indicator backwards by 6, 7, or 8 years relative to the actual intervention year.

Sensitivity Test

Additionally, I perform a sensitivity analysis by re-estimating the triple-differences model after excluding two highly influential outlier regions. These territories stand out for their extreme homicide rates and exceptional relevance in the public security debate, making them plausible candidates to disproportionately drive the baseline results. Table 4 presents the estimates. The coefficients remain very similar in both magnitude and sign to the baseline, and the triple interaction term stays positive and statistically significant at the 1% level. The persistence of the effect after removing these extreme cases suggests that it is not artificially driven by outlier regions; if anything, the estimates gain slight

precision and the triple interaction coefficient increases marginally. This reinforces the credibility and robustness of the main findings.

Table 4: Triple DiD excluding high influential regions

	Excluding influential outlier regions
Criminal groups	9.09** (3.15)
Criminal groups × Border	-16.10*** (3.03)
Criminal groups × Paraguay	-12.50*** (3.02)
Criminal groups × Border × Paraguay	12.80*** (3.22)
Fixed Effects:	
Region FE	Yes
Year FE	Yes
Observations	826
R^2	0.7783
Within R^2	0.0997

Notes: Standard errors in parentheses are clustered at the region level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample excludes Amambay (Paraguay) and Bahia (Brazil).

Moderation Analysis: Institutional Capacity × Criminal Group Presence

Given the difficulty of parameterising institutional capacity directly, the mechanism can be explored by analysing how the effect of criminal group presence on homicide rates interacts with various institutional indicators, estimated separately for Paraguay and Brazil.

Although the institutional indicators for corruption, military expenditure, and security force size are only available at the national level, they still capture relevant cross-country differences over time that may moderate the relationship between criminal group presence and lethal violence.

For Paraguay, the interaction between criminal presence and corruption is positive and statistically significant, indicating that higher perceived corruption strengthens the association between organised crime presence and higher homicide rates. In contrast, in Brazil this interaction is negative and significant, suggesting that improvements in corruption control weaken the link between criminal presence and lethal violence.

Military expenditure (as a share of GDP) shows a similar pattern: in Paraguay, higher military spending is associated with a stronger positive effect of criminal presence on violence, whereas in Brazil the effect is negative, consistent with a deterrent or containment role.

Security forces (share of labour force) yield the largest marginal effects. In Paraguay, the interaction is small and insignificant, while in Brazil it is strongly negative and significant: higher security force presence substantially reduces the violent impact of criminal group presence.

Interestingly, prison overcrowding exhibits a counterintuitive negative interaction with criminal presence in both countries. Higher overcrowding rates are associated with weaker effects of criminal presence on homicide rates, with this pattern reaching statistical significance only in Brazil. This suggests that prison governance under extreme overcrowding may paradoxically act as a temporary pacifying force, though the causal mechanisms behind this unexpected finding are examined more thoroughly in the discussion section.

Table 5: Institutional moderators of the effect of criminal group presence on homicide rates.

Interaction w/ criminal presence	Paraguay	Brazil
Corruption index	1.546**	-0.872*
	(0.652)	(0.482)
Military expenditure (% GDP)	0.415	-1.230**
	(0.388)	(0.546)
Security forces (% labour force)	0.980*	-0.756**
	(0.562)	(0.341)
Prison overcrowding rate	-2.579	-1.697*
	(2.584)	(0.807)

Notes: Coefficients from country-specific regressions of homicide rates on criminal group presence interacted with institutional indicators. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Alternative Estimators

As previously mentioned, one way to interpret a Triple Difference-in-Differences (DDD) approach is as the difference between two Difference-in-Differences (DiD) estimates, where a third dimension serves as the axis of comparison. In this case, the presence of two countries, Paraguay and Brazil, provides a meaningful institutional contrast that enhances the validity of this comparison, as expressed in equation (1)

Regarding inference, standard errors for the DDD estimator are constructed as the sum of the variances of the two DiD components (Cunningham 2021), accounting for clustering at the appropriate level (e.g., by region). Formally:

$$\text{Var}(\widehat{DDD}) = \text{Var}(\widehat{DiD}_{\text{PY}}) + \text{Var}(\widehat{DiD}_{\text{BR}}) \tag{3}$$

This approach, while conservative in the absence of covariance adjustment, allows for a transparent decomposition of the DDD into component effects. This formulation assumes independence between the DiD estimates of each country. Robust standard errors clustered at the regional level are used to address potential autocorrelation and heteroskedasticity within units over time, following the guidance of (Bertrand et al. 2004).
This approach also facilitates the application of alternative estimands as robustness checks, through the classical estimation of two Difference-in-Differences (DiD) models and computing their difference. Based on this, I employ modern estimators specifically designed for staggered adoption settings, since the traditional Two-Way Fixed Effects (TWFE) model, although widely used, can lead to biased estimates under staggered treatment adoption due to heterogeneous treatment effects and problematic weighting (including negative weights) as highlighted by (Callaway & Sant'Anna 2021).
The Callaway and Sant'Anna (2021) estimator provides a more flexible and robust approach for estimating treatment effects when units receive treatment at different time periods. Unlike TWFE, which typically uses never-treated units as the control group, this method constructs valid control groups using units that have not yet received treatment at a given time, thus addressing issues of contamination and bias.
It is important to clarify that, when using the Callaway and Sant'Anna estimator, the quantity being estimated differs from the traditional ATT. Specifically, the estimator focuses on group-time average treatment effects:

$$ATT(g,t) = \mathbb{E}[Y_t(1) - Y_t(0) \mid G = g] \tag{4}$$

Where $G = g$ denotes the group of units that first receive treatment in period g, and t indicates the time period. $Y_t(1)$ represents the potential outcome for group g at time t if treated, while $Y_t(0)$ denotes the potential outcome for group g at time t if untreated.

This estimator therefore measures the average treatment effect for units that are exposed in a given year g at time t, by comparing them to units that remain untreated at that point (either not yet treated or never treated). The overall treatment effect is obtained by aggregating these group–time specific ATTs using appropriate weighting schemes.

Keeping in line with recent developments in robust estimation under treatment effect heterogeneity, we implement the estimator proposed by (De Chaisemartin & D'Haultfoeuille 2020). Their method addresses the limitations of standard two-way fixed effects (TWFE) models in staggered adoption settings. The estimator targets causal parameters defined as weighted averages of group time specific difference-in-differences comparisons, under the assumption that at least one group is always untreated and another is always treated, and that common trends hold across units.

Formally, the Average Treatment Effect on the Treated (ATT) in a given period is estimated as:

$$\widehat{\theta} = \sum_{g,t} w_{g,t} \cdot \left(\bar{Y}_{g,t}^{\text{post}} - \bar{Y}_{g,t}^{\text{pre}} - \left(\bar{Y}_{c,t}^{\text{post}} - \bar{Y}_{c,t}^{\text{pre}} \right) \right), \tag{5}$$

where $w_{g,t}$ are weights for each group g and time t, $\bar{Y}_{g,t}^{\text{post}}$ and $\bar{Y}_{g,t}^{\text{pre}}$ denote average outcomes before and after treatment in group g, and c denotes the control group(s). This estimator remains valid even when treatment effects are heterogeneous and dynamic.

