Essays in the Political Economy of Environment and Crime

A Thesis Submitted to Trinity College Dublin, the University of Dublin in Application for the Degree of Doctor of Philosophy in Economics

By

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Enrico Cavallotti
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Summary

This thesis includes three essays at the intersection of political, environmental, and crime economics. Each chapter tackles important questions regarding the impact of environmental shocks on criminal activity, the influence of labor market green transitions on voting and political attitudes, and the strategies criminal groups use to infiltrate institutions. The analysis relies primarily on empirical methods within a causal inference framework, with theoretical models invoked when they inform the empirical approach. It draws on novel data from online blogs, surveys, climate records, and administrative sources.

The first essay (Chapter 2) examines the impact of environmental shocks on criminal activity. Analysis of four waves of survey data from Mexico reveals that droughts push individuals out of the labor market—especially those in the age range susceptible to recruitment by criminal organizations. Building on this empirical foundation, I construct a novel measure of Mexican drug cartels' activity from the most popular Mexican *narcoblog* for 2010–2022 to examine how cartels respond to droughts. I find that droughts boost criminal activity over the following 3 to 6 months—particularly in locations where it is easier to recruit adversely affected civilians and in strategically important locations for cartels. At the same time, droughts undermine the business of cartels invested in illicit crop cultivation, preventing expansion where such cultivation is viable. Using data on the universe of water concessions released at the municipal-level, the paper illustrates how criminal groups can overcome climate threats by capturing local policymaking and overexploiting water resources.

The second essay (Chapter 3) examines how the green transition in European labor markets shapes electoral preferences. The analysis centers on the hypothesis that material interests depend on the relative "greenness" versus "brownness" of individual occupational profiles—that is, the degree to which individuals stand to benefit or lose from a transition to a greener economy. Using individual-level data from 14 Western European countries spanning 2010-2019, the study develops novel measures of occupational environmental exposure. For each individual,

predicted greenness and brownness scores are computed based on the predicted probabilities of employment across all possible occupations and occupation-specific environmental characteristics. The findings reveal that individuals with higher predicted brownness scores are significantly less likely to vote for Green parties or parties with stronger environmental agendas, while those with higher predicted greenness scores demonstrate the opposite pattern. Notably, voting preferences of individuals with brown occupational profiles tend to converge toward those of greener profiles in regions better positioned to gain from the green transition.

The third essay (Chapter 4) analyzes when and how do criminal organizations resort to violence against politicians. It addresses this question in the context of Italian municipalities, arguing that this decision is shaped by the availability and timing of economic rents. It develops a theoretical framework in which criminal groups can engage in violence both before the election, to affect the result, and after the election, to intimidate the winner. Then, we test the model's predictions using earthquakes as exogenous shocks to municipal resources. Drawing on data on violent episodes against politicians between 2010 and 2020, the estimates show that these shocks lead to more frequent and severe violence, with the timing of the violence systematically shifting across the electoral cycle: shocks occurring after elections increase post-electoral violence, while those occurring before elections increase pre-electoral violence, with no cross-period spillovers.

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Contents

List of Figures

List of Tables

Chapter 1

General Introduction

What is the environment? In economics, it is the configuration of conditions under which agents interact–not merely background scenery, but an active force that shapes economic behavior. When environmental conditions change, they alter the relative payoffs of different choices, reshaping how people participate in labor markets, elections, and even illegal activities. This dissertation examines three profound ways environmental change is transforming economic interactions: through climate shocks that push workers toward criminal organizations, green transitions that realign electoral coalitions, and resource competition that intensifies institutional capture by criminal groups.

This work sits at the intersection of applied microeconomics, environmental economics, political economy, and crime economics. Each chapter demonstrates a common mechanism: environmental pressures change outside options and resource flows, which in turn determine whether people choose legal or illegal work, how they vote, and when criminal groups attempt to capture local institutions.

The key contribution is showing that environmental change propagates through two widely overlooked channels, namely criminal governance and electoral politics, that are crucial for understanding how individuals and institutions adapt to environmental stress. Traditional environmental economics focuses on direct effects like agricultural productivity or health outcomes. This thesis reveals indirect effects that may be equally important: how environmental change reshapes coercion, coalition-building, and control over local institutions. These channels determine not just economic outcomes, but who holds power and how that power is exercised. The thesis consists of three essays.

Chapter 2, *Droughts in the Field, Drug Lords on the Hunt: Climate and Criminals*, investigates how environmental shocks reshape criminal organizations' strategies

through a dual adaptation mechanism. While the environmental economics literature has extensively documented impacts on legal economic activity, this chapter situates environmental shocks within the context of illicit economies, highlighting how criminal groups strategically respond to drought-induced disruptions. I construct a novel dataset from Mexico's leading *narcoblog*, *Borderland Beat*, covering drug cartels-related events for the period 2010–2022, combined with municipal-level drought data and household surveys. Using variation in drought timing, the chapter reveals that cartels pursue a dual strategy: first, they exploit drought-induced labor market disruptions to expand their operations, particularly benefiting from economically displaced young workers; second, in regions where droughts undermine their illicit crop operations, they capture local water policymaking processes to secure critical resources for continued production. Results show that droughts increase criminal activity by roughly one percentage point in the quarter following onset, with effects concentrated in areas where civilian recruitment by criminal groups is easier and along strategic trafficking corridors. However, this expansion occurs only where cartels lack economic interests in agriculture. In the period analyzed in this chapter, opium poppies are grown by Mexican drug cartels to produce heroin, the main plant-based drug produced by these groups, which is then smuggled into the United States. Using variation in opium-poppy suitability, I show that the effect falls to zero in areas suitable for cultivating this illegal crop. By contrast, I present additional suggestive evidence that cartels manipulate surface water concessions to offset agricultural losses, contributing to environmental degradation through resource overextraction. By connecting climate shocks, labor market disruptions, and institutional capture, this chapter contributes to an emerging literature at the intersection between environmental economics and economics of organized crime, demonstrating how criminal organizations may amplify the economic impacts of climate shocks on local communities by exploiting institutional vulnerabilities.

Chapter 3, *Green Collars at the Voting Booth: Material Interest and Environmental Voting*, coauthored with Italo Colantone, Piero Stanig, and Francesco Vona, explores how occupation-related material interests shape support for environmental policies and Green parties across Western European democracies. While the green transition creates winners and losers in labor markets, yet the electoral consequences of these distributional effects remain poorly understood. This chapter addresses this gap in the literature by examining whether voters' occupational profiles–specifically their exposure to green versus brown job opportunities–systematically predict environmental voting patterns. The paper employs individual-level data from the European Social Survey covering 14 Western Euro-

pean countries over 2010-2019, combined with occupation-specific greenness and brownness measures derived from the O*NET database. To avoid endogeneity concerns with current occupation choices, we construct predicted greenness and brownness scores for each individual based on demographic characteristics and regional labor market conditions, capturing occupational profiles independent of current employment status. Results show that individuals with higher predicted brownness scores are significantly less likely to vote for Green parties and support environmental policies, while those with higher predicted greenness scores exhibit the opposite pattern. These effects vary systematically across regions with different renewable energy potential: in areas better positioned to benefit from the ecological transition, individuals with "browner" occupational profiles converge in political preferences toward workers with higher predicted green profiles. This suggests that local economic opportunities can moderate occupation-based political divisions. By linking labor market positioning with electoral behavior, this chapter provides the first cross-country evidence on how material interests drive environmental voting, contributing to broader literature on the political consequences of structural economic transformations.

Chapter 4, *Carpe Diem: When and How Criminal Groups Infiltrate Political Institutions*, coauthored with Livio Di Lonardo and Nicola Mastrorocco, investigates how criminal organizations strategically time violent interventions in local politics around economic opportunities and electoral cycles. Despite extensive evidence of criminal groups in politics, little is known about how the timing of violence against politicians responds to changes in extractable rents from infiltration. We develop a theoretical framework in which attacks on politicians are not random: they respond systematically to the availability of economic rents, with timing shaped by the electoral calendar. When lucrative opportunities arise close to elections, criminal groups increase violence to influence electoral outcomes, with no corresponding shifts in violence after the vote. By contrast, when opportunities emerge earlier in the term, groups deploy violence to signal strength and pressure incumbents to grant the economic benefit. To test these predictions, we combine data on violent episodes against Italian politicians in Campania, Calabria, and Sicily from 2010 to 2020 with exogenous variation in extractable rents generated by earthquake-induced government transfers. The evidence strongly supports our theoretical predictions. First, earthquakes increase the probability of criminal attempts to capture local government resorting to violence by more than half, and both the frequency and severity of violence scale with earthquake magnitude. These effects arise quickly, peaking within two months of the shock. Second, we document the predicted timing asymmetries: earthquakes

occurring in the two years before elections raise pre-electoral violence without post-electoral spillovers, whereas earthquakes occurring in the two years after elections significantly increase post-electoral violence.

Chapter 2

Droughts in the Fields, Drug Lords on the Hunt

Climate and Criminals

2.1 Introduction

Climate change is driving an increase in both the frequency and intensity of extreme weather events worldwide, with significant adverse impacts on economic output and livelihoods (IPCC, 2022). Strikingly, regions most vulnerable to these climate shocks often coincide with areas where organized criminal groups exert substantial influence (United Nations Security Council, 2021). Such overlaps recur consistently across different parts of the globe. For instance, Honduras stands out as one of the countries most severely impacted by weather-related losses in Latin America. At the same time, it is home to some of the most powerful criminal organizations in the world, e.g., the Barrio 18 and MS-13. Similarly, in Europe, the Italian mafias *Cosa Nostra*, *'Ndrangheta*, *Camorra*, are hosted by the country that lately suffered the highest impacts from weather-related disasters in the continent. The same applies to Southeast Asia, where Myanmar is one of the most climate-exposed countries, and hosts the United Wa State Army, an ethnic armed force extremely relevant in local politics and also largely involved in regional narcotics trafficking.[1]

Despite this recurrent empirical regularity, the economics literature has largely documented the adverse effects of climate on the legal economy (Albert, Bustos, and Ponticelli, 2021; Cascarano, Natoli, and Petrella, 2025; Colmer, 2021; Dell, Jones, and Olken, 2014), but we still know little about the link between illicit actors and climate-related shocks. In this paper, I document how Mexican drug

[1]Organized Crime Index data available at: https://ocindex.net/. Climate Risk Index data available at https://www.germanwatch.org/en/cri. Last accessed on May 5, 2025.

cartels recalibrate their operations in the wake of droughts through a two-pronged adaptation strategy. First, they capitalize on drought-induced negative labor market shocks to expand their operations. Second, in regions where drought undermines illegal crop yields–making expansion unprofitable–they incur economic losses and instead subvert local policymaking, particularly water concession processes, to secure the natural resources they need. Ignoring illicit actors in climate impact analyses thus risks overlooking a key dimension of communities' and environments' responses to extreme weather.

Studying how criminal organizations adapt to climate shocks poses a major empirical challenge: researchers need variation in exposure to these shocks, and a context where illicit activity can be measured reliably at high frequency. Mexico provides an ideal natural laboratory for this analysis. The country has experienced increasingly frequent and severe droughts over the past decades, creating widespread water stress and economic disruption. Simultaneously, Mexico hosts some of the world's most powerful and diversified drug cartels, organizations that extend far beyond traditional drug production and smuggling to encompass illegal mining, human trafficking, kidnapping, and territorial control. Crucially, the emergence of independent *narcoblogs* since the early 2010s has created an unprecedented opportunity to systematically track cartel activity in real time. These online platforms were created specifically to fill gaps in official reporting by allowing anonymous contributors to aggregate news reports, social media content, and local intelligence on cartel operations. Among these, *Borderland Beat* stands out. Founded in 2009, it publishes thousands of articles each year, serving as the primary international source for NGOs, journalists, and researchers monitoring Mexican drug cartels, with approximately 40,000 Twitter followers. By scraping and classifying the universe of *Borderland Beat* posts from 2010 to 2022, I construct a novel municipal-level panel on cartel activity. I then use this data to analyze shifts in criminal behavior at the municipal-level following a drought, and how these shifts depend on local conditions that determine whether these criminal groups to expand their activities.

First, I leverage detailed, monthly municipal-level droughts data from Mexico's *Monitor de Sequía* alongside rich household surveys to show that droughts depress employment, especially among young individuals most likely to be recruited by criminal organizations, and that this effect is strongest in regions where agriculture relies primarily on rain-fed crops. Building on this evidence, I investigate how these shocks impact criminal activity, defined as any type of cartel

operations detected by *Borderland Beat* posts. I find that in the quarter following an initial drought, the probability of criminal activity rises by roughly one percentage point, showing that criminal groups might benefit from the drought-induced negative shock. Given that I cannot definitively distinguish newly arrived from previously present groups, the overall uptick in cartel activity may reflect either existing organizations deepening their operations (becoming more visible) or the entry of entirely new groups exploiting drought-driven labor shortages. However, to provide suggestive evidence on the latter, I hand-code the more recurrent cartel names mentioned in Borderland Beat posts and track group appearances after drought events. The data reveal a clear surge in first-time appearances immediately following droughts, but this entry effect is driven exclusively by "challenger" cartels. These are those groups formed more recently, characterized by higher violence and smaller organizational scale, whose limited economies of scale make them particularly sensitive to labor-supply shocks (Battiston et al., 2024).

Next, I show that cartel expansion is muted where alternative income options for affected civilians are more attractive, consistent with a labor-supply mechanism. Using municipal-level data on migration networks, I find that the drought-crime link weakens in areas where migrants to the United States are more likely to work in agriculture (i.e., lower migration frictions for farmworkers). By contrast, the effect is stronger along key trafficking corridors. Crucially, in municipalities suitable for opium poppy cultivation, droughts do not trigger cartel growth: revenue losses from crop failures prevent both existing groups from expanding and new groups from entering, creating a countervailing effect via the agricultural channel.[2]

Building on this countervailing effect, I then examine whether cartels subvert local water policy when crop revenues fall. In poppy-suitable municipalities with known cartel influence, droughts trigger a sharp rise in surface-water concession volumes–while groundwater and federal allocations remain unchanged–pointing to targeted manipulation of the easiest permit channel. Stream-sampling data show that only in these areas the likelihood of anomalies in dissolved-oxygen readings rises significantly after droughts, which can be evidence of overextraction. Together, these findings reveal a two-stage adaptation: cartels exploit labor shortages where they occur and, when crop income falls, hijack local water-allocation processes to sustain their operations at the environment's expense.

[2] After OxyContin's 2010 reformulation and the first U.S. marijuana legalizations in 2012, heroin became the most profitable plant-based drug, obtained from Mexican poppy.