In addition, they propose a dynamic linear specification where treatment effects depend on current and lagged exposure:

$$Y_{it} = \alpha_i + \lambda_t + \sum_{s=0}^{L} \beta_s \cdot D_{i,t-s} + \varepsilon_{it}, \tag{6}$$

where $D_{i,t-s}$ is a dummy for treatment s periods ago, allowing the estimation of lagged treatment effects. This specification accommodates group-specific but time-invariant dynamic effects, and can be used to simulate *ex-ante* the impact of future treatments.

The estimation proceeds in two stages: the first removes unit and time fixed effects by residualizing the outcome variable, and the second regresses the residualized outcome on the treatment variable. Standard errors are clustered at the unit level.

Moreover, I also employ the estimator proposed by (Sun & Abraham 2021)Sun and Abraham (2021), which addresses the same issues in TWFE models under staggered treatment by explicitly accounting for treatment timing heterogeneity and estimating event-study type dynamic effects. Their method allows for clean identification of treatment effects over time by avoiding contamination from already treated units, offering a complementary perspective to that of Callaway and Sant'Anna.

$$Y_{it} = \alpha_i + \lambda_t + \sum_{e \neq -1} \delta_e \cdot \mathbb{1}\{E_{it} = e\} + \varepsilon_{it} \tag{7}$$

- Y_{it}: Outcome variable (e.g., homicide rate) for unit i at time t.
- α_i: Unit fixed effects.
- λ_t: Time fixed effects.
- $E_{it} = t - G_i$: Event time for unit i at time t, where G_i is the treatment start period.
- δ_e: Event-time effect, the coefficient for period e relative to treatment ($e = 0$ is treatment year).
- $\mathbb{1}\{E_{it} = e\}$: Indicator equal to 1 if unit i is e periods away from treatment in time t.
- ε_{it}: Error term.

Apart from the fundamental assumption in causal inference, namely the Stable Unit Treatment Value Assumption (SUTVA), which requires no interference between units and consistency of the treatment across groups.

The Difference-in-Differences (DiD) framework relies on two core assumptions: (i) in the absence of treatment, treated and control units would have followed the same pre-treatment trajectory in the outcome variable (the Parallel Trends assumption), and (ii) the treatment has no impact prior to its actual implementation, meaning units do not adjust their behaviour in anticipation (the No Anticipation assumption). While these conditions cannot be directly verified since counterfactual outcomes are unobservable researchers often employ graphical inspections of pre-treatment dynamics to gauge the plausibility of these assumptions.

Parallel trends

In the context of a Triple Difference-in-Differences (DDD) design where identification depends on variation across three dimensions, the parallel trends assumption becomes more complex. Specifically, the identifying assumption requires that the difference in trends between treated and control groups is itself stable across the third dimension. In other words, the evolution of the treatment-control gap in Paraguay must closely mirror the evolution of the same gap in Brazil during the pre-treatment period. If this "difference-in-differences" remains consistent over time before the intervention, then the identifying assumption becomes more plausible (Wooldridge 2010, Pischke & Angrist 2009, Wing et al. 2018).

However, recent literature notes that this assumption can be partially relaxed. If both underlying Difference-in-Differences (DiD) estimates are biased by the same time-invariant confounder, then the bias may cancel out in the third-difference comparison. As long as the bias is symmetric across the third dimension such as country or region, the DDD estimator remains unbiased (Olden & Moen 2022). One common strategy to evaluate this is through an event study specification, which estimates the dynamic effects of treatment over time while allowing for flexible testing of pre-treatment differences. In the context of DDD, this involves estimating a model with interacted event-time indicators and the third dimension. Specifically:

$$Y_{it} = \alpha_i + \lambda_t + \sum_{k \neq -1} \beta_k \cdot \mathbb{1}(EventTime = k) \cdot D_i + \epsilon_{it} \tag{8}$$

Where D_i captures the third difference dimension (e.g., country), and the β_k coefficients trace out the dynamic treatment effects. The key test involves examining whether the pre-treatment coefficients (β_k for $k < 0$) are statistically indistinguishable from zero.

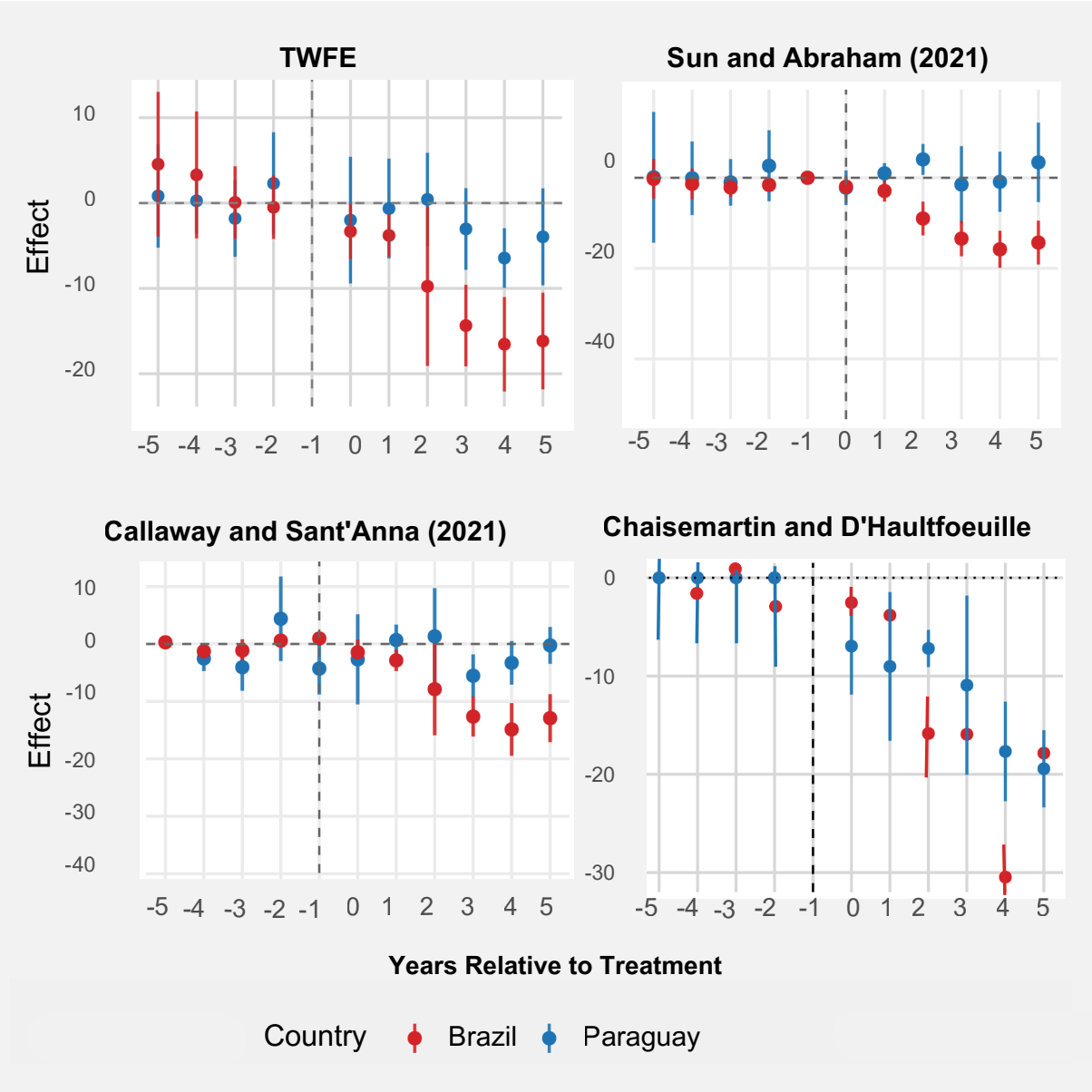


Figure 6: Event Study- Different Methods

If the pre-treatment coefficients of this fully interacted event study are close to zero and statistically insignificant, this provides supporting evidence that the identifying assump-

tions of the DDD strategy are plausible.

When separating by countries, the individual parallel trends within each country hold. Visually, there is also some similarity in trends between countries, which adds further evidence supporting the parallel trends assumption in this triple interaction

No anticipation

This assumption is theoretically reasonable in this context. The expansion of organised criminal networks tends to be sudden, covert, and driven by internal dynamics of the criminal economy such as disputes over smuggling routes or market control that are rarely predictable for local institutions or the general population. As a result, it is unlikely that states would experience preemptive increases in violence simply due to expectations of future criminal group presence. Moreover, the empirical strategy disaggregates the analysis by country (Paraguay and Brazil), acknowledging that institutional responses and early warning mechanisms may differ. This approach enhances internal validity by reducing the likelihood that cross country differences confound the results. Supporting narrative evidence from media reports and official sources suggests that in many cases, local actors became aware of the presence of criminal groups only after violent incidents had occurred. The clandestine nature of these groups makes their arrival difficult to detect in advance, limiting the possibility of behavioral adjustments or pretreatment violence related to their anticipated entry. Nonetheless, the possibility of partial anticipation cannot be fully ruled out. Law enforcement agencies or certain communities may have had access to early signals such as rumors, threats, or increased trafficking activity. To assess this risk, the empirical section includes event study models with treatment leads, testing whether violence increased before the documented entry of criminal groups. The absence of significant pretreatment effects would support the credibility of the no anticipation assumption.

SUTVA

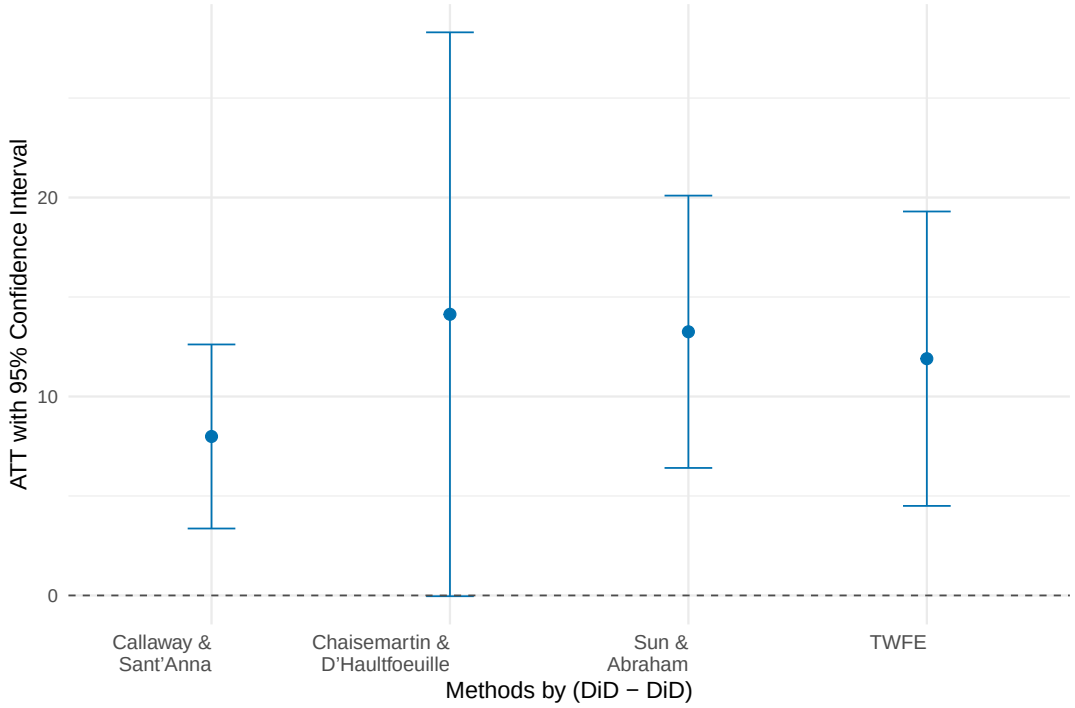
Even though there is a possibility that violence may expand into nearby non border areas or zones without an established criminal presence, the SUTVA assumption may still hold under specific contextual conditions. Criminal groups such as the PCC and CV typically operate in areas they control directly where they have logistical command, political or police ties, and territorial knowledge. This localized control reduces the likelihood of spillover effects into untreated areas. Moreover, once a violent event tied to organised crime occurs in a given region, that region is often formally recognized as a high-risk or criminal zone by local authorities and media. If I assume that criminal organizations prefer to operate in controlled environments and do not randomly expand their influence beyond strategic zones, then treatment in one unit does not affect the outcomes in neighboring untreated units.

Alternative Estimators Results

The results derived from the difference between the two DiD estimations are consistent in both sign and statistical significance with the initial model. When computing the difference using the TWFE model, the final result matches that of the baseline estimation, thereby serving as a robustness check.

Regarding alternative estimators, the Callaway and Sant'Anna estimator, which is more conservative due to its underlying assumptions yields a slightly smaller effect (7.9 percentage points), though still in the same direction and magnitude as the others. The Sun and Abraham estimator shows a larger effect (13.2 percentage points), and while the overall effect is statistically significant, the DiD estimated solely for the Paraguayan side is not, leaving room for debate regarding potential explanations. The De Chaisemartin & D' Haultfoeuille estimator shows a larger positive effect for Paraguay (14.133) but with a wide standard error (7.23) because, after 2016, almost all Paraguayan regions are treated and only a handful remain untreated to serve as controls. With so few comparisons, the

Figure 7: ATT comparison between DiDpy and DiDbr for the presence of criminal groups



Model	DiD Paraguay	DiD Brazil	Difference (Triple DiD)
Callaway-Sant'Anna	-3.498^{*}	-11.493^{***}	7.995^{***}
	(1.274)	(1.976)	(2.360)
Chaisemartin & D'Haultfoeuille	3.038	-11.095^{***}	14.133^{*}
	(7.045)	(1.622)	(7.230)
Sun and Abraham	-0.603	-13.856^{***}	13.253^{***}
	(2.844)	(2.060)	(3.492)
TWFE	-4.84^{*}	-16.80^{***}	11.961^{***}
	(2.24)	(3.04)	(3.775)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

estimate is imprecise, hence the borderline significance.