This paper relates to different strands of literature. First, it speaks to the expanding literature on the economic drivers of criminal organizations strategies by highlighting how climate shocks reshape cartel behavior. Prior studies have examined how cartels respond to government enforcement (Battiston et al., 2024; Dell, 2015; Esberg, 2025; Mejia and Restrepo, 2016), shifts in demand for illicit services (Dipoppa, 2025; De Haro, 2025) or drugs (Sobrino, 2020), international commodity price swings (Dube, García-Ponce, and Thom, 2016), and changes in trade openness (Hidalgo, Hornung, and Selaya, 2022). By exploiting the quasi-random timing of severe droughts in Mexico and a new, high-frequency panel on cartel presence, I show that climate shocks also shape cartel behavior, and do so in two distinct ways. First, droughts lower income in the legal economy and thereby increase the local supply of potential cartel recruits, mirroring the labour-supply channel in Dube, García-Ponce, and Thom (2016). Second, in areas where cartels rely on illicit crop cultivation, droughts cut off essential water inputs and directly undermine their agricultural revenues.

Second, I extend the research on the local effects of criminal presence (Acemoglu, De Feo, and De Luca, 2019; Barone and Narciso, 2015; Daniele, Le Moglie, and Masera, 2023; Di Cataldo and Mastrorocco, 2022; Lucas, Marshall, and Riaz, 2020; Pinotti, 2015b; Sviatschi, 2022) by uncovering potentially criminal-driven distortions in natural resource governance. Specifically, I document that in areas both historically infiltrated by cartels and suitable for opium poppy cultivation, droughts lead to a sharp rise in the volume of surface water concessions granted. This adjustment allows criminal groups to secure critical water inputs even as the legal economy suffers. I further show that this surge in extraction is associated with a significant deterioration in stream water quality. To my knowledge, this is the first systematic evidence that organized crime can manipulate environmental policy to safeguard its own production inputs in response to climate shocks.

Third, this paper contributes to the growing literature on climate and violence (for a recent review, see Burke et al., 2024) by shifting attention away from spontaneous, communal, or interpersonal violence toward the calculated, profit-oriented use of force by non-state criminal organizations. A closely related paper, Baysan et al. (2019), shows that fluctuations in temperature influence interpersonal and inter-group violence in Mexico by altering individuals' propensity for aggression. In contrast, I do not treat violence as an incidental byproduct of climatic stress, nor do I investigate psychological "taste for violence." Rather, I examine violence as one tool in a strategic response to droughts by criminal gangs, alongside labor-supply adjustments and policy capture, revealing how organized crime adapts its entire business model to extreme weather events.

Finally, this paper expands the climate-economy literature (Albert, Bustos, and Ponticelli, 2021; Colmer, 2021; Dell, Jones, and Olken, 2014; Lai et al., 2023), especially the one on the impacts of weather fluctuations on employment (Alfani et al., 2023; Branco and Féres, 2021; Feriga, Gracia, and Serneels, 2024; Jayachandran, 2006; Jessoe, Manning, and Taylor, 2017; Sánchez Guijosa, Murray-Tortarolo, and Martínez Salgado, 2025), by explicitly integrating the informal and illegal sectors. Criminal organizations represent a large, often overlooked component of local economies–especially in regions highly vulnerable to climate risk–so understanding how they respond to extreme weather is essential for a complete picture of climate impacts. By showing that droughts can both drive new cartel recruitment and prompt policy capture of water resources, this study highlights how illicit actors mediate the economic and institutional consequences of climate shocks.

The remainder of the paper is structured as follows. Section 2.2 introduces the conceptual framework. Section 2.3 provides background on the institutional setting. Section 2.4 presents the data. Section 2.5 investigates the impact of droughts on criminal activity. Section 2.6 looks at how criminal groups may adapt through influence on local water policy. Section 2.7 concludes.

2.2 Conceptual framework

This section outlines the conceptual framework underlying the empirical analysis. Droughts induce two countervailing effects on local cartel activity: a positive labor supply effect and a negative illegal crop profit effect. The net impact of a drought depends on which of these two channels dominates.

Labor supply channel. A drought reduces the productivity of legal agriculture, causing farm incomes and local wages to fall. Displaced agricultural workers and other rural laborers then become more likely to accept the wage offered by criminal organizations, everything else equal. In the canonical Becker framework (Becker, 1968), the supply of labor to illicit activities rises when returns in the legal sector decline. Consequently, existing cartels can expand by recruiting additional affiliates, and new groups may enter the municipality. This mechanism is weakened in areas where attractive outside options exist. For example, in Mexico drought-affected agricultural workers often migrate abroad as a coping strategy (Arceo-Gómez, Hernández-Cortés, and López-Feldman, 2020), thereby

reducing the pool of potential cartel recruits. Conversely, the channel is amplified in strategically important areas (e.g., drug smuggling corridors), where criminal groups can exploit the negative shock to expand.

Illegal crop profit channel. In municipalities with agro-climatic conditions suitable for illicit cultivation, cartels derive substantial revenues from illegal crops. In the Mexican context during the study period, opium poppy is the primary illicit crop, grown for heroin production. A drought directly reduces potential yields and, consequently, cartels' agricultural profits. As profitability falls, cartels have less incentive either to expand operations in the affected area or to establish a presence there if they are not already active. This countervailing effect can offset expansion driven by increased labor supply: existing groups find that the economic gains from new recruits are negated by reduced crop returns, while potential entrants are discouraged by the diminished profitability of controlling the region.
I propose a potential channel for criminal organizations to adjust to this negative shock. Cartels with substantial political influence in poppy-suitable areas may mitigate drought impacts by securing alternative water sources. Specifically, they can leverage local connections to obtain additional water concessions, offsetting rainfall deficits and sustaining illicit cultivation. This channel operates only where the cost of influencing policy is low.

This simple conceptual framework leads to the following hypotheses:

H1 *Net Effect*: Droughts may increase, decrease, or have no net impact on overall criminal activity (existing cartels or new entrants) depending on the relative strength of the labor-supply and illegal-crop channels.

H2 *Modulators of the Labor-Supply Channel*: The positive labor supply effect is weaker in municipalities where legal outside options are stronger, and stronger where the profitability of expansion is higher (e.g., along strategic smuggling routes).

H3 *Illegal Crop Channel Only in Suitable Areas*: The negative impact on cartel profits from illicit cultivation operates only in areas agro-climatically suitable for these crops; in non-suitable areas, this channel is inactive.

H4 *Policy Capture Adjustment*: Following a drought, increases in water-concession allocations occur only in municipalities that are both suitable for illegal

crops and where cartels' political influence lowers the cost of obtaining concessions.

2.3 Institutional Background

2.3.1 Mexican drug cartels

Mexican drug cartels have played a central role in the transnational drug trade since 1980, when the former Judicial Federal police agent Miguel Angel Felix Gallardo founded the Guadalajara Cartel (Yadav, 2022). Some of the oldest and most powerful cartels rose to prominence during the 1980s and 1990s, capitalizing on smuggling routes for heroin, marijuana, and later cocaine, primarily destined for the U.S. market. These groups developed durable trafficking networks and strong political connections, often securing territorial control through violence and corruption. Their primary business remains drug trafficking, particularly of cocaine, heroin, methamphetamine, and, more recently, fentanyl. However, many of these cartels have also diversified into other illicit markets, including oil theft, extortion, and kidnapping (Battiston et al., 2024).

In 2006, President Felipe Calderón of the *Partido Acción Nacional* (PAN) launched a nationwide militarized campaign against organized crime, marking the beginning of what is commonly referred to as the "War on Drugs." This policy involved deploying the military and federal police across regions with high cartel presence, aiming to dismantle the most powerful criminal groups. While initially framed as a necessary security measure, the strategy led to a sharp escalation in violence and the proliferation of criminal organizations as former allies turned into rivals (Dell, 2015). Older cartels such as Sinaloa maintained a competitive advantage due to their established routes and international reach, while newer entrants–like the Jalisco New Generation Cartel (CJNG)–have emerged with more diversified and territorially embedded business models. These challenger groups often rely on a mix of traditional drug trafficking and local revenue streams, including illegal mining and extortion, reflecting a shift toward hybrid forms of organized crime.

2.3.2 Water emergency and criminals

Due to its geographic location spanning both tropical and subtropical zones, Mexico faces a high risk of drought. Its vulnerability is further compounded by a pronounced mismatch between the spatial distribution of rainfall and the

geography of water demand, which heightens the socioeconomic consequences of water scarcity (Dobler-Morales and Bocco, 2021).
Climate change is expected to intensify both the frequency and severity of droughts, exacerbating Mexico's exposure to water stress. By mid-century, under a high emissions scenario, Mexico is projected to experience a 15% increase in the frequency of hydrological droughts CMCC (2021). Projections suggest that the number of Mexican states classified as highly vulnerable to water scarcity could nearly double by 2050 (S&P Global, 2023). This trend worsens an already critical situation, in which only about 43% of the population has access to safely managed drinking water, well below the regional average for Latin America.[3]
Agriculture is typically the first sector to suffer during droughts, given its strong dependence on adequate soil moisture. In Mexico, where agriculture plays a central role in the economy, its vulnerability is amplified by the fact that approximately 80% of cropland depends entirely on rainfall for irrigation (Dobler-Morales and Bocco, 2021). As a result, droughts account for a very high portion of total agricultural losses nationwide. For instance, the drought that struck Mexico in 2022 was the primary factor reducing agricultural output in 31 of the nation's 32 states, according to data from INEGI (Rodríguez, 2024). Beyond agriculture, other critical sectors are also adversely affected, including livestock production and the energy sector, particularly hydropower generation. Between 2010 and 2012, one of the major droughts in the country resulted in economic damage worth $7.4 billion pesos (CENAPRED, 2022).

As water scarcity intensifies and prices rise, water has become a strategic resource in Mexico, driving criminal organizations to adapt like any other economic actor. On one hand, cartels capitalize on drought-induced hardship to recruit vulnerable civilians and address persistent labor shortages driven by high turnover from violence. For example, following the severe mid-2013 drought in Chihuahua's Sierra Madre Occidental, many members of the Tarahumara, an Indigenous people traditionally reliant on subsistence maize and bean farming, found their livelihoods devastated and increasingly accepted cartel work as a means of survival. Given their world famous endurance running skills, they were mainly employed as drug mules across the U.S.-Mexico border (Argomedo, 2020). On the other hand, cartels have infiltrated municipal water distribution networks to secure supply and extract illicit rents. The Sinaloa Cartel, for instance, now manages key irrigation infrastructure in its northwestern stronghold, imposing

[3]Data available from the WHO/UNICEF Joint Monitoring Programme. Link: https://washdata.org/data/household!/mex. Last accessed 5th May 2025.

unauthorized fees on commercial distributors and directing water allocation to serve its own interests, thereby distorting local markets and undermining water security (InSight Crime, 2025). Examining these dual adaptation strategies forms the core contribution of this paper.

2.4 Data

2.4.1 Mexican drug cartels activity: *Narcoblogs*

Measuring criminal activity with both temporal depth and fine spatial resolution represents a major challenge. Most existing studies have turned to machine learning and natural language processing algorithms applied to traditional media or global news aggregator feeds (e.g., Coscia and Rios, 2012; Osorio and Beltran, 2020; Sobrino, 2020). However, these approaches can suffer from reporting bias due to at least three channels. First, illicit markets are by nature opaque, so many events simply go unrecorded. Second, criminal groups can co-opt or intimidate outlets, skewing what gets published (Lucas, Marshall, and Riaz, 2020). Third, the profit maximization logic of traditional media (Mullainathan and Shleifer, 2005) potentially favors sensational and violent incidents over non-violent footprint of organized crime.

However, Mexico offers a rare alternative: beginning in 2009, independent *narcoblogs* emerged, specifically to gather and report cartel-related information from newspapers, citizens, and freelance reporters. As contributors remain completely anonymous and content is freely accessible online and via social media, these platforms alleviate concerns about cartel intimidation and sensationalism bias that are typical of traditional media.

Drawing on Esberg (2025), I focus on *Borderland Beat*, by far the leading English language *narcoblog* in the country. This blog was founded in 2009 by "Buggs" (later revealed to be a retired Albuquerque police officer), it now has around 40,000 followers on Twitter, and serves NGOs, journalists, and researchers. It also feeds data on inter-cartel violence into the Uppsala Conflict Data Program, one of the most widely used platforms providing data on organized violence and armed conflict. Other Spanish language *narcoblogs* such as *El Blog del Narco*[4] serve similar functions but present important limitations for systematic analysis. For instance, they have occasionally been used by cartels themselves as direct communication channels with civilians. They also often include sensationalized content, such as coverage of drug lords' personal relationships and lifestyle stories, that dilutes the focus on operationally relevant criminal activities. Given these concerns, I

[4]Link: https://elblogdelnarco.com/. Last visited on 12th August 2025.

exclusively rely on *Borderland Beat*, which maintains the highest standards of editorial independence.

2.4.1.1 Building a measure of cartel activity

I build my measure of cartel activity by following several steps.
First, I scrape the universe of articles from *Borderland Beat* from its launch in April 2009 until the end of December 2022. This gives me a total of more than 17,000 articles. For each article, I extract the headline, author, full text, and publication date. An example of the outline of an article from the blog is reported in Figure 2.A.1.
Second, I employ the GPT-4o large language model [5] to identify and classify every reported event. Specifically, the model is prompted to determine: *(i)* the actor (e.g., Mexican cartel, individual criminal, police force); *(ii)* the nature of the action or event; *(iii)* the municipality and state, when such geographic information is provided; and *(iv)* the date on which the event occurred. Appendix 2.C reproduces the exact API prompt. This process yields approximately 131,000 distinct event records. Municipalities are mentioned on average 6.6 times over the full period of analysis (2010-2022). However, the number of mentions is highly skewed: the median is 0, while the 99th percentile is 123, with a standard deviation of 40.67.
Third, I construct alternative indices of local cartel activity. The first counts the number of mentions of each municipality m in a given period. The second is a binary indicator that switches to one from the first mention of municipality m onward. The binary measure mitigates post-detection under-reporting bias but places disproportionate emphasis on the initial report.
Fourth, I classify each action extracted by the large language model into a fixed set of predefined categories by applying the multilingual `mDeBERTa-v3-base-mnli-xnli` model (Laurer et al., 2024)[6]. This model casts classification as a natural language inference (NLI) problem, yielding for each action a probability distribution over our category labels. To reduce dimensionality, I collapse the LLM's raw action vector into the following eleven categories: "criminal business, including drugs", "criminal violence between cartels", "general violence", "kidnappings or thefts", "killings", "police or state intervention", "arrests", "seizures", "posting a video", "showing a banner or *narcomanta*"[7], "other". For each action instance, the model

[5] A multilingual, multimodal generative pre-trained transformer developed by OpenAI and released in May 2024.