Overall, the findings suggest that, despite the geographic proximity and structural similarities between border regions in Paraguay and Brazil, the Paraguayan side experiences a significantly greater increase in violence following the expansion of criminal organizations. (**This effect is captured through the difference between the two country-specific DiD estimates, rather than being solely attributable to the DiD estimate for Paraguay**), whereas the Brazilian side sees a decrease. Although these results are discussed in greater detail later, an initial interpretation is that the divergence may stem from differences in institutional strength and state capacity.

Discussion and Policy Implications

The results reveal a clear contrast between the Paraguayan and Brazilian sides of the frontier. In Paraguayan border regions, the triple interaction coefficient indicates that the arrival of transnational criminal organisations (PCC or CV) increases the homicide rate by approximately 12 homicides per 100,000 inhabitants. This finding is consistent with the "violent governance" logic documented for weak frontiers (Lessing 2016, Snyder & Duran-Martinez 2009*b*): where police presence is limited and judicial follow-up is rare, criminal groups employ targeted killings to control smuggling routes and local markets. Violence functions as a low-cost enforcement tool, and homicides escalate until a group consolidates control over a given territory.

In contrast, Brazilian border regions display the opposite effect: the presence of the same organisations is associated with a reduction of about 17 homicides per 100,000 inhabitants (Misse 2018). Field reporting by InSight Crime (2021*d*) confirms that joint federal police, army, and customs units patrol the frontier almost continuously. A single flare-up can trigger a high-profile crackdown, prompting PCC and CV cells to adopt low-visibility strategies, bribery, selective intimidation, and shifting logistics into Paraguay, rather than engaging in open gun battles. Violence therefore falls not because the groups have disappeared, but because they "keep quiet" where state retaliation is swift, hereby confirming the proposed hypothesis.

Away from the frontier, the signs reverse. In Brazil's interior, criminal presence is associated with nearly 10 additional homicides per 100,000 inhabitants, reflecting turf wars in retail drug markets and contested prison networks (Diniz & Manso 2021). In Paraguay's inland departments, by contrast, once a faction consolidates dominance, it can impose a form of "criminal pacification"; lethal disputes subside and the homicide rate falls by about 14 homicides per 100,000 inhabitants.

To test whether institutional conditions shape these patterns, I interact criminal presence with four indicators of state capacity: prison overcrowding, corruption, military expenditure, and the share of security forces in the labour force (Table 5). The results broadly align with the proposed mechanism.

Corruption. In Paraguay, higher corruption in the presence of criminal groups is associated with a significant increase in homicide rates ($+1.546$, $p < 0.05$). In Brazil, by contrast, the effect is negative (-0.872, $p < 0.1$), suggesting that greater corruption coincides with lower homicide rates. This counterintuitive result can be understood as evidence of covert governance: in a relatively high-capacity state, criminal organisations substitute open violence with bribery and political protection, reducing the need for lethal enforcement. In other words, corruption in Brazil functions as an informal mechanism of control that lowers the visibility of violence, whereas in Paraguay it amplifies it. This finding is consistent with the argument advanced earlier by (Snyder & Durán-Martínez 2009*a*) and (Lessing 2016), who emphasise that in stronger institutional contexts corruption often substitutes for violence, while in weaker ones it exacerbates it.

Military expenditure. In Brazil, higher defence spending significantly reduces violence (-1.230, $p < 0.05$), whereas in Paraguay it has no deterrent effect. This indicates that military resources translate into effective deterrence only where institutional deployment capacity is strong.

Security forces. In Paraguay, a larger share of security forces in the labour force is positively associated with violence ($+0.980$, $p < 0.1$), while in Brazil it is negatively associated (-0.756, $p < 0.05$). This contrast reflects the difference between preventive, intelligence-led policing in Brazil and reactive or embedded security forces in Paraguay.

Taken together, these findings reinforce the central argument: differences in institutional capacity, rather than geography, explain why the same criminal organisations adopt contrasting violent strategies across the border. High-capacity settings raise the costs of overt violence, pushing groups toward low-visibility forms of control, while low-capacity

settings facilitate violent governance until monopolisation occurs.

One institutional indicator, however, yields counterintuitive results: **prison overcrowding**. In Brazil, higher overcrowding in regions with criminal presence is significantly associated with lower homicide rates (-1.697, $p < 0.1$), consistent with "criminal governance" behind bars, where dominant factions regulate violence to protect illicit economies (Fondevila & Vilalta-Perdomo 2024, Skarbek 2011, Dudley 2017). In Paraguay, the effect is also negative but not statistically significant, reflecting more fragmented prison control. This seemingly paradoxical result suggests that prison systems may constitute a distinct governance ecosystem with internal dynamics that operate partly independently from external violence patterns. Under extreme overcrowding, prisons can become recruitment centres and territorial domains for criminal organisations, generating what may be characterised as a form of "militarised peace" within correctional facilities. Rather than producing chaos, overcrowded prisons can provide controlled environments where criminal groups consolidate organisational structures, establish hierarchies, and coordinate external operations while minimising internal conflicts that could undermine their broader enterprises.

Policy implications. The findings indicate that merely deploying troops along the Paraguayan frontier is insufficient. In Brazil, the observed reduction in violence stems from a combination of credible investigative capacity such as crime scene units, data-driven hotspot policing, swift prosecution through specialised organised crime courts, and cross-border intelligence sharing, which collectively raise the expected cost of engaging in violence. **In other words, trust in institutions to effectively combat and punish organised crime is a key factor in reducing lethal criminal activity.** Replicating these institutional features could encourage criminal actors in Paraguay to adopt the lower-visibility strategies already observed on the Brazilian side.

Prison reform and the consolidation of institutional trust are equally urgent, especially given that both countries are currently debating legislative changes in their respective congresses. While national contexts differ and legal reforms will inevitably depend on do-

mestic political dynamics, organised crime adapts to institutional gaps between systems, turning criminal governance and presence into a shared regional challenge. Legislative reforms should therefore be conceived in a coordinated manner, while respecting the sovereignty of each country. Any reform of the prison system must avoid measures that exacerbate overcrowding. Policies that increase the inmate population without addressing institutional weaknesses risk reinforcing criminal governance rather than dismantling it.

More broadly, institutional reform can seem abstract in policy debates, yet the evidence presented here and in the wider literature shows that credible and trusted institutions send strong signals to organised crime groups. Such signals alter criminal behaviour by raising the expected costs of violence, prompting groups to adapt their strategies in ways that reduce lethal outcomes.

Limitations and Critics

This study faces several limitations. First, as in much organised crime research, many key variables are measured only indirectly, given the inherent difficulty of capturing the underlying phenomena. Indicators for corruption, military expenditure, and security force size are available only at the national level, thus failing to capture subnational variation in institutional capacity. These constraints limit the precision with which the hypothesised institutional mechanism can be empirically tested.

Second, data availability is uneven across countries. In Paraguay, official statistics are incomplete, and key variables such as homicide rates rely on population projections from the 2012 census, which the 2022 census revealed to be overestimated by roughly 20%. All Paraguayan figures are aggregated at the departmental (regional) level, while Brazilian data exist at regional and municipal levels, restricting spatial resolution and preventing more precise designs focused on twin cities like Pedro Juan Caballero–Ponta Porã. Missing years and reliance on imputed values leave the dataset unbalanced.

Third, the methodological approach has its own limitations. The triple Differences-in-Differences framework, while suitable for exploiting variation across time, countries, and border status, remains a developing tool particularly when incorporating covariates in a staggered setting. More advanced DDD estimators (Ortiz-Villavicencio & Sant'Anna 2025) require balanced panels, which would necessitate discarding a substantial portion of Paraguayan data. Moreover, the possibility of endogeneity cannot be ruled out: institutional capacity may both influence and be influenced by organised crime presence.

Finally, although some degree of external validity can be argued, it remains limited. The "export of violence" mechanism identified here is unlikely to generalize to contexts without porous borders, comparable institutional asymmetries, or transnational criminal organizations with the scale and structure of the PCC and CV.

Conclusion

In this research, I evaluate how organised crime affects lethal violence in the Paraguay–Brazil dry border region, focusing on how institutional capacity moderates this relationship. Using a staggered triple Difference-in-Differences design, the study finds that institutional strength plays a central role in shaping the strategies and outcomes of criminal group activity. In Paraguayan border regions, the presence of groups such as the PCC and CV is associated with a significant increase in homicide rates, whereas in comparable Brazilian regions, it is linked to a decrease.

These results indicate that the behaviour and impact of organised crime are conditioned by the strength of state institutions. In weaker institutional environments such as Paraguay's, expansion is accompanied by visible and violent strategies aimed at consolidating territorial control. In stronger institutional settings such as Brazil's, expansion instead produces a shift toward more discreet forms of criminal governance, reducing open conflict while maintaining illicit operations.

By directly answering the research question, this study demonstrates that the same criminal shock can produce divergent outcomes depending on the institutional capacity to investigate, prosecute, and control organised crime. Methodologically, it contributes by applying a staggered triple Difference-in-Differences approach to a high-violence transnational context rarely studied in quantitative political economy.

The policy implications are substantial. Strategies to reduce lethal violence must address institutional weaknesses. For Paraguay, replicating Brazil's relative success would require strengthening permanent investigative units, establishing specialised organised crime courts, and formalising cross-border intelligence sharing.

The analysis is subject to important limitations. Data availability in Paraguay remains inconsistent and at a coarser level than in Brazil, constraining precision. The use of

regional rather than municipal data likely masks important micro-level dynamics, particularly in twin cities such as Pedro Juan Caballero and Ponta Porã on the dry border, which would provide an ideal setting for a natural experiment. Furthermore, the unbalanced nature of the dataset and the still developing methodology of staggered Triple DiD mean that causal estimates should be interpreted with caution.

Future research should prioritise high-resolution data collection, particularly at the municipal or institutional level in Paraguay. Greater transparency and digitisation of crime statistics, judicial case records, and prison demographics would allow for more granular analysis and facilitate the design of natural experiments. Additionally, expanding the analysis to include another high criminal area like the the Tri-Border Area and assessing spillover effects from Argentina could provide a more comprehensive understanding of transnational criminal governance in South America.

To conclude, this dissertation provides robust empirical evidence that the expansion of transnational criminal groups does not have a uniform effect on lethal violence: its impact is mediated by the architecture and effectiveness of state institutions. Policy responses that ignore these institutional asymmetries risk reinforcing, rather than reducing, the power of organised crime along the frontier.

Replication Link: Data & Code

Bibliography

Acemoglu, D. & Robinson, J. A. (2012), *Why Nations Fail: The Origins of Power, Prosperity and Poverty*, Crown Publishing Group.

Arias, E. D. (2006), *Drugs and democracy in Rio de Janeiro: Trafficking, social networks, and public security*, University of North Carolina Press, Chapel Hill.

BBC (2017), 'El espectacular robo a un banco en paraguay atribuido a la banda criminal brasileña pcc'. Accessed: 30 July 2025.
URL: *https://www.bbc.com/mundo/noticias-america-latina-39699487*

Berg, R. C. (2021), 'Tussle for the amazon: New frontiers in brazil's organized crime'. PCC expansion through Amazon corridor.

Bertrand, M., Duflo, E. & Mullainathan, S. (2004), 'How much should we trust differences-in-differences estimates?', *Quarterly Journal of Economics* **119**(1), 249–275.

Calderón, G., Robles, G. & Magar, E. (2020), 'The evolution of organized crime and homicides in mexico', *Journal of Economic Behavior Organization* **171**, 128–145.

Callaway, B. & Sant'Anna, P. H. (2021), 'Difference-in-differences with multiple time periods', *Journal of Econometrics* **225**(2), 200–230.

Ceballos, G. C. (2018), 'Transnational organized crime as a hybrid threat to argentina, paraguay and brazil's triple frontier', *Revista Científica General José María Córdova* .

Centre of Excellence for Illicit Drug Supply Reduction (2021), 'Covid-19 and drug trafficking in brazil: The adaptation of organized crime and the actions of police forces during the pandemic'. Accessed: 30 July 2025.
URL: *https://www.gov.br/mjsp/pt-br/assuntos/politicas-sobre-drogas/publicacoes/Covid19*$_a$*nd*$_D$*rug*$_T$*raf ficking*$_i$*n*$_B$*razil*$_U$*NODC.pdf*

Cohen, J. (1988), *Statistical Power Analysis for the Behavioral Sciences*, 2nd edn, Lawrence Erlbaum Associates, Hillsdale, NJ.

Cunningham, S. (2021), *Causal Inference: The Mixtape*, Yale University Press. Chapter 9 explains DDD standard error construction via the sum of DiD variances.
URL: *https://mixtape.scunning.com/*

De Chaisemartin, C. & D'Haultfoeuille, X. (2020), 'Two-way fixed effects estimators with heterogeneous treatment effects', *American Economic Review* **110**(9), 2964–2996.

Diniz, A. & Manso, B. P. (2021), 'Homicide trends in brazil: The role of drug trafficking and organized crime', *Revista Brasileira de Segurança Pública* **15**(2), 10–29.

Dudley, S. (2017), *MS-13: The Making of America's Most Notorious Gang*, Hanover Square Press, New York.

Fondevila, G. (2024), 'Prison violence in latin america: Criminal governance inside prisons', *Latin American Politics and Society* . Study on prison governance by dominant gangs.

Fondevila, G. & Vilalta-Perdomo, C. (2024), 'Prison violence in latin america: Governance, criminal groups, and overcrowding', *Journal of Comparative Criminal Justice* **58**(2), 134–156.

Fuentes, F. (2025), 'Revelan el mapa del pcc, el mayor grupo criminal de brasil, presencia en otros 27 países incluido chile'. Accessed: 2025-08-10.
URL: *https://www.latercera.com/mundo/noticia/revelan-el-mapa-del-pcc-el-mayor-grupo-criminal-de-brasil-presencia-en-otros-27-paises-incluido-chile/*

Global Initiative Against Transnational Organized Crime (2023), 'Global organized crime index 2023'. Accessed: 30 July 2025.
URL: *https://ocindex.net*

Guardian, T. (2020), 'Drug cartel members tunnel way out of paraguay prison'. The Guardian, accessed 30 July 2025.