[6] More information at: https://huggingface.co/MoritzLaurer/mDeBERTa-v3-base-mnli-xnli. Last visited on 12th August 2025.

[7] *Narcomantas* are banners showed by drug cartels to communicate with civilians.

returns a probability p_c for each category c. I assign the label corresponding to $\arg\max_c p_c$, provided $\max_c p_c > 0.25$;[8] if all $p_c \leq 0.25$, the action remains unclassified. The frequency of all the events classified is report in Table 2.B.1 in the Appendix.

2.4.1.2 Sanity checks and correlation with other datasets

To check the consistency of the dataset, I present a few stylized facts and sanity checks. Finally, I also report correlations with data on official killings.

Figure 2.A.2 displays a word-cloud of the blog's full text. Notably, the most prominent tokens correspond to cartel and gang names rather than explicitly violent terminology. Figure 2.A.3 plots the share of Mexican municipalities with at least one blog mention over time. When this series is juxtaposed with U.S. overdose rates for heroin and synthetic opioids over the same period, the expansion of cartel-related reporting closely aligns with the onset of the opioid crisis triggered by the 2010 OxyContin reformulation. Figure 2.A.4 presents analogous time-series for four of the largest cartels. The trajectories closely mirror established accounts in the literature: the Sinaloa and Zetas organizations display an early, sustained presence; the Cártel Jalisco Nueva Generación (CJNG), although emerging later, exhibits a striking rise in reported activity; and La Familia Michoacana, while less prominent in absolute terms, nevertheless maintains a broad geographic footprint. Figure 2.A.5 illustrates the geographic spread of cartel activity in four benchmark years within the study period. In Figures 2.A.6(a) and 2.A.6(b), I depict, for two of the largest cartels, the set of municipalities in which at least one incident was recorded over the entire sample. The spatial patterns corroborate established narratives: the Sinaloa Cartel's presence is clustered in Mexico's northwest, whereas the Gulf Cartel's influence is concentrated in the northeastern region.

Finally, Table 2.1 reports cross-sectional correlation coefficients between official municipal-level violence indicators and the number of events recorded by the blog, broken down by event type. Official data on killings come from the Mexican *Secretaría de Salud*.[9] Inter cartel killings are proxied with 15-39 aged men killed

[8] The 0.25 threshold is chosen to balance classification precision and coverage in the presence of noisy probability estimates from large language models. While the choice is ultimately heuristic, it is informed by a manual validation exercise comparing model predictions against hand-coded event labels, which suggested that lower thresholds substantially increased false positives, whereas higher thresholds discarded a significant number of plausible classifications.

[9] Data available at: https://datos.gob.mx/busca/dataset/defunciones. Last visited on 4th May

with a firearm, following De Haro (2025). Each municipality contributes a single observation, defined as the average value of each series over the full sample period.

Table 2.1: Blog measures and official killings

	Blog mentions regarding:			
	Killings	Kidnappings/thefts	Narcomantas	Police intervention
Inter cartel killings	0.8210***	0.7193***	0.6801***	0.5854***
Killings by shooting	0.8163***	0.7168***	0.6899***	0.5845***
All killings	0.8147***	0.7238***	0.7046***	0.5904***

Notes: Cross-sectional correlation coefficients between official statistics and blog measures for the period 2010-2022. Inter cartel killings are measured by number of young males killed by shooting, following De Haro (2025). Sample: all Mexican municipalities. p-value < 0.05 *, < 0.01 **, < 0.001 ***.

Correlation coefficients are uniformly positive and highly statistically significant, reflecting the well-established association between cartel presence and local violence. In particular, the coefficient for homicides is the largest, whereas correlations for non-fatal events (e.g., kidnappings, seizures) are moderately lower. Blog-based measures capture then dimensions of cartel activity beyond lethal violence, making it a richer proxy than homicide counts alone. This is in line with what also presented in Table 2.B.1, which shows that reported events span a wide array of categories, not limited to violence. Figures 2.A.7(a) and 2.A.7(b) propose a visualization of the same intuition, plotting log-transformed blog mentions against killings, either inter cartel or not.

2.4.2 Other data

Droughts. I use data on droughts at the month and municipal-level provided by the Mexican government program *Monitor de Sequía*.[10] This program is sponsored by the National Meteorological Service (*Servicio Meteorológico Nacional*, SMN), as part of the North American Drought Monitor (NADM). It uses data from local meteorological stations, radars, and satellite imagery to assess drought conditions. Drought intensity is classified on a scale from 0 (abnormally dry) to 4 (exceptional drought), depending on: precipitation (Standardized Precipitation Index, and Percent of Average Precipitation), water availability temperatures, and evaporation (Palmer index, Palmer hydrological index, and Palmer Z index),

2025.

[10] More information available at: https://smn.conagua.gob.mx/es/climatologia/monitor-de-sequia/monitor-de-sequia-en-mexico. Last visited on 24th May 2025.

a vegetation health index (VHI), and soil moisture. A group of experts then determines the drought level basing their decisions on these parameters. This makes the measure more suitable for analysis than a simple elaboration of raw climate data. I classify a drought for all those months when the *Monitor de Sequía* index is equal or larger than 1, following Arceo-Gómez, Hernández-Cortés, and López-Feldman (2020).
Despite it has been used in the literature as reliable and particularly well suited data source, I propose a validity check of *Monitor de Sequía*'s data. I reconstruct municipal-level monthly rainfall data using the Climate Hazards Center Infrared Precipitation with Station data (CHIRPS v3.0). Since 1981, CHIRPS v3.0 has combined 0.05° resolution satellite imagery with in situ station data to produce a gridded rainfall time series. For each municipality in Mexico, I impute rainfall by assigning the value of the grid cell it belongs to; if a municipality spans multiple grid cells, I take the unweighted average of rainfall across all those grids. I then use this monthly time series to check whether months classified as droughts by the SMN systematically show lower rainfall than other months. To do this, I run a municipal-level regression where the outcome variable is rainfall (in mm of precipitation), and the only controls are municipality and date fixed effects. I then compare the residuals from this regression between drought and non-drought months. Figure 2.A.8 shows the distribution of residuals for the two groups, dropping the top and bottom 1%. The distribution for drought months is more left skewed, as expected. Although low rainfall not being the only element contributing to droughts, this result is reassuring about the quality of *Monitor de Sequía*'s data.

Employment. I draw on data from the Mexican National Survey of Household Income and Expenditure (ENIGH), conducted biennially by INEGI (*Instituto Nacional de Estadística y Geografía*) between August 21 and November 28 of the survey year. ENIGH provides detailed information on household expenditures, income, and employment status. To ensure comparability over time, when using this data source I restrict the analysis to the last four survey waves (2016, 2018, 2020, and 2022), since earlier waves employed different methodologies.

Water concessions and water quality. CONAGUA, the Mexican National Water Commission, provides detailed data on all water concession titles issued by local and national authorities from 1991 to the present. The data includes the exact location, date of registration, issuing authority, concession holder, intended use (e.g., industrial, agricultural), and the authorized volume of water extraction. It also specifies the source type, i.e., whether the concession draws

from groundwater, surface water, or other bodies. In addition, CONAGUA provides water quality data starting from 2012. Water quality is assessed through samples collected at numerous stations across the country, offering good spatial coverage for both groundwater and surface water. Each sample includes a set of quality indicators measured consistently across locations. Surface indicators include several parameters, including levels of dissolved oxygen, that I use as a parameter for overexploitation of water.

Additional data sources. Socioeconomic and demographic controls are drawn from the 2000 and 2010 Population and Housing Censuses by INEGI. Data on Mexican migrants living in the U.S. come from *matrículas consulares*, identification cards issued by Mexican consulates abroad, collected between 2004 and 2009 by the *Instituto de los Mexicanos en el Exterior*. Municipality-to-municipality distances were computed with OpenStreetMap API.[11] Lastly, the time invariant measure of opium poppy suitability is taken from Daniele, Le Moglie, and Masera (2023).

2.5 Droughts, Employment and Criminal Activity

This section examines how droughts shape criminal activity through multiple channels. The analysis begins by establishing the labor market mechanism: droughts displace civilians from formal employment, with particularly strong effects on young individuals most vulnerable to cartel recruitment. Building on this foundation, the study documents a significant increase in criminal activity in the months following drought events. This relationship, however, varies systematically across geographic contexts. The drought-crime effect is strongest in economically vulnerable regions with limited alternative livelihoods and along strategically important drug-smuggling corridors where cartels actively compete for territorial control. Conversely, in areas suitable for illicit crop cultivation, the positive effect disappears entirely as droughts impose direct economic costs on cartel operations dependent on opium poppy production. These findings reveal that drought-induced increases in criminal activity are geographically concentrated in regions unsuitable for drug agriculture, where cartels pivot toward non-agricultural illicit activities including drug trafficking, kidnappings, and extortion.

[11] The API can be used via the `osrm` R package.

2.5.1 Droughts and Labor Market Participation

Extensive literature documents how weather fluctuations affect employment (Alfani et al., 2023; Branco and Féres, 2021; Feriga, Gracia, and Serneels, 2024; Jayachandran, 2006), including in Mexico (Jessoe, Manning, and Taylor, 2017; Sánchez Guijosa, Murray-Tortarolo, and Martínez Salgado, 2025). Given agriculture's central role in many Mexican municipalities, water scarcity predictably erodes incomes and reduces labor-market participation. In this Section, I replicate these empirical findings for contemporary Mexico, showing that the mechanism persists and that my droughts data predict these variations in employment. I further introduce a new heterogeneity dimension: droughts disproportionately reduce labor-market participation among young individuals at prime ages for cartel recruitment, namely between 15 and 30 years of age.

I exploit the Mexican National Survey of Household Income and Expenditure (ENIGH), which is conducted biennially by INEGI between August 21 and November 28, to provide some stylized facts on the relationship between drought conditions and probability of participating in the labor market. I focus on ENIGH's last four waves to ensure methodological consistency across survey rounds.[12] Importantly, the ENIGH survey provides data on a set of outcomes, both for people that declare to be actively working and for those that are not. I exploit information on interviewed individuals declaring to have a job at the moment of the interview, to capture the likelihood of participating in the labor market. I match this data with data on droughts from *Monitor de Sequía* and I estimate the following equation:

$$Employed_{imt} = \beta NumberDroughts_{imt} + \alpha_m \times t + \gamma_t + X'_{it}\delta + \varepsilon_{imt} \tag{2.1}$$

where the dependent variable $Employed_{imt}$ is a binary indicator equal to one (multiplied by 100 for ease of interpretation) if individual i in municipality m reports having at least one job at time t.[13] The key regressor $NumberDroughts_{imt}$ counts the number of months during which municipality m experienced drought conditions over two alternative exposure windows: *(i)* the nine months preceding the survey (from the beginning of the calendar year through the interview month) and *(ii)* the previous growing season for legal crops (April-August).[14] I define

[12] A major methodological change was carried out from the 2016 onwards by INEGI, which makes it harder to compare with previous surveys. I use waves from 2016, 2018, 2020, and 2022.

[13] I define individuals as having at least one job all those that appear in ENIGH's *TRABAJOS* survey, i.e., the part of the survey containing information on declared jobs.

[14] In Mexico, around 70% of maze–by far the main legal crop–is grown in this growing season.

drought conditions whenever the drought index from *Monitor de Sequía* is equal or larger than 1, as in the remainder of the paper. I include municipality-specific linear time trends to capture gradual local changes, and year fixed effects to absorb national shocks common across municipalities. The vector X'_{it} comprises individual controls for age, gender, and a dummy for secondary education, which account for demographic determinants of labor market performance. Individuals declaring any disabilities at the time of interview are excluded to ensure the analysis pertains only to those eligible for formal employment. ε_{imt} are robust standard errors.

Table 2.2: Droughts and employment, by age group

	Dep var: Employed					
	All		15-30		30-65	
	(1)	(2)	(3)	(4)	(5)	(6)
Droughts last 9 months	-0.013		-0.094*		-0.051	
	(0.027)		(0.054)		(0.041)	
Droughts last growing season		-0.035		-0.181**		-0.073
		(0.044)		(0.086)		(0.065)
Observations	1,067,398	1,067,398	294,035	294,035	423,192	423,192
N. municipalities	1,623	1,623	1,622	1,622	1,623	1,623
Mean	48.57	48.57	58.46	58.46	74.78	74.78
R^2	0.295	0.295	0.220	0.220	0.184	0.184
Municipality Time Trend	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the coefficient β obtained by estimating Equation (2.1) for three different samples: all individuals, 15-30 years old, and 30-65 years old. Individuals declaring any disabilities at the time of interview are excluded. Municipality time trends, year fixed effects, and individual controls are included throughout all specifications. Individual controls include age, gender, and a dummy for secondary education. The variable for number of droughts in the last 9 months captures the number of months with droughts reported at the municipal-level where the individual was residing at the moment of the survey in the 9 months leading to the interview (from January to September). The variable for number of droughts in the last growing season captures the number of months with droughts from April to August before the survey. The outcome variable is a dummy equal to 1 (multiplied by 100 for ease of interpretation) whenever individual *i* declares they are working. Robust standard errors in parentheses. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 2.2 presents estimates of β from Equation (2.1) for three age groups: the full sample, individuals aged 15-30, and those between 30 and 65 years of age. I find no significant relationship between recent occurrence of droughts and likelihood of declaring a job, when I focus on the full sample. However, results are more interesting when splitting the sample by age of respondents. An

additional month with a drought in the nine months before the survey decreases the probability of reporting to have a job for the 15-30 cohort. However, the result is only significant at the 10% level. When I focus on droughts occurring in the growing season preceding the survey, the effect goes up by twice the size in absolute value, up to 0.18 percentage points, significant at the 5% level. This is not surprising, given the more disruptive economic effects of these shocks when occurring in the most critical season of the year. Importantly, the effect is smaller and imprecise for interviewed individuals over 30.
Drought-induced labor market disruptions seem to disproportionately affect younger workers. This age group is the primary target for cartel recruitment, given the high physical demands and risks of illicit activities. Young individuals being both more susceptible to drought-induced job loss and at the same time preferred targets for cartel recruitment may therefore constitute a potential link through which climatic shocks facilitate the growth of organized criminal activity.