URL: *https://www.theguardian.com/world/2020/jan/19/drug-cartel-members-tunnel-way-out-of-paraguay-prison*

InSight-Crime (2018), Paraguay profile, Technical report.

InSight-Crime (2020), 'The rise of the pcc: How the first capital command became the most powerful criminal group in brazil'. Accessed: 30 July 2025.

URL: *https://insightcrime.org/wp-content/uploads/2020/12/InSight-Crime$_T$he − Rise − of − the − PCC − 1.pdf*

InSight-Crime (2021*a*), 'Comando rojo (comando vermelho)'. Accessed: 30 July 2025.

URL: *https://insightcrime.org/es/noticias-crimen-organizado-brasil/comando-rojo/*

InSight-Crime (2021*b*), Paraguay grapples with evolving crime, persistent corruption, Technical report.

InSight Crime (2021*c*), 'Primeiro comando da capital (pcc)'. Accessed: 30 July 2025.

URL: *https://insightcrime.org/brazil-organized-crime-news/first-capital-command-pcc-profile/*

InSight Crime (2021*d*), 'The triple border area: Organized crime and terrorism hub'. Analysis of illicit flows and money laundering in the TBA.

URL: *https://insightcrime.org/triple-border-profile/*

InSight-Crime (2022), 'Marijuana production in paraguay continues despite eradication efforts'. Accessed: 30 July 2025.

URL: *https://insightcrime.org/news/marijuana-production-amambay-paraguay-continues-despite-efforts-against/*

InSight-Crime (2023*a*), 'Brazil: Organized crime profile'. Accessed: 30 July 2025.

URL: *https://insightcrime.org/brazil-organized-crime-news/brazil-profile/*

InSight Crime (2023*b*), 'Foreign criminals in paraguayan prisons: Strategic weakness and regional implications'. Accessed: 30 July 2025.

URL: *https://insightcrime.org/paraguay-prisons/foreign-inmates-pcc/*

Lessing, B. (2016), 'Inside-out: The challenge of prison-based criminal organizations', *Brookings Institute Press* . Prison gangs and policy implications.

Magaloni, B., Franco, E. & Melo, V. (2020), 'Killing in the slums: An impact evaluation of police reform in Rio de Janeiro', *Journal of Peace Research* **57**(4), 552–567.

Martens, J. (2020), *Desafíos al desarrollo en contexto de grupos armados*, 1 edn, INECIP – Paraguay & Universidad Nacional de Pilar, Asunción, Paraguay. Diseño de tapa y diagramación: Liza Jara. Edición y corrección: Diego Molinas y Juan Martens.

Misse, M. (2018), Violência, crime e política no brasil contemporâneo, *in* C. Jacques & J. Vargas, eds, 'Segurança Pública e Violência', FGV Editora, Rio de Janeiro, pp. 45–70. Chapter on the dynamics of state enforcement and organized crime.

North, D. C. (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge University Press.

Olden, A. & Moen, J. (2022), 'The triple difference estimator', *The Econometrics Journal* **25**(3), 531–550. The triple difference estimator can be computed as the difference between two Difference-in-Differences estimators.

Ortiz-Villavicencio, M. & Sant'Anna, P. (2025), 'Better understanding triple differences estimators', *Working Paper* .

Pischke, J.-S. & Angrist, J. (2009), *Mostly Harmless Econometrics*, Princeton University Press.

SciELO (2023), 'Cross-border integration and cultural dynamics in pedro juan caballero and ponta porã'. Accessed: 30 July 2025.
URL: *https://www.scielo.org.mx/scielo.php?pid=S0187-73722023000100102script=sci$_a$rttexttlng = en*

Skarbek, D. (2011), 'Governance and prison gangs', *American Political Science Review* **105**(4), 702–716.

Snyder, R. & Durán-Martínez, A. (2009*a*), 'Does illegality breed violence? Drug trafficking and state-sponsored protection rackets', *Crime, Law and Social Change* **52**(3), 253–273.

Snyder, R. & Duran-Martinez, A. (2009*b*), 'Does illegality breed violence? drug trafficking and state-sponsored protection rackets', *Crime, Law and Social Change* **52**(3), 253–273.

Soifer, H. D. (2015), 'State capacity and inclusive development: New evidence and policy lessons', *Studies in Comparative International Development* **50**(1), 50–73.

Sun, L. & Abraham, S. (2021), 'Estimating dynamic treatment effects in event studies with heterogeneous treatment effects', *Journal of Econometrics* **225**(2), 175–199.

UNAV, G. A. A. (2021), 'Paraguay se mantiene como principal productor de marihuana de sudamérica'. Universidad de Navarra.
URL: *https://en.unav.edu/web/global-affairs/detalle/-/blogs/paraguay-se-mantiene-como-principal-productor-de-marihuana-de-sudamerica-3*

UNICRI (2024), 'The nexus between transnational organized crime and terrorism in latin america'. Accessed via UNICRI.

United Nations Office on Drugs and Crime (2023), 'Global study on homicide 2023'. Accessed: 30 July 2025.
URL: *https://www.unodc.org/documents/data-and-analysis/gsh/2023/GSH*$_2$*023*$_L$*AC*$_w$*eb.pdf*

UNODC (2019), Global study on homicide 2019, Technical report, UNODC. Accessed: August 2025.
URL: *https://www.unodc.org/unodc/en/data-and-analysis/global-study-on-homicide.html*

UNODC (2024), 'Firearms and drugs: Partners in transnational crime'. UNODC global study.

Wing, C., Simon, K. & Bello-Gomez, R. (2018), 'Designing difference in difference studies: Best practices for public health policy research', *Annual Review of Public Health* **39**, 453–469.

Wooldridge, J. M. (2010), *Econometric Analysis of Cross Section and Panel Data*, MIT Press.

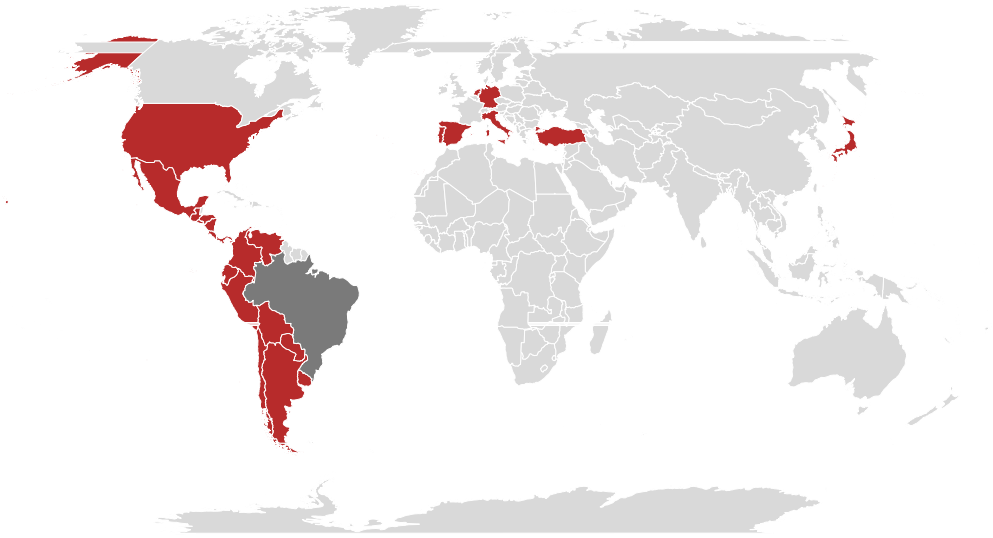
World Bank (2022), 'Homicide rate data: Paraguay and brazil'. Accessed: 30 July 2025.
URL: *https://data.worldbank.org/indicator/VC.IHR.PSRC.P5?locations=PY,BR*