To rule out spurious correlations or anticipatory effects, I perform a placebo test using drought counts in the following growing season. Table 2.B.2 in the Appendix presents estimates for both the full sample and the 15-30 year-old subsample, with neither coefficient reaching statistical significance.
To verify that these results capture the impact of water scarcity on employment via reduced agricultural profits, I conduct a heterogeneity analysis based on whether the country's principal legal crop, i.e., maize, is grown exclusively by rainfall. Table 2.B.3 in the Appendix replicates the regressions from columns (3) and (4) of Table 2.2, adding an interaction between the drought indicator and a dummy for municipalities where all summer maize relies solely on rainfall rather than artificial irrigation. Columns (2) and (6) show that this interaction term is negative and statistically significant. Splitting the sample into purely rain-fed areas and those with any irrigation systems confirms that the drought-employment relationship is stronger where maize depends entirely on rainfall. This suggests that the negative association between drought frequency and employment among 15-30 year-olds is driven mainly by regions where rainfall is the dominant irrigation source.
Interestingly, for individuals who remain employed after a drought, the number of jobs increases, reflecting that remaining workers take on additional positions to compensate for widespread drought-induced employment losses, consistent with Branco and Féres (2021). Restricting the analysis to employed respondents and estimating Equation (2.1) with job count as the outcome, I find a positive and significant drought coefficient only for the 15-30 year-old cohort, again highlighting the acute labor-market shock among those at prime recruitment age.

Table 2.B.4 in the Appendix reports the results from this estimation.

2.5.2 Droughts and Criminal Activity

2.5.2.1 Main results

To first understand the dynamic effect of droughts on criminal activity, I work with data aggregated at the municipality-by-quarter level, taking advantage of the available data frequency. I build a balanced panel of municipalities covering the period from 2010 to 2022.[15] I define a drought as occurring in a given quarter if at least one month within that quarter is affected.[16] Nearly all municipalities in the sample (2,426 out of 2,456, about 98.8%) experience at least one drought during the period. On average, municipalities face drought conditions in 13.65 out of 52 quarters.

I estimate an event study using the estimator proposed by Chaisemartin and D'Haultfoeuille (2022), which can accommodate treatment reversals.[17] The following equation describes the empirical strategy:

$$C_{mt} = \gamma_m + \delta_t + \sum_{k=-K}^{K,\, k\neq -1} \beta_k \cdot 1\{q_{mt} = k\} + \lambda_{s(m)} \times t + X'_{m,2010} \times t + \varepsilon_{mt} \qquad (2.2)$$

Subscripts m and t denote municipality and quarter, respectively. The subscript $s(m)$ refers to the state where municipality i is located. Throughout all main specifications, C_{mt} is a dummy equal to one from the first time municipality m was reported in the blog *Borderland Beat* onwards, multiplied by 100 to ease interpretation. The indicator $1\{q_{mt} = k\}$ equals one in quarter k relative to a drought event in municipality m. The vector of coefficients β_k captures the leads and lags in the event study following Chaisemartin and D'Haultfoeuille (2022). γ_m and δ_t are municipality and quarter fixed effects, the term $\lambda_{s(m)} \times t$ includes

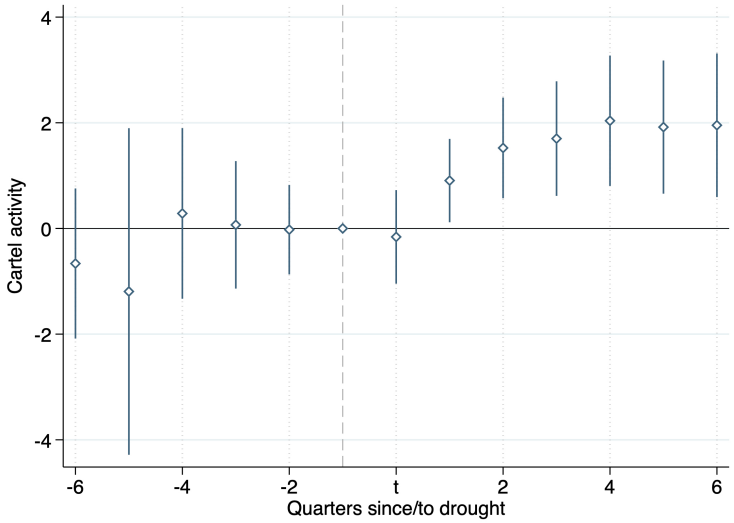
[15] I use the INEGI 2010 Census municipalities classification, which leaves me with 2,456 distinct municipalities as observation units.

[16] Consistently with section 2.5.1, I define a drought whenever the index reported by *Monitor de Sequía* is equal or above 1.

[17] Given the recurrent nature of droughts as a treatment, this estimator seems particularly well-suited. However, I also re-estimate the same event-study specification using a standard two-way fixed effects (TWFE) estimator (Figure 2.A.9). In this specification, only the first drought is treated as the event and municipalities that are always treated are excluded, following the identifying assumptions of Chaisemartin and D'Haultfoeuille (2022). I include state-time trends and time-invariant controls interacted with year fixed effects for greater flexibility. The TWFE results closely mirror the estimates from the Chaisemartin and D'Haultfoeuille (2022) estimator.

state-specific time trends. The vector $X_{m,2010}$ contains baseline controls from the 2010 INEGI Household Census, interacted with time trend. These controls include total population, unemployment share, and land suitability for opium poppy cultivation. Standard errors are clustered at the municipality level.
Figure 2.1 reports the estimates from the event study computed with the Chaisemartin and D'Haultfoeuille (2022) estimator. Six lags and leads are reported.

Figure 2.1: Droughts and criminal activity, dynamic specification



Notes: The figure shows lags and leads of an event study computed with the Chaisemartin and D'Haultfoeuille (2022) estimator (95% confidence intervals). Time periods are 3-months periods, i.e., quarters, and the unit of observations is municipality. Standard errors are clustered at municipal-level, and state-time trends and time-invariant controls linearly interacted with year variable are included.

Reassuringly, no pre-trends are detected before the shock. In the quarter immediately following the drought, there is an increase in the likelihood of observing cartel-related activity, by around 1 percentage point. In the following quarters, this increase seems to be even larger in magnitude, with point estimates reaching around 2 percentage points and then stabilizing around one year after the event.
The effect appears to be sizeable, given that criminal activity, measured as described in Section 2.4.1.1, is observed in about 26 percent of municipality-month observations in the sample. The estimated effect represents then roughly 5 percent of the dependent variable's mean one quarter after the event.

Having established the timing of the effect, I corroborate the result using an alternative criminal activity measure: the number of times a municipality is mentioned in *Borderland Beat*. This specification also enables more detailed

heterogeneity testing. I collapse the data at the municipal-semester level and regress three outcomes: the raw count of mentions, its log-plus-one transformation to account for non-linear relationships, and a dummy for any mention. The main regressor is a dummy equal to one whenever at least one drought occurred in the previous semester. The estimated equation is the following:

$$C_{mt} = \gamma_m + \delta_t + \beta Drought_{m,t-1} + \lambda_{s(m)} \times t + X'_{m,2010} \times \theta_t + \varepsilon_{mt} \tag{2.3}$$

where now C_{mt} is the number of mentions in the blog, while $Drought_{m,t-1}$ is a dummy equal to one whenever in semester $t-1$ municipality m was affected by a drought. State time trends, municipality and semester fixed effects, and controls at baseline interacted with year fixed effects are included.

Table 2.3 presents the two-way fixed effects estimates. A drought yields roughly 0.04 additional blog mentions in the subsequent semester, about 16 percent of the dependent variable mean. The result holds after adding state-specific linear time trends and interacting baseline controls with year fixed effects, and it remains consistent across all three outcome transformations.
Considering the structure of my data, I run a robustness check, estimating an alternative version of Table 2.3, where I allow for a Conley (1999)-type clustering structure, following Colella et al. (2019). Results are reported in Table 2.B.5 in the Appendix.

Consolidation or expansion. Changes in blog mention frequency may reflect either existing cartels consolidating their presence or new groups entering and expanding. Due to the inherent limitations of illicit activity data, it is difficult to disentangle whether observed changes reflect consolidation by existing cartels or entry by new groups. However, the granularity of the data from *narcoblogs* allows me to provide suggestive evidence on the expansion channel.
First, I manually code all the cartels most frequently cited in *Borderland Beat* and classify them into incumbent, challenger, emergent, or minor types. Following Battiston et al. (2024), I classify as incumbent cartels the four long-standing, market-dominant syndicates, namely Sinaloa, Gulf, Juárez, and Tijuana, while as challenger cartels the newer Beltrán-Leyva, La Familia Michoacana, and Los Zetas. Building on this scheme, I further define two additional categories. I label rapidly expanding organizations as emergent cartels (CJNG, Knights Templar, Los Chapitos, Cártel del Noreste, and Guadalajara), and I group smaller, locally confined cells (such as Ciclones, Metros, Aztecas, Pueblos Unidos, Salazares,

Table 2.3: Droughts and criminal activity

	Dep var: Blog mentions					
	Count		ln(Count+1)		Dummy	
	(1)	(2)	(3)	(4)	(5)	(6)
Drought_{t-1}	0.036***	0.040***	0.013***	0.016***	0.010***	0.013***
	(0.013)	(0.015)	(0.003)	(0.003)	(0.002)	(0.003)
Observations	61,400	61,400	61,400	61,400	61,400	61,400
N. municipalities	2,456	2,456	2,456	2,456	2,456	2,456
Mean	0.246	0.246	0.0823	0.0823	0.0723	0.0723
R^2	0.492	0.534	0.537	0.565	0.381	0.398
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes	Yes	Yes
State × Time Trend	No	Yes	No	Yes	No	Yes
Controls × Year FE	No	Yes	No	Yes	No	Yes

Notes: This table shows coefficients from different versions of a TWFE regression. In all columns the variable $Drought$ is a dummy = 1 for the semesters with a drought occurring. Municipality and semester fixed effects are included throughout all specifications, while columns 2, 4, and 6 include also state time trends and controls measured at baseline in 2010 interacted with year fixed effects. The outcome variable is the sum of mentions regarding the municipality in columns 1 and 2, the logarithmic transformation of the same variable + 1 in columns 3 and 4, and a dummy = 1 for each semester with at least one mention in columns 5 and 6. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Tláhuac, Unión Tepito, Tequileros, Mexicles, Rojos, Caborca, Ardillos, Viagras, and Santa Rosa de Lima) as minor cartels. I then estimate Equation (2.3) where the dependent variable is now the probability that a cartel appears in municipality m for the first time, by type of cartel.

Table 2.4 presents the results for this specification. In the semester following a drought, the probability of observing a new cartel increases by 0.4 percentage points. This result seems to be entirely driven by challenger cartels, that appear to be particularly responsive to these shocks, and for which this likelihood goes up by 0.2 percentage points. One possible explanation of this is that these groups have sufficient territorial reach to recruit displaced workers and expand quickly, but their limited economies of scale make them more sensitive to changes in local labor availability.

Violence and inter-cartel conflict. Cartel activity is synonymous with violence whenever inter-cartel competition is involved. However, I expect no change in violence following droughts, as this type of shock does not increase competition for at least two reasons. First, I expect one cartel to first exploit the post-drought

Table 2.4: Droughts and new cartels expansion

	Dep var: New cartel observed				
	Any	Incumbent	Challenger	Emergent	Minor
	(1)	(2)	(3)	(4)	(5)
Drought_{t-1}	0.004***	0.001	0.002***	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Observations	61,400	61,400	61,400	61,400	61,400
N. municipalities	2,456	2,456	2,456	2,456	2,456
Mean	0.0138	0.00379	0.00335	0.00622	0.00174
R^2	0.085	0.054	0.057	0.056	0.059
Municipality FE	Yes	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes	Yes	Yes

Notes: This table shows coefficients from different versions of a TWFE regression. In all columns the variable $Drought$ is a dummy = 1 for the semesters with a drought occurring. Municipality and semester fixed effects are included throughout all specifications, together with state time trends and controls measured at baseline in 2010 interacted with year fixed effects. The outcome variable is a dummy = 1 in any semester when a new cartel is observed, by type of cartel: any cartel in column 1, incumbent cartels in column 2, challenger cartels in column 3, emergent cartels in column 4, and minor cartels in column 5. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

increase in available labor and capture gains without provoking new entry or turf battles, in a first mover advantage type of framework. Second, droughts do not enhance the profitability of controlling territory *per se*, as instead Sobrino (2020) shows that it is the case for shifts in heroin prices, that drive violence in places suitable for poppies. Furthermore, establishing that violence remains unchanged also rules out the alternative explanation that the observed rise in cartel mentions simply reflects greater visibility of violent incidents.

To verify this, I re-estimate Equation (2.3) using four violence-related outcomes as dependent variable. I draw on official data from Mexico's *Secretaría de Salud*, examining *(i)* inter-cartel killings (men aged 15-39 killed by firearms) and *(ii)* all firearm-related homicides. I also use Uppsala Conflict Data Program records to capture *(iii)* inter-cartel attacks and *(iv)* associated deaths. Table 2.5 reports the estimates, showing no relationship between droughts and violence for any of these variables, in line with previous research (Baysan et al., 2019).
I also run an event study in the fashion of Equation (2.2), using again the Chaisemartin and D'Haultfoeuille (2022) estimator and focusing on the effect of

the first drought, to corroborate the results. Figures 2.A.10(a), 2.A.10(b), 2.A.11(a), and 2.A.11(b) in the Appendix show no jumps in violence after the shock.

Table 2.5: Droughts and violence

	Dep var:			
	Killings		Cartel-related conflicts	
	Inter-cartel	By shooting	Total number	Deaths
	(1)	(2)	(3)	(4)
Drought_{t-1}	0.077	0.092	-0.031	-0.132
	(0.076)	(0.116)	(0.051)	(0.292)
Observations	61,400	61,400	61,400	61,400
N. municipalities	2,456	2,456	2,456	2,456
Mean	2.414	3.915	0.187	0.570
R^2	0.685	0.715	0.479	0.304
Municipality FE	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes	Yes

Notes: This table shows coefficients from different versions of a TWFE regression. In all columns the variable $Drought$ is a dummy = 1 for the semesters with a drought occurring. Municipality and semester fixed effects are included throughout all specifications, together with state time trends and controls measured at baseline in 2010 interacted with year fixed effects. The outcome variables are related to killings in the first two columns (inter-cartel killings proxied by 15-39 year old men shot in column 1, all killings by shooting in column 2) and to conflicts between cartels registered by UCDP in the last two (number of conflicts between gangs in column 3, deaths caused by such conflicts in column 4). Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

2.5.2.2 Mechanisms

This section investigates two mechanisms that can intensify or attenuate the effect of droughts on criminal expansion: migration as an alternative coping strategy to crime, and geographic factors that alter the profitability of controlling affected areas.

Fishman and Li (2022) show that, in the context of Mexico, international migration is an extremely relevant outside option for agricultural workers affected by droughts. Thus, when migration represents a more appealing outside option for the local population affected, the positive effect of droughts on criminal presence and activity may be weaker, as workers migrate rather than work for criminal groups. Lower migration frictions make leaving the area a more credible

and accessible alternative for affected individuals. To proxy for the strength of migration networks abroad, I use the number of *matrículas* sent by Mexican immigrants in the U.S. to the Mexican *Instituto de los Mexicanos en el Exterior*,[18] measured in the five years prior to the start of the analysis period (until 2009). These documents, commonly sent by both legal and undocumented migrants, enable access to various services in the hosting country, making them a reliable proxy for U.S.-bound migration. As in the existing literature, I use the municipality of birth to proxy for the municipality of origin, due to lack of data on the last place of residence before migration. I proxy migration frictions in a given municipality using either the total number of migrants in the U.S. from that municipality (normalized by number of inhabitants), or the share of those migrants who reported working in agriculture when applying for their *matrícula*. While the former captures migration frictions for any affected civilian, regardless their occupation at the moment of the shock, the latter is specific to agricultural workers, as it better captures how easily these workers can migrate and find similar jobs elsewhere.

The second mechanism potentially at play involves how strategic the affected location is for drug cartels. These groups may exploit adverse climate shocks to enter or consolidate in strategically important jurisdictions–particularly those closer to U.S. border crossings, where the returns to illegal trade are highest. To test this, I use municipal-level measures of the shortest overland distance via OpenStreetMap to the nearest U.S. port of entry to examine whether drought-induced expansions are larger in municipalities with lower strategic distance.[19]

To empirically test these two channels, I estimate the following model that allows for interaction terms, augmenting Equation (2.3):

[18] This measure for migrants abroad has already been used in the literature (Caballero, Cadena, and Kovak, 2018; Daniele, Le Moglie, and Masera, 2023), together with other sources such as the Mexican Migration Project (Fishman and Li, 2022). However, *matrículas* have a few important advantages when compared to other sources, namely better coverage, representativity, and granularity.

[19] Mexico–United States border crossings (source: Wikipedia, last visited 31st July 2025):
· Baja California: Tijuana, Tecate, Mexicali
· Sonora: San Luis Río Colorado, General Plutarco Elías Calles, Saríc, Nogales, Naco, Agua Prieta
· Chihuahua: Janos, Ascensión, Juárez, Guadalupe, Práxedis G. Guerrero, Ojinaga
· Coahuila de Zaragoza: Ocampo, Acuña, Piedras Negras
· Nuevo León: Anáhuac
· Tamaulipas: Nuevo Laredo, Guerrero, Miguel Alemán, Camargo, Gustavo Díaz Ordaz, Reynosa, Río Bravo, Matamoros.
Municipalities in Campeche, Yucatán, and Quintana Roo are excluded, as their distances to any U.S. port exceed feasible thresholds and the `osrm` package fails to compute routes for these regions.

$$C_{mt} = \gamma_m + \delta_t + \beta_1 Drought_{m,t-1} + \beta_2 Drought_{m,t-1} \times H_m + \lambda_{s(m)} \times t + X'_{m,2010} \times \theta_t + \varepsilon_{mt} \tag{2.4}$$

As in Equation (2.3), C_{mt} is a different transformation of the count of blog mentions. The term H_m represents the variable used to test heterogeneity, i.e., the number of *matrículas* or the distance from closest port, and, in case time-varying, is measured at baseline. The coefficient of interest β_2 captures how the main effect varies with different values of H_m.

Table 2.6: Droughts, criminal activity, and migration frictions

	Dep var: Blog mentions					
	Count		ln(Count+1)		Dummy	
	(1)	(2)	(3)	(4)	(5)	(6)
$Drought_{t-1}$	0.033	0.048**	0.014***	0.018***	0.012***	0.015***
	(0.020)	(0.019)	(0.004)	(0.004)	(0.003)	(0.003)
$Drought_{t-1}$× Migrants	0.044		0.009		0.005	
	(0.054)		(0.012)		(0.011)	
$Drought_{t-1}$× Migrants in agriculture (%)		-0.203*		-0.064***		-0.049***
		(0.118)		(0.022)		(0.019)
Observations	61,400	60,325	61,400	60,325	61,400	60,325
N. municipalities	2,456	2,413	2,456	2,413	2,456	2,413
Mean	0.246	0.249	0.0823	0.0832	0.0723	0.0731
R^2	0.534	0.535	0.565	0.566	0.398	0.398
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the coefficients β_1 and β_2 from two different versions of equation (2.4). In all columns the variable $Drought$ is a dummy = 1 for the semesters with a drought. In columns 1, 3, and 5, the variable interacted with the drought dummy is the total number of *matriculas* sent up to 2009 from migrants in the U.S. born in the municipality (by 1,000 inhabitants). In columns 2, 4, and 6, the variable interacted is instead the share of this number that declared having a job in the agricultural sector in the U.S. when sending the *matriculas* documents back to Mexico. Controls include municipality and semester fixed effects, controls measured at baseline in 2010 interacted with year fixed effects, and state-specific yearly time trends. The outcome variable is the sum of mentions regarding the municipality in columns 1 and 2, the logarithmic transformation of the same variable + 1 in columns 3 and 4, and a dummy = 1 for each semester with at least one mention in columns 5 and 6. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 2.6 presents estimates of the heterogeneous effect of droughts on criminal activity based on the strength and composition of migration networks in the U.S. In columns (1), (3), and (5) the drought indicator is interacted with the total number of *matrículas* sent up to 2009 (by 1,000 inhabitants), showing no significant differential effect. In contrast, in columns (2), (4), and (6) I interact the drought

variable with the share of migrants reporting employment in agriculture when sending their *matrícula*. The coefficient estimated for this interaction term is statistically significant and negative. Migration provides a credible outside option that reduces the expansionary effect of droughts on criminal activity. However, the mitigation is driven not by the overall size of the diaspora, but by networks that specifically lower migration frictions for agricultural workers, the group most directly exposed to weather shocks.

Table 2.7: Droughts, criminal activity, and strategic locations

	Dep var: Blog mentions					
	Count	ln(+1)	Dummy	Count	ln(+1)	Dummy
	(1)	(2)	(3)	(4)	(5)	(6)
Drought_{t-1}	0.212***	0.038***	0.019**	0.001	0.008**	0.011***
	(0.073)	(0.011)	(0.008)	(0.015)	(0.003)	(0.003)
$\text{Drought}_{t-1}\times$ Distance from border	-0.019***	-0.002**	-0.001			
	(0.007)	(0.001)	(0.001)			
$\text{Drought}_{t-1}\times$ Close to border				0.072**	0.013**	0.004
				(0.030)	(0.006)	(0.005)
Observations	58,250	58,250	58,250	58,250	58,250	58,250
N. municipalities	2,330	2,330	2,330	2,330	2,330	2,330
Mean	0.254	0.0848	0.0747	0.254	0.0848	0.0747
R^2	0.534	0.563	0.394	0.534	0.563	0.394
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the coefficients β_1 and β_2 from two different versions of equation (2.4). In all columns the variable $Drought$ is a dummy = 1 for the semesters with a drought. In columns 1, 2, and 3, the variable interacted with the drought dummy is the minimum distance from the closest Mexico–United States border crossings (100km). In columns 4, 5, and 6, the variable interacted is instead a dummy = 1 whenever municipality m's distance from the closest crossing is below the median distance. Controls include municipality and semester fixed effects, controls measured at baseline in 2010 interacted with year fixed effects, and state-specific yearly time trends. The outcome variable is the sum of mentions regarding the municipality in columns 1 and 4, the logarithmic transformation of the same variable + 1 in columns 2 and 5, and a dummy = 1 for each semester with at least one mention in columns 3 and 6. Municipalities in Campeche, Yucatán, and Quintana Roo are excluded. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 2.7 shows instead that the positive effect of droughts on cartel-related activity is significantly larger in municipalities closer to U.S. border crossings. Each additional 100 km of road distance reduces the post-drought rise in mentions by about 0.02 counts. Specularly, municipalities within the median distance threshold experience an additional 0.07 mentions. These results confirm that strategic proximity to major smuggling routes amplifies the incentives of criminal groups to exploit adverse environmental shocks to expand or consolidate their

presence locally.

2.5.2.3 Countervailing Forces: Illegal Crop Viability

I have demonstrated that droughts can catalyze criminal-activity expansion via labor-supply shocks and identified key moderating mechanisms. However, climate shocks also threaten cartels' revenue when these depend on illicit crop cultivation. In drought-affected municipalities, diminished land productivity reduces the returns to illegal agriculture, weakening incentives for existing groups to consolidate through new recruits and deterring prospective entrants who face lower profitability despite increased labor availability.
To examine this channel, I focus on the cultivation of opium poppy, which is a key agricultural input for drug trafficking organizations to produce heroin. This focus is particularly relevant during the period under analysis (2010–2022), when the heroin market in the U.S. expanded significantly due to the opioid crisis.[20] I use data from Daniele, Le Moglie, and Masera (2023) on opium poppy suitability, a time-invariant measure based on agro-climatic conditions drawn from the FAO EcoCrop database.[21] In this context, the hypothesis is that the expansionary effect of droughts on criminal activity should be attenuated in areas suitable for opium poppy cultivation, as the shock negatively affects land productivity and thus criminal enterprises' agricultural revenues.

To test this, I re-estimate Equation (2.3) excluding the interaction term, splitting the sample into municipalities that are suitable and not suitable for poppy cultivation. The expansionary effect should be concentrated in the latter group, where criminal organizations have no direct agricultural interest and therefore face no offsetting losses from drought-related declines in land productivity.

Table 2.8 reports results from estimating the effect of droughts separately for municipalities suitable (Panel A) and not suitable (Panel B) for opium poppy cultivation. The first three columns of each panel show that the increase in criminal activity following the shock occurs only in locations not suitable for poppies. This pattern is consistent with the hypothesis that droughts are less likely to spur cartel expansion where criminal enterprises hold agricultural interests that would be harmed by the shock.
The next question is which illicit activities cartels pursue when expanding in

[20] The reformulation of OxyContin in 2010 made prescription opioids less accessible, prompting a shift toward heroin consumption and driving a surge in demand and related deaths (see Figure 2.A.3).

[21] The suitability index combines temperature, precipitation, and soil pH to assess potential for opium poppy cultivation.

Table 2.8: Droughts and criminal activity, suitable *vs* not suitable municipalities

	Panel A – Suitable for illegal crops								
	Any criminal activity			Kidnappings & thefts			Drugs selling & seizures		
	Count	ln(+1)	Dummy	Count	ln(+1)	Dummy	Count	ln(+1)	Dummy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Drought_{t-1}$	0.010	0.005	0.008	-0.007	-0.002	-0.002	0.004	0.002	0.001
	(0.033)	(0.007)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Observations	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
N. municipalities	460	460	460	460	460	460	460	460	460
Mean	0.307	0.106	0.0930	0.0329	0.0175	0.0200	0.0130	0.00746	0.00887
R^2	0.552	0.559	0.400	0.306	0.293	0.217	0.386	0.351	0.263
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B – Not suitable for illegal crops								
	Any criminal activity			Kidnappings & thefts			Drugs selling & seizures		
	Count	ln(+1)	Dummy	Count	ln(+1)	Dummy	Count	ln(+1)	Dummy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Drought_{t-1}$	0.047***	0.018***	0.014***	0.003	0.002*	0.004**	0.001	0.001*	0.002*
	(0.017)	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Observations	49,900	49,900	49,900	49,900	49,900	49,900	49,900	49,900	49,900
N. municipalities	1,996	1,996	1,996	1,996	1,996	1,996	1,996	1,996	1,996
Mean	0.232	0.0768	0.0676	0.0241	0.0131	0.0151	0.00868	0.00514	0.00629
R^2	0.538	0.570	0.399	0.253	0.305	0.246	0.265	0.238	0.193
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the coefficients β from estimating Equation (2.3). In all columns the variable $Drought$ is a dummy = 1 for the semesters with at least 1 drought. Panel A estimates the regression for the subsample of municipalities suitable for opium poppies, while Panel B for the subsample of not suitable municipalities. The dependent variable is the count of mentions, the log transformation of the count + 1, and a dummy for at least one mention (first three columns of each panel). Columns (4) to (6) use the mentions related to kidnappings or thefts, Columns (7) to (9) related to drug selling and seizures. Controls include municipality and quarter fixed effects, controls measured at baseline in 2010 interacted with year fixed effects, and state-specific yearly time trends. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

locations where cultivation is infeasible. Columns (4) to (9) decompose the mentions of criminal activity detected via the natural language inference algorithm described in Section 2.4.1.1 into kidnappings, thefts, drug trafficking, and seizures, and identify some non-agricultural activities that drive the expansion in cartels' activity in unsuitable municipalities. Taken together, the evidence points to substitution away from legal cultivation and toward organized crime's core (not agriculture-related) activities. In municipalities not suitable for illegal crops,

droughts depress legal earnings, and cartels exploit this shock by expanding predatory crimes, trafficking, and logistics rather than farm-based rents.

To further isolate the mechanisms at play, I exploit seasonal variation in drought timing to test whether shocks affecting legal versus illicit crop calendars produce distinct effects on criminal activity. Anecdotal evidence reports that opium poppy cultivation in Mexico follows a winter growing cycle. I confirm this seasonal pattern using seizure data from Mexican authorities. Results are shown in Figure 2.A.12 in the Appendix: seizures only happen between October and May, with peak cultivation during the winter months. Since virtually no opium poppies are grown during summer months, summer droughts can only influence criminal activity through the labor-supply channel by displacing maize farmers and making them available for cartel recruitment, even in regions otherwise suitable for poppy cultivation. In fact, summer droughts are particularly relevant for legal crops: for instance, rain-fed maize, the country's principal legal crop, depends entirely on summer precipitation.[22] This seasonal separation provides clean identification of the recruitment mechanism, as the negative profitability effect that could otherwise offset increased criminal activity is absent during summer. Winter droughts, by contrast, should produce more ambiguous effects as they simultaneously reduce both legal employment opportunities and cartel agricultural profits.
I then disaggregate the drought indicator into quarterly dummies. Table 2.9 reveals that droughts generate a significant rise in criminal activity within poppy-suitable municipalities only when occurring in July–September, the critical period for rain-fed maize production. Droughts in all other quarters show virtually no effect on cartel mentions. Even where illicit cultivation is viable, disruption to legal livelihoods still drives cartel expansion via the labor supply channel.

Finally, one potential concern is that municipalities suitable for opium poppy may be structurally different from other areas, particularly in terms of climatic and agronomic conditions. For example, if legal crop cultivation were generally unviable in these regions, the economic impact of a drought would likely be minimal, reducing incentives for workers to seek alternatives, such as employment in the illegal sector. In such a case, the muted effect of droughts on cartel activity could simply reflect limited economic exposure, rather than any direct constraint on criminal enterprises.

[22] USDA Foreign Agricultural Service. Link: https://ipad.fas.usda.gov/countrysummary/default.aspx?id=MX. Last visited on 1st August 2025.