World Bank (2023), 'Worldwide governance indicators: Paraguay and brazil (2023)'. Accessed: 30 July 2025.
URL: *https://info.worldbank.org/governance/wgi/*

World Prison Brief (2025), 'World prison population rates and occupancy levels'. Data for Paraguay and Brazil.
URL: *https://www.prisonstudies.org*

Appendix

Additional Figures



PCC presence outside Brazil

Source: Re-adaptation from São Paulo Public Prosecutor's Office (MP-SP). Map data: Natural Earth (2020).

Data Availability

Variable Category	Sources and Time Periods
Homicide Rates	**Brazil:** IBGE (2000-2009), Public Security Yearbook (2010-2012), Atlas da Violência/IPEA (2013-2023) **Paraguay:** CONACYT Atlas de Violencia (2010-2014), INE (2015-2023)
Criminal Group Presence	Administrative intelligence reports, media sources, public datasets (varies by region)
Violence Indicators	Web scraping from national/local news outlets (2015-2023)
Geographic Controls	Border dummy based on municipality adjacency to international borders
Prison Overcrowding	**Paraguay:** Supreme Court (2016), MNP (2019-2023) **Brazil:** National Secretariat for Penal Policies (2016-2024)
Institutional Capacity	Transparency International CPI (2000-2023), World Bank WGI (2000-2023)

Summary of data sources used in the empirical analysis

Country	State	Group	Year	Initial Event or Context
Paraguay				
Paraguay	Amambay	PCC	2014	Expansion of trafficking routes; conflict with Jorge Rafaat.
Paraguay	Amambay	CV	2015	CV presence increases in Pedro Juan Caballero.
Paraguay	Canindeyú	PCC / CV	2008	Rising seizures and reports of group activity.
Paraguay	Alto Paraná	PCC	2015	PCC expansion in border zones.
Paraguay	Itapúa	CV	2015	CV infiltration from southern Brazil.
Brazil				
Brazil	São Paulo	PCC	1993	PCC founded after Carandiru massacre.
Brazil	Mato Grosso do Sul	PCC	2008	Strategic control of trafficking corridors.
Brazil	Mato Grosso do Sul	CV	2010	CV competes with PCC near border.
Brazil	Paraná	PCC	2010	Logistics hub for cross-border trade.
Brazil	Pará	CV	2005	Early CV influence in prisons.
Brazil	Amazonas	FDN	2000	FDN founded to dominate Manaus prisons.
Brazil	Amazonas	CV	2015	CV entry triggers violent disputes.
Brazil	Roraima	PCC / CV	2014	Mass prison violence erupts.
Brazil	Rondônia	PCC / CV	2010	Disputes along Amazonian routes.
Brazil	Ceará	CV	2005	CV gains foothold in Fortaleza.
Brazil	Acre	CV / PCC	2012	Armed conflict in prison system.
Brazil	Amapá	CV / FDN	2008	Both groups expand in prisons.
Brazil	Tocantins	CV	2015	New CV-aligned prison factions.
Brazil	Alagoas	PCC	2006	PCC absorbs local gangs.
Brazil	Piauí	PCC	2010	Expansion to northeast routes.
Brazil	Minas Gerais	PCC	2006	Coordination with prison affiliates.
Brazil	Bahia	CV	2008	CV enters through local alliances.
Brazil	Rio de Janeiro	CV	1990	Founding territory of the CV.

Entry of Criminal Groups in Paraguay and Brazil

Note: EPP (Ejército del Pueblo Paraguayo) is excluded, as it is a domestic insurgent group and not a transnational cartel like PCC or CV.

Complementary Research

As complementary research to the main analysis, I examine a related aspect of the organised crime and violence ecosystem under study, although it does not form part of the primary causal pathway.

Overcrowding and Violence in Paraguay–Brazil Prisons

I conducted a focused study on the probability of organised crime related incidents including attacks, assassination attempts, and prison breaks occurring within penitentiaries experiencing overcrowding. Drawing on incident level prison data from Paraguay and Brazil, the analysis explores whether extreme saturation in carceral facilities increases the likelihood of such violent events. This approach complements the main findings by highlighting how institutional weakness within the prison system may not only reflect state fragility but also actively enable criminal governance and violence from within The dependent variable, which captures attacks or events related to organised crime such as prison breaks, attempted escapes, and assassinations attributed to criminal organizations was constructed using web scraping techniques applied to news media sources.

Regarding the independent variables, the prison occupational index is calculated as the ratio between the prison population and the official prison capacity[4]:

$$\text{Occupational Index} = \frac{\text{Prison population}}{\text{Prison capacity}} \tag{9}$$

To ensure statistical robustness and reduce multicollinearity when controlling for regional

[4]In the case of Paraguay, prison occupational rate is measured using the concept of *maximum real capacity*, as defined by the National Mechanism for the Prevention of Torture (MNP). This measure is grounded in human rights standards, calculating the number of inmates that can be accommodated based on a minimum of 7 square meters per person. This standard reflects the minimum required space to ensure humane conditions for individuals deprived of liberty and serves as the basis for the prison overcrowding index used in this study.

factors, this index was calculated at the regional level for both Paraguay (departments) and Brazil (federal units).

This indicator captures the degree of institutional saturation within penitentiary facilities, and is used throughout the analysis to evaluate its relationship with the likelihood of violent incidents linked to organised crime.

In the case of Paraguay, prison population data for 2016 was obtained from the Supreme Court of Justice. Due to the unavailability of data for 2017 and 2018, information for the years 2019 to 2023 was sourced from the National Mechanism for the Prevention of Torture.

Meanwhile, on the Brazilian side, the prison overcrowding rate calculated as the ratio between the prison population and the official prison capacity was provided by the National Secretariat for Penal Policies (Secretaria Nacional de Políticas Penais) for the period from 2016 to 2024. I control for the homicide rate, the same I used for the estimation in the first part. The resulting dataset is an unbalanced panel comprising 309 observations.