Table 2.9: Growing season-specific shocks in municipalities suitable for opium poppy

	Dep var: Blog mentions		
	Count	ln(+1)	Dummy
	(1)	(2)	(3)
Drought[Jan-Mar]$_{t-1}$	0.043	-0.004	-0.001
	(0.093)	(0.009)	(0.008)
Drought[Apr-Jun]$_{t-1}$	-0.011	0.010	0.011
	(0.055)	(0.009)	(0.009)
Drought[Jul-Sep]$_{t-1}$	0.074	0.025*	0.021**
	(0.068)	(0.013)	(0.010)
Drought[Oct-Dec]$_{t-1}$	-0.047	-0.005	0.003
	(0.059)	(0.014)	(0.011)
Observations	11,500	11,500	11,500
N. municipalities	460	460	460
Mean	0.307	0.106	0.093
R^2	0.552	0.559	0.400
Municipality FE	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes

Notes: This table shows the β coefficients from a version of equation (2.3) augmented with four different drought indicators instead of one main regressor. The drought variables are a dummy = 1 for the months with a drought, respectively from January to March (first row), April to June (second row), July to September (third row), October to December (fourth row). Controls include municipality and semester fixed effects, controls measured at baseline in 2010 interacted with year fixed effects, and state-specific yearly time trends. The outcome variable is the sum of mentions regarding the municipality in column 1, the logarithmic transformation of the same variable + 1 in column 2, and a dummy = 1 for each semester with at least one mention in column 3. Only municipalities suitable for opium poppy cultivation are included in the sample. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

To address this concern, Figures 2.A.13 and 2.A.14 present descriptive evidence on the relationship between poppy suitability and maize cultivation, the dominant legal crop in Mexico during the period of analysis.[23] The figures show that poppy-suitable municipalities are not significantly less suited for maize cultivation, suggesting that the absence of an expansionary drought effect in these areas is

[23]According to five-year average estimates for 2020–2024 by the U.S. Department of Agriculture, maize is by far the most widely cultivated crop in Mexico, with production volumes over five times greater than sorghum–the second most common–and nearly eight times greater than wheat, the third.

unlikely to be driven by structural differences in legal agricultural viability. Figure 2.A.13 plots the relationship between opium poppy suitability and average maize cultivation, showing virtually no correlation. Figure 2.A.14 confirms that the distribution of maize production is highly similar across suitable and non-suitable municipalities, reinforcing the claim that legal agricultural potential does not systematically differ between the two groups.

2.6 Cartel Adaptation via Local Resource Capture

Section 2.5.2.3 shows that climate shocks can also threaten criminal organizations. Here, I exploit municipal-level variation in water concessions to study one adjustment margin: influencing local policy to secure access to natural resources. As initial evidence, I test whether fluctuations in U.S. heroin demand shift the allocation of water concessions toward Mexican municipalities that are more suitable for opium poppy cultivation. When U.S. heroin demand is higher, cartel water needs for poppy cultivation should rise in suitable places; where cartels can influence local policy, the number or volumes of newly issued concessions should increase. I therefore estimate the following regression:

$$\begin{aligned} WaterConcessions_{mt} = \beta\big(PoppySuitability_m \times HeroinDemand_t\big) + \\ + \alpha_m + \delta_t + \lambda_{s(m)} \times t + X'_{m,2010} \times \eta_{y(t)} + \varepsilon_{mt} \end{aligned} \tag{2.5}$$

where $WaterConcessions_{mt}$ are different measures of water concessions granted in municipality m during year t; α_m and δ_t are municipality and year fixed effects; and $HeroinDemand_t$ is proxied by the annual number of heroin overdose deaths in the United States.[24] Because overdose counts inherently reflect lagged demand, I include this variable contemporaneously rather than imposing an additional lag. For this analysis, I also include the pre-2010 period (2005–2009) to fully exploit the variation in heroin demand surrounding the 2010 OxyContin reformulation.

Table 2.B.6 in the Appendix presents results from specifications with different dependent variables. Columns (1) and (2) employ a binary indicator for at least one concession in a given year and reveal no extensive margin effect: higher U.S. heroin demand does not alter the probability that poppy suitable municipalities receive any concessions–for neither surface water nor groundwater. Columns (3) and (4) address the intensive margin, estimating the effect of changes in illegal drugs

[24]This number is provided annually from 2003 by the U.S. National Center for Health Statistics. Data available at: https://www.cdc.gov/nchs/products/databriefs/db522.htm. Last visited on 30th June 2025.

demand on volumes, conditional on concession receipt. The dependent variable is the logarithmic transformation of volumes given access to via concessions. In years of high demand for illegal drugs, municipalities suitable for poppy cultivation obtain significantly larger surface and groundwater allocations. This is in line with the hypothesis that cartels leverage local water allocation policies to secure the volumes required for illicit crop production in response to short term demand shocks.
Section 2.6.1 then illustrates how this strategic manipulation of surface water access intensifies after drought episodes, when water becomes scarcer. Finally, Section 2.6.2 supplements the analysis with high resolution water quality data, highlighting the potential environmental externalities of such cartel driven resource allocations.

2.6.1 Droughts and the allocation of water concessions

I estimate Equation (2.2) using a standard two-way fixed effects specification, now interacting baseline controls with year fixed effects to allow for a more stringent identification strategy. The estimation is conducted at the quarterly level to take full advantage of the temporal granularity of the data. The treatment variable corresponds to the first drought occurring in municipality m, while the outcome is the number of water concessions granted by local authorities at the municipal level. As detailed in Section 2.4, I use monthly data from CONAGUA on concessions for access to surface water bodies, groundwater, and federal water resources. Importantly, I exclude municipalities always treated, i.e., those already treated in the first quarter, as these might follow different trends than the rest of the observations in the sample, as also proposed by the Chaisemartin and D'Haultfoeuille (2022) estimator.

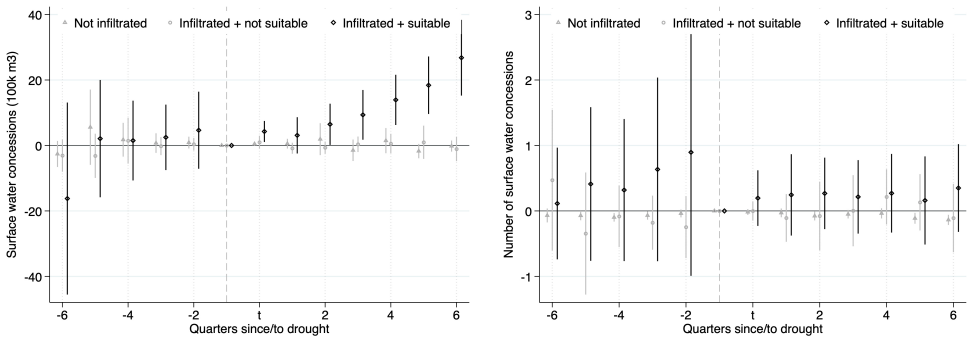
Crucially, I estimate this event study separately for three distinct subsamples. The first includes municipalities where no cartel activity was reported in the *narcoblog* before 2010, which I take as a proxy for the absence of historical presence of drug trafficking organizations. The second and third subsamples instead include municipalities where at least one cartel was reported as active at least once before 2010. The large language model helps me reconstruct historical presence by also accounting for past events reported in articles published later, which increases the share of municipalities with cartel activity in 2010 to just over 11%. These two subsamples are further differentiated based on suitability for opium poppy cultivation: the second includes municipalities with historical cartel presence but low agro-climatic suitability for poppy; the third includes those

with both historical cartel presence and high suitability for poppy cultivation.

The identifying assumption is that in the first group, i.e., municipalities without historical cartel presence, criminal groups have more limited influence over local policy decisions, including those governing water rights. In contrast, in the second and third groups, the presence of criminal organizations may enable policy influence. However, only in the third group cartels plausibly have a direct economic interest in agriculture, and thus a motive to secure water access following an adverse climate shock. If water concessions function as an adjustment mechanism for criminal organizations, we should observe a different pattern in access to water only in this third group. In the other two groups, concession decisions are expected to reflect standard institutional responses to droughts, generally uninfluenced by organized crime.

Figure 2.2: Effect of droughts on surface water concessions

((a)) Volume of water **((b))** Number of concessions



Notes: The figure shows lags and leads of an event study computed with a standard TWFE estimator (95% confidence intervals). Time periods are 3-months periods, i.e., quarters, and the unit of observations is the municipality. Time 0 is when first drought occurring in the municipality takes place. Always treated municipalities are excluded. Standard errors are clustered at municipal-level, and state-time trends and time-invariant controls interacted with year fixed effects are included. Estimates for three subsamples are reported: municipalities without any cartels observed before 2010 ("not infiltrated"), with at least 1 cartel before 2010 but not suitable for poppies ("infiltrated + not suitable"), with at least 1 cartel before 2010 and also suitable for poppies ("infiltrated + suitable"). In panel a, the outcome variable is the volume of surface water given access to via local concessions (100k m3), in panel b is the total number of concessions for access to surface water bodies.

Figure 2.2(a) shows that the volume of surface water granted through concessions rises significantly after a drought, but only in municipalities that exhibit both historical cartel presence and agro-climatic suitability for opium poppy cultivation. This suggests that in these areas, criminal organizations may leverage their local influence to secure larger quantities of water when agricultural operations

are threatened by adverse climatic conditions. In contrast, Figure 2.2(b) reveals no comparable pattern on the extensive margin: the number of new surface water concessions granted remains flat across all subsamples. This might indicate that the observed response operates primarily through increased allocation volumes within existing concession channels, rather than through expanded concession issuance.

Notably, Figures 2.A.15(a), 2.A.15(b), 2.A.16(a), and 2.A.16(b) report no similar effects for groundwater or federally managed water bodies, suggesting that criminal groups selectively exploit surface water systems. This likely reflects both the governance structure and the practical constraints associated with these resources: surface water concessions are often managed and approved by local water authorities, where criminal organizations may exert influence, while groundwater and federal waters are subject to stricter regulation and oversight by higher levels of government, limiting opportunities for informal bargaining or capture.

In fact, under the Mexican National Water Law, all rights to national waters (either surface or groundwater) are granted by the Executive through the Mexican *Comisión Nacional del Agua* (CONAGUA) via basin agencies. In practice, however, surface water concessions follow a relatively streamlined, locally administered process. Under CONAGUA's internal procedure "CONAGUA-01-003-A", applicants receive a decision within 60 working days, no on-site inspection is required, and approvals are issued directly by Basin Agencies or local user services.

By contrast, groundwater in regulated aquifers is subject to strict federal controls requiring an environmental impact statement and detailed technical, legal, and hydrological documentation for any concession. Federal waters concessions demand prior registration in the *Padrón Único de Usuarios y Contribuyentes* (PUUC), a CONAGUA user account, and online submission. These centralized, multi-step requirements limit local discretion and can make groundwater and federal water far less accessible than surface water concessions, thus harder for criminal groups to capture.

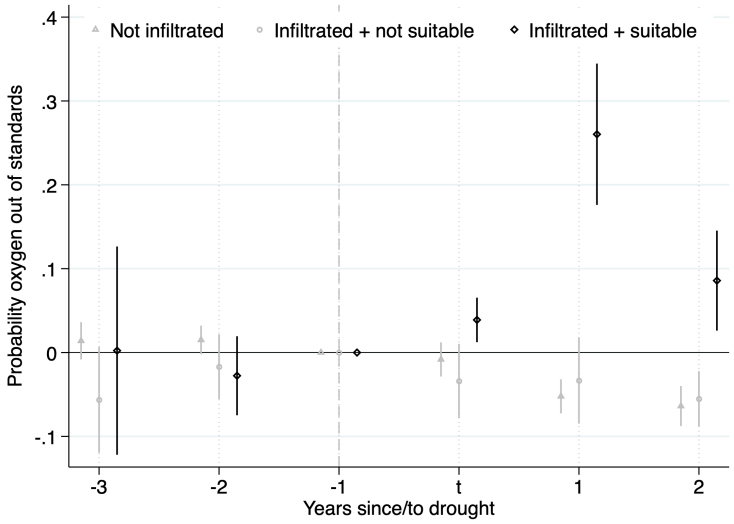
2.6.2 Implications for water quality

If cartels adapt by influencing local policy to overexploit surface water, this should be detectable in downstream water quality. As a proxy for water quality, I use levels of dissolved oxygen.[25] I estimate an annual event study analogous to that

[25] Flow reductions can lead to hypoxia or even anoxia in the water, especially during summer low-flow events (Pardo and García, 2016).

in Section 2.6.1, since water-quality data are only reported yearly. To account for repeated drought treatments in a yearly panel, I employ the Chaisemartin and D'Haultfoeuille (2022) estimator with state-specific linear trends and no additional covariates. I aggregate site-level CONAGUA measurements at the municipal-level by taking unweighted averages of all sampling points, focusing solely on surface water streams, i.e., the resource most vulnerable to local capture. As before, I conduct the analysis separately for three subsamples: (i) municipalities without cartel presence at baseline; (ii) those with baseline cartel presence but unsuitable for opium poppy; and (iii) those with both baseline cartel presence and suitable for poppy cultivation.

Figure 2.3: Effect of droughts on water overexploitation



Notes: The figure shows lags and leads of an event study computed with Chaisemartin and D'Haultfoeuille (2022) estimator (95% confidence intervals). Time periods are years, and the unit of observations is the municipality. Time 0 is when the drought occurs. Standard errors are clustered at municipal-level, and state-time trends are included. Estimates for three subsamples are reported: municipalities without any cartels observed before 2010 ("not infiltrated"), with at least 1 cartel before 2010 but not suitable for poppies ("infiltrated + not suitable"), with at least 1 cartel before 2010 and also suitable for poppies ("infiltrated + suitable"). The outcome variable is a dummy = 1 when the level of percentage of dissolved oxygen saturation is outside normal parameters ($\leq$ 10% or $>$ 150%), signalling highly contaminated waters.

Figure 2.3 plots the event-study estimates for the probability that dissolved oxygen saturation falls the 10% to 150% range, a standard indicator of surface water contamination and overexploitation, according to CONAGUA. Extreme dissolved oxygen values often reflect excessive withdrawal that modify the natural oxygen balance. The estimates show a pronounced post-drought increase only in municipalities with both historical cartel presence and opium poppy suitability:

the probability of out-of-bounds dissolved oxygen rises by about 25% one year after the shock and remains elevated ($\approx 10\%$) two years later. In contrast, there is no significant change in municipalities without prior cartel infiltration or in infiltrated areas lacking poppy suitability. In fact, the likelihood of dissolved oxygen violations appears to decrease following droughts, possibly reflecting heightened regulatory attention to water quality during periods of acute water stress. This pattern is in line with the idea that only in agriculturally strategic, cartel-infiltrated locations do criminal groups intensify surface water extraction after droughts, with measurable declines in water quality.

2.7 Conclusions

Climate change doesn't just reshape economies; it transforms criminal enterprises. Focusing on Mexico, a country facing increasing drought exposure and hosting some of the world's most powerful drug cartels, I first demonstrate that droughts significantly reduce labor market participation among individuals at prime cartel recruitment ages. Next, I construct a novel municipal-level panel on Mexican cartels activity for 2010–2022 by scraping data from a leading independent English language *narcoblog* in the country. I find that a drought increases the probability of cartel activity by approximately one percentage point in the subsequent quarter and present suggestive evidence that new groups exploit these shocks to expand. I then show that this expansion is attenuated in municipalities with strong migration networks for agricultural workers and amplified in strategically important locations.

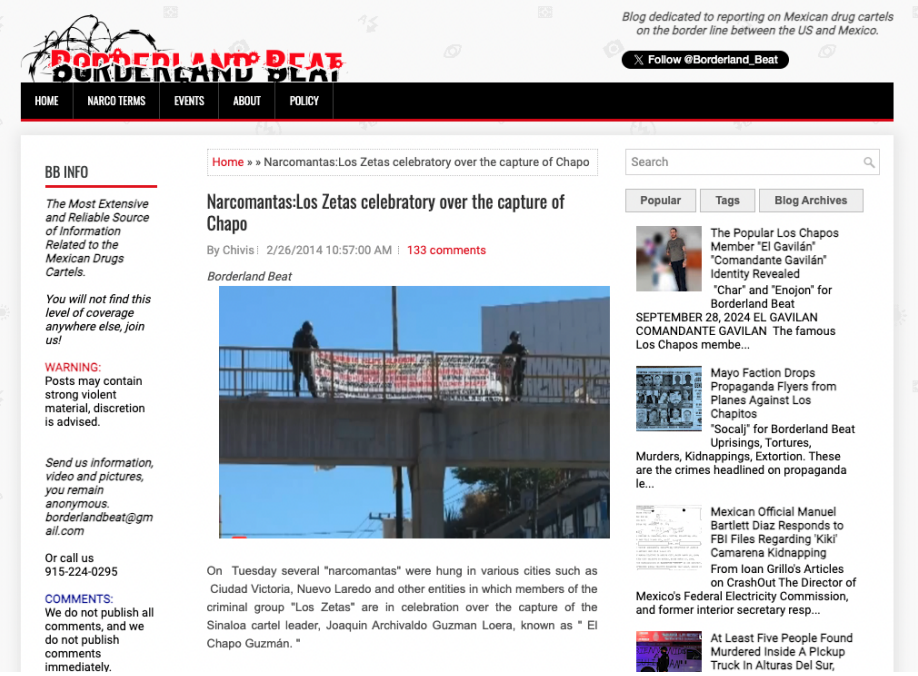
In contrast, in municipalities agro-climatically suitable for illicit crop cultivation, the positive effect of droughts on cartel activity vanishes, indicating that water scarcity can undermine cartel revenues from illegal agriculture. Yet, in these same areas with established cartel influence, droughts trigger a sharp increase in volumes of surface water concessions, reflecting a targeted policy capture strategy to secure scarce water inputs. This strategy accelerates extraction and degrades water quality, as revealed by anomalously low dissolved-oxygen readings in surface streams.

These findings point to two critical policy imperatives. First, strengthening legal employment alternatives can reduce the appeal of criminal recruitment following climate shocks. This can be done by developing climate-resilient job programs targeting youth in drought-prone regions, including vocational training and temporary employment schemes during environmental crises. Second, enhancing oversight of natural resource use and allocation, particularly during climate-

driven scarcity periods, can limit opportunities for criminal capture of essential resources. This can involve improving transparency in concession processes, and implementing stricter monitoring when resources become scarce.

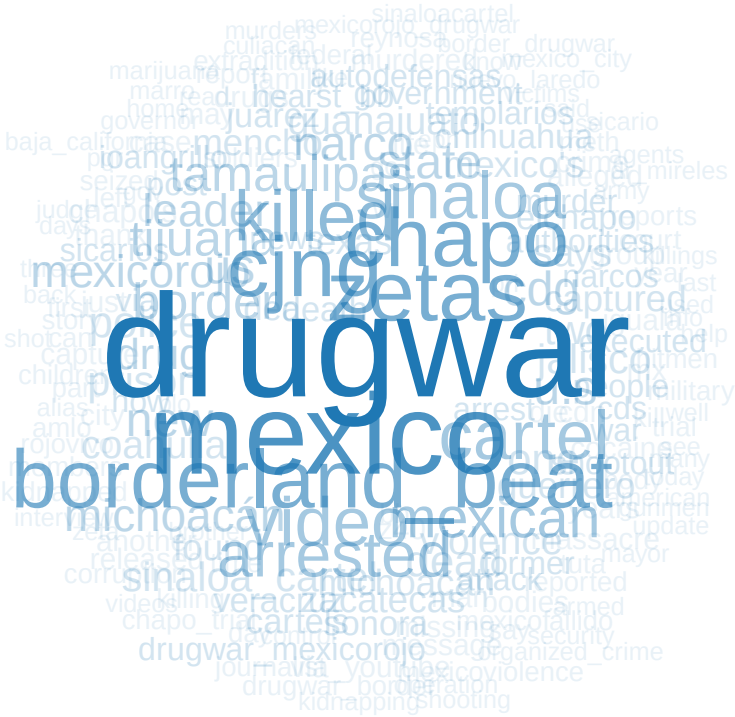
Appendix 2.A Figures

Figure 2.A.1: Extract of article from *Borderland Beat*



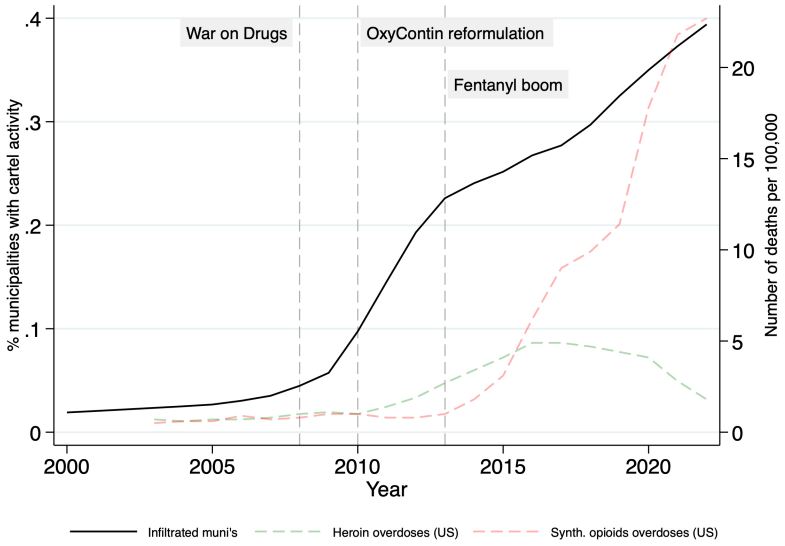
Notes: Example of article from *Borderland Beat*, February 2014.

Figure 2.A.2: Word cloud from universe of *Borderland Beat* blog articles, 2009-2022



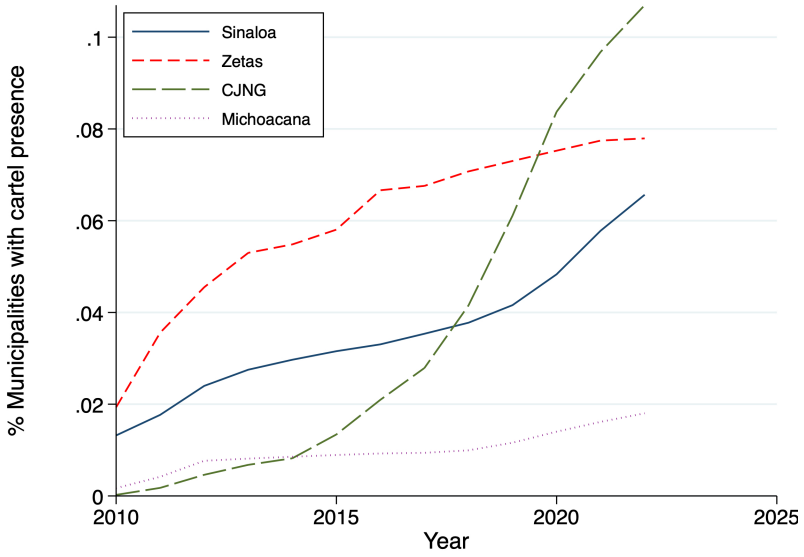
Notes: Word cloud obtained from analyzing the text of the universe of *Borderland Beat* blog articles since its launch in 2009 until end of 2022. Stop words have been removed.

Figure 2.A.3: Municipalities with criminal presence ever registered



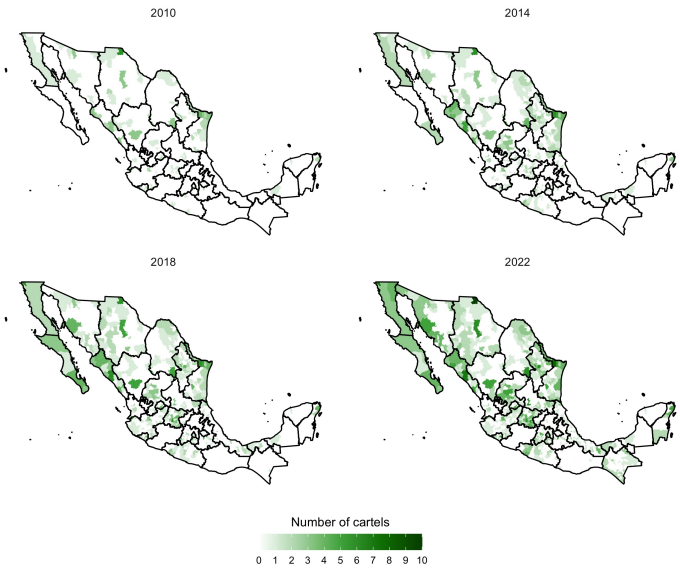
Notes: Left hand axis: Time series of share of municipalities with at least one mention in the *Borderland Beat* blog. The measure of cartel activity is a dummy = 1 from the first time the municipality is mentioned in the *Borderland Beat* blog, thus the time series can be interpreted as a cumulative distribution of municipalities with cartel activity as a function of time. Right hand axis: Number of deaths per year in the United States due to heroin overdoses (green line) and synthetic opioids overdoses (red line).

Figure 2.A.4: Expansion of four major cartels over time



Notes: Time series of share of municipalities where Sinaloa cartel, Los Zetas, CJNG or Michoacana were observed at some point. The measure of cartel activity is a dummy = 1 from the first time the municipality is mentioned in the *Borderland Beat* blog, thus the time series can be interpreted as a cumulative distribution of municipalities with cartel activity as a function of time.

Figure 2.A.5: Expansion of cartels over space and time



Notes: Spatial distribution of cartels' activity in 4 distinct years within the period of analysis. The number of cartels increases every time a new cartel is observed in the municipality.

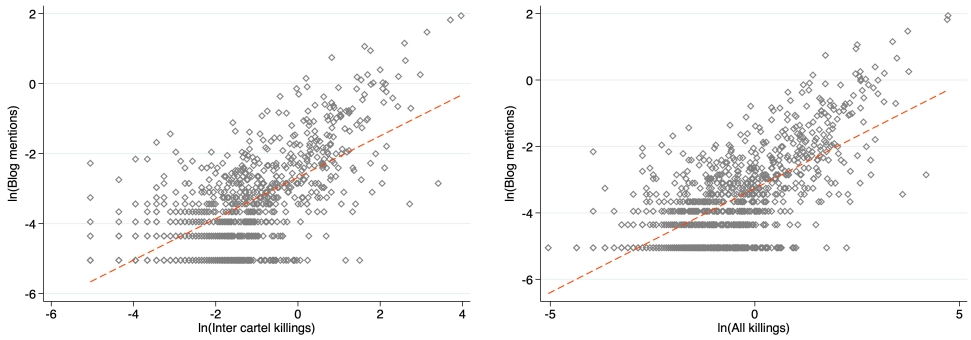
Figure 2.A.6: Area of influence of Sinaloa and Gulf cartels

((a)) Sinaloa cartel **((b))** Gulf cartel

Notes: Spatial distribution of Sinaloa (left) and Gulf (right) cartel. In the left (right) panel, municipalities in red (green) are where Sinaloa (Gulf) cartel was mentioned at least once in the *Borderland Beat* blog from the launch of the blog until the end of 2022.

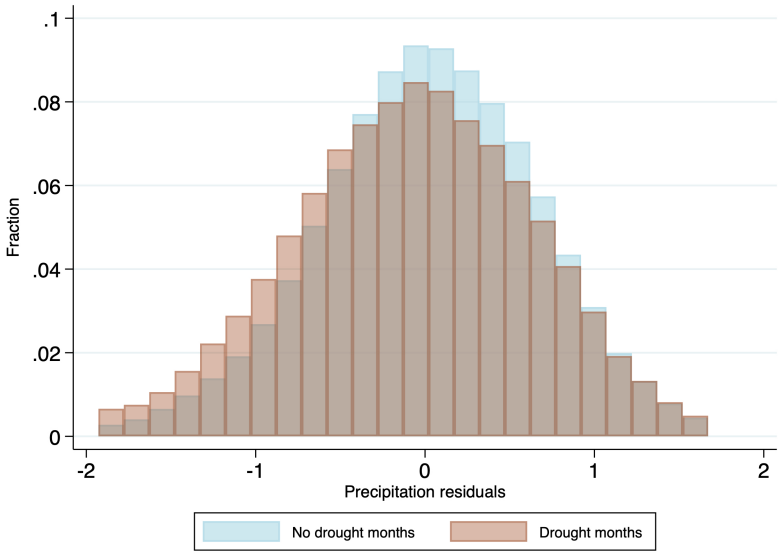
Figure 2.A.7: Correlation between blog mentions and official homicides figures

((a)) Inter cartel killings **((b))** All killings



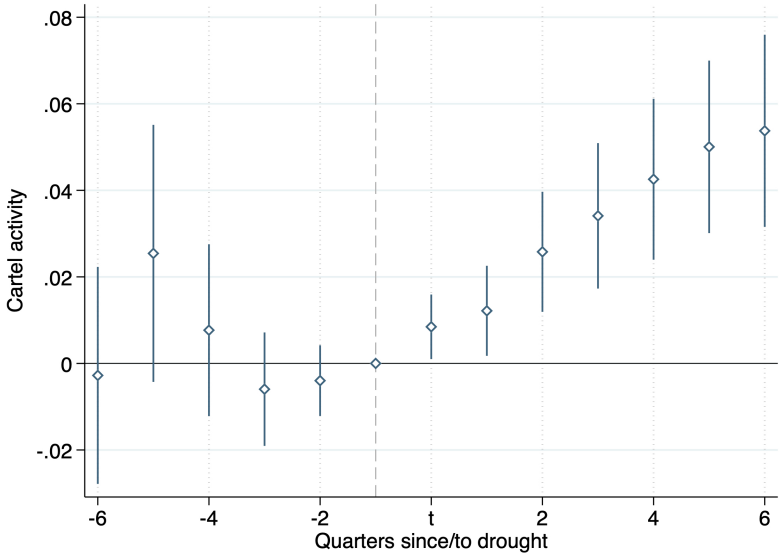
Notes: Scatter plots of correlation between average number of mentions in *Borderland Beat* blog and official killings. All variables are the log-transformed 2010-2022 municipal-level average. Panel A shows results for inter-cartel killings as defined by De Haro (2025) (number of 15-39 year old men killed by a gun), Panel B for all killings.