Estimation

To estimate the effect of prison overcrowding on the likelihood of violent criminal attacks, I use a binary response model where the outcome variable is defined as:

$$attacks_i = \begin{cases} 1 & \text{if a criminal attack related to organised crime occurred in unit } i, \\ 0 & \text{otherwise.} \end{cases}$$

Key Events Related to PCC, CV, and organised Crime (2015–2023)

Country	**Region / State**	**Year**	**Detailed Event**
Paraguay	Amambay	2016	Assassination of Jorge Rafaat Toumani, a major drug lord, using .50 caliber weapons. Attack attributed to the PCC.
Paraguay	Alto Paraná	2017	Armed robbery at Prosegur vault in Ciudad del Este. Over 50 men involved, with up to USD 11 million stolen. PCC involvement confirmed.
Paraguay	Amambay	2019	Mass escape of 76 PCC inmates from the Pedro Juan Caballero prison through a tunnel.
Paraguay	San Pedro	2020	Riot in San Pedro prison involving PCC and CV factions. Multiple injuries and use of force reported.
Brazil	Roraima	2016	Prison massacre attributed to PCC and CV, with over 30 deaths due to internal gang conflict.
Brazil	Amazonas	2017–2023	Ongoing violence and expansion of PCC and CV. Notable events include a 2019 prison riot in Manaus with 55 deaths.
Brazil	Pará	2019	Altamira prison massacre: 67 inmates killed in a conflict between PCC and a local criminal faction.

Given the binary nature of the dependent variable, I estimate logit models, which assume that the log odds of the outcome are a linear function of the covariates. The probability of an attack is modeled as:

$$\Pr(attacks_i = 1 \mid X_i) = \frac{\exp(X_i\beta)}{1 + \exp(X_i\beta)} \tag{10}$$

where X_i is a vector of explanatory variables and β is the vector of coefficients, estimated via maximum likelihood.

I begin with a specification that treats prison occupation rate as a **continuous variable**:

$$\text{logit}(attacks_i) = \beta_0 + \beta_1 \cdot \text{Prison Occupation rate}_i + \beta_2 \cdot \text{kill\_rate}_i + \varepsilon_i \tag{11}$$

where $kill\_rate_i$ controls for the general level of violence in each unit.

Additionally, to allow for potential nonlinearities and threshold effects, I discretize the prison occupation rate into groups using quintiles of its empirical distribution and re estimate the model with categorical indicators.

The final specification is:

$$\text{logit}(\text{attacks}_i) = \beta_0 + \sum_{q=2}^{5} \beta_q \cdot Q_{q,i} + \beta_6 \cdot \text{kill\_rate}_i + \varepsilon_i \tag{12}$$

where:

- Qq_i are dummy variables for the second through fifth quintiles of overcrowding, with the first quintile ($Q1$) as the omitted baseline.
- $kill\_rate_i$ remains as a control variable.

Because logit coefficients represent changes in log odds, they are not directly interpretable. Therefore, I report odds ratios (OR) , obtained via the transformation:

$$\text{OR} = \exp(\hat{\beta}) \tag{13}$$

An odds ratio greater than 1 indicates that the covariate increases the likelihood of a criminal attack; an odds ratio below 1 suggests a mitigating effect.

For added interpretability, I also approximate the change in predicted probability for each quintile relative to the baseline using:

$$\Delta \Pr \approx \left(\frac{\exp(\hat{\beta})}{1 + \exp(\hat{\beta})} \right) - 0.5 \tag{14}$$

assuming a baseline probability of 0.5. This provides a more intuitive sense of how each level of overcrowding affects the likelihood of criminal violence.

Key Findings

As previously mentioned, a logit model was first estimated using the continuous variable prison overcrowding rate. Although the results presented in the following table are not statistically significant, the marginal effects suggest that for every 1 point increase in the prison occupation rate, the probability of a criminal incident or attack linked to organised crime increases approximately 1.5 percentage points(pp) and between 5.7 and 10.6 pp in border regions.

Effect of Prison Overcrowding Rate on the Likelihood of Criminal Attacks: Odds Ratios and Average Marginal Effects

	(1) Full Sample	**(2) Border Regions**
	No Controls / With Controls	No Controls / With Controls
Odds Ratio (OR)	1.19 / 1.18	1.40 / 2.23
AME (p.p.)	1.5† / 1.5	5.7* / 10.6
SE (AME)	(0.97) / (1.40)	(2.71) / (11.24)

Notes: Table reports Odds Ratios (OR) and Average Marginal Effects (AMEs) from logit models. AMEs are expressed in percentage points (p.p.), showing the estimated change in the probability of a criminal attack for a one-unit increase in the prison overcrowding rate. Standard errors in parentheses.

† $p < 0.1$, * $p < 0.05$. Models with controls include population size and homicide rate.

To avoid imposing arbitrary thresholds and to capture potential nonlinear effects across the distribution, I chose to estimate the model using quintiles of the prison overcrowding

rate. This strategy allowed me to assess whether the risk of criminal attacks increases only at specific levels of institutional saturation.

The next table, summarizes the characteristics of the different quintiles, reporting the minimum, average, and maximum occupancy rates observed in each group.

Descriptive statistics of prison occupational rate by quintile group

Quintile	**n**	**Min**	**Mean**	**Max**
Q1 (Lowest)	62	0.25	0.49	0.57
Q2	62	0.57	0.62	0.67
Q3	62	0.67	0.74	0.81
Q4	62	0.81	1.09	1.62
Q5 (Highest)	61	1.64	3.61	9.03

Note: Quintile groups are based on the distribution of `Tasa_DH`, a proxy for prison overcrowding. Each row reports the number of observations (n) and the minimum, mean, and maximum overcrowding ratios within the group. Values are rounded to two decimal places.

Effect of overcrowding quintile on the probability of criminal attacks

Variable	**Coef.**	**OR**	**Δ Prob. (p.p.)**	**p-value**	**Sig.**
Quintile Q2 (vs Q1)	0.737	2.090	17.6	0.300	
Quintile Q3 (vs Q1)	-0.432	0.649	-10.6	0.627	
Quintile Q4 (vs Q1)	0.297	1.346	7.4	0.746	
Quintile Q5 (vs Q1)	1.856	6.396	36.5	0.009	**

Note: The OR column reports the *odds ratio*, which indicates how many times more likely an attack is compared to the reference group. OR > 1 means increased odds; OR < 1 means reduced odds. The Δ Prob. column shows the estimated change in the probability of an attack in percentage points, compared to the reference tercile (Q1). Model include control for homicide rate

Statistical significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

As shown in the table above, the probability of an organised crime related violent event increases by 36 percentage points in the highest quintile of the prison overcrowding rate, where the average occupancy exceeds 164%. This effect is statistically significant. Although the fourth quintile (the second highest) does not reach statistical significance, the positive direction of the effect suggests that as the occupancy rate approaches institutional capacity limits, the likelihood of criminal incidents tends to rise. An exception is observed in the third quintile, which displays a negative but nonsignificant effect. To make the quintile result more intuitive, I express it per 10 percentage point of overcrowding. The reference group (Q1) averages about 40% occupancy, whereas the highest quintile (Q5) begins at 160% a gap of roughly 120 percentage points. Moving from Q1 to Q5 raises the probability of an organised crime incident by 36.5 percentage points. Dividing that increase by the 120-point gap and scaling to a 10 point step gives

$$\frac{36.5}{160 - 40} \times 10 \;\approx\; 3 \text{ percentage points} \tag{15}$$

Thus, each additional 10 percentage-point increase in prison occupancy is associated with approximately a 3 percentage point rise in the likelihood of an organised crime incident, for occupancy rates above 40%. Stating the effect in this incremental form makes the magnitude easier to interpret than quoting the full quintile jump.