Figure 2.A.8: Rainfall in droughts and non droughts months



Notes: Distribution of residuals from municipal and month-level regression, with precipitation as outcome variable, and municipality and year-month fixed effects. The comparison between drought months (brown) *vis-à-vis* non-drought months (light blue) is reported.

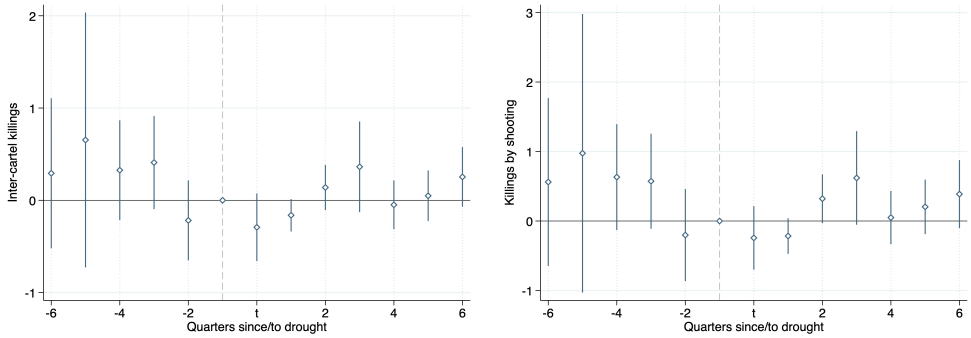
Figure 2.A.9: Standard TWFE event study



Notes: The figure shows lags and leads of an event study computed with a standard TWFE estimator (95% confidence intervals). Time periods are 3-months periods, i.e., quarters, and the unit of observations is the municipality. Time 0 is when first drought occurring in the municipality takes place. Always treated municipalities are excluded. Standard errors are clustered at municipal-level, and state-time trends and time-invariant controls interacted with year fixed effects are included. The outcome variable is a dummy = 1 from the first time the municipality is reported in the *Borderland Beat* blog.

Figure 2.A.10: Droughts and killings, dynamic specification

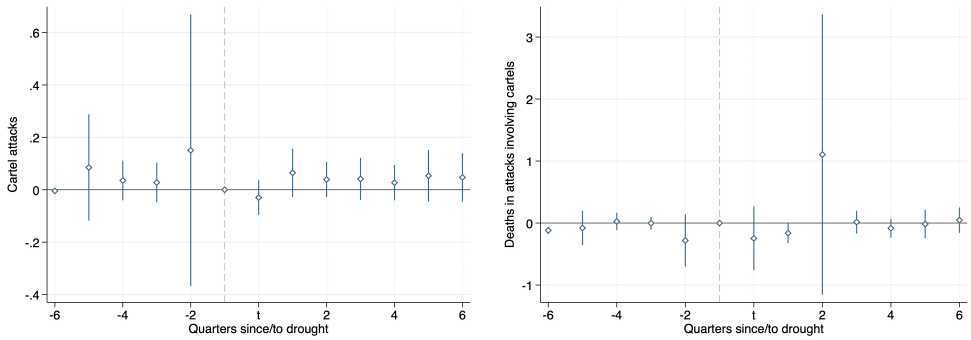
((a)) Inter-cartel killings **((b))** Killings by shooting



Notes: The figure shows lags and leads of an event study computed with Chaisemartin and D'Haultfoeuille (2022) estimator (95% confidence intervals). Time periods are 3-months periods, i.e., quarters, and the unit of observations is municipality. Standard errors are clustered at municipal-level, and state-time trends and time-invariant controls linearly interacted with year variable are included. In panel a, the outcome variable is the number of inter-cartel killings proxied by deaths of young men (15-39) killed with a firearm, in panel b is the total number of killings with a firearm.

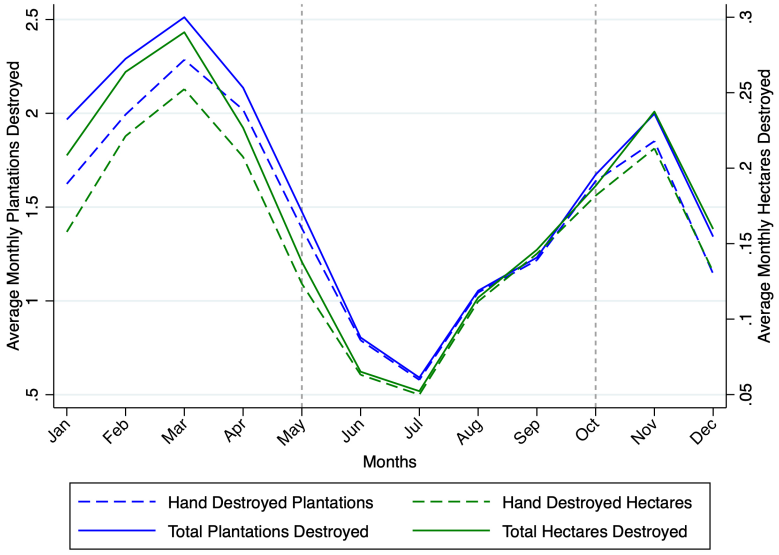
Figure 2.A.11: Droughts and inter-cartel conflict, dynamic specification

((a)) Inter-cartel attacks **((b))** Deaths in inter-cartel conflicts



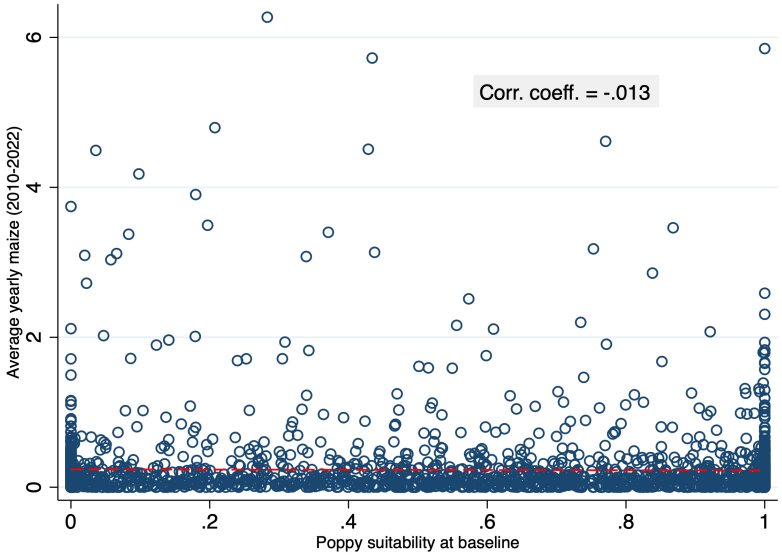
Notes: The figure shows lags and leads of an event study computed with Chaisemartin and D'Haultfoeuille (2022) estimator (95% confidence intervals). Time periods are 3-months periods, i.e., quarters, and the unit of observations is municipality. Standard errors are clustered at municipal-level, and state-time trends and time-invariant controls linearly interacted with year variable are included. In panel a, the outcome variable is the number of inter-cartel attacks measured by the Uppsala Conflict Data Program, in panel b is the total number of deaths reported in these conflicts.

Figure 2.A.12: Seasonality of poppy seizures



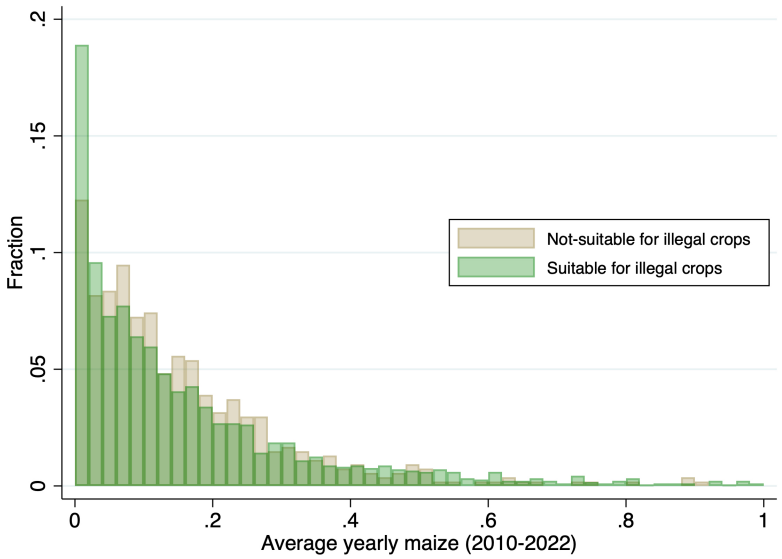
Notes: Official data provided by Mexican authorities. Sample of suitable municipalities only. Left hand vertical axis (blue lines): monthly average of plantations of poppies seized by authorities (total/destroyed by hand). Right hand vertical axis (green lines): monthly average of hectares of poppies seized by authorities (total/destroyed by hand).

Figure 2.A.13: Average maize produced by level of suitability for poppies



Notes: Level of average yearly maize for the period 2010-2022 plotted against poppy suitability. Fitting line is plotted in red, together with the correlation coefficient. Suitability is time-invariant, from Daniele, Le Moglie, and Masera (2023).

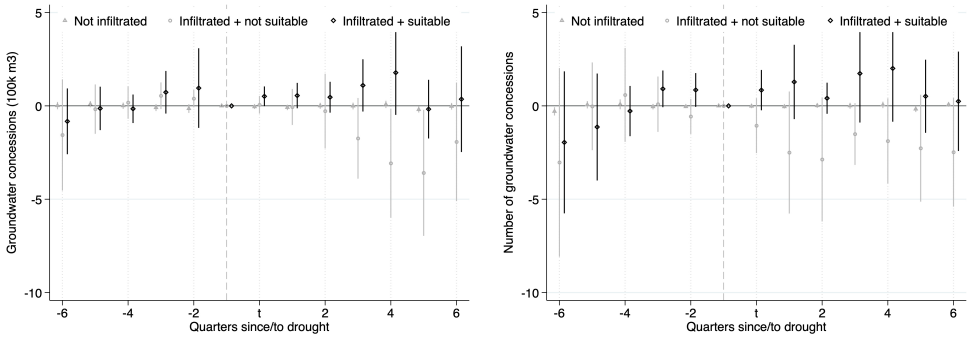
Figure 2.A.14: Distribution of average maize produced by suitability for poppies



Notes: Distribution of average yearly maize for the period 2010-2022. The comparison between municipalities not suitable (brown) *vis-à-vis* suitable (green) for opium poppy is reported. Suitability is time-invariant, from Daniele, Le Moglie, and Masera (2023).

Figure 2.A.15: Effect of droughts on access to groundwater

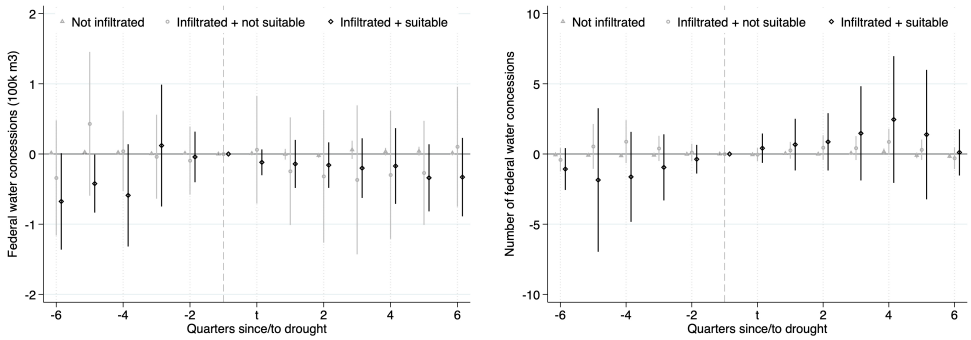
((a)) Volume of water **((b))** Number of concessions



Notes: The figure shows lags and leads of an event study computed with a standard TWFE estimator (95% confidence intervals). Time periods are 3-months periods, i.e., quarters, and the unit of observations is the municipality. Time 0 is when first drought occurring in the municipality takes place. Always treated municipalities are excluded. Standard errors are clustered at municipal-level, and state-time trends and time-invariant controls interacted with year fixed effects are included. Estimates for three subsamples are reported: municipalities without any cartels observed before 2010 ("not infiltrated"), with at least 1 cartel before 2010 but not suitable for poppies ("infiltrated + not suitable"), with at least 1 cartel before 2010 and also suitable for poppies ("infiltrated + suitable"). In panel a, the outcome variable is the volume of groundwater given access to via local concessions (100k m3), in panel b is the total number of concessions for access to groundwater.

Figure 2.A.16: Effect of droughts on access to federal water

((a)) Volume of water **((b))** Number of concessions



Notes: The figure shows lags and leads of an event study computed with a standard TWFE estimator (95% confidence intervals). Time periods are 3-months periods, i.e., quarters, and the unit of observations is the municipality. Time 0 is when first drought occurring in the municipality takes place. Always treated municipalities are excluded. Standard errors are clustered at municipal-level, and state-time trends and time-invariant controls interacted with year fixed effects are included. Estimates for three subsamples are reported: municipalities without any cartels observed before 2010 ("not infiltrated"), with at least 1 cartel before 2010 but not suitable for poppies ("infiltrated + not suitable"), with at least 1 cartel before 2010 and also suitable for poppies ("infiltrated + suitable"). In panel a, the outcome variable is the volume of federal waters given access to via local concessions (100k m3), in panel b is the total number of concessions for access to federal water bodies.

Appendix 2.B Tables

Table 2.B.1: Types of events reported in the *Borderland Beat* blog

Event type	Freq.	%	Cum.
Killings	34,355	26.22	26.22
Unclassified	25,610	19.55	45.77
Criminal business, including drugs	18,963	14.47	60.24
Other	17,333	13.23	73.47
Arrests	17,306	13.21	86.68
Kidnappings or thefts	8,625	6.58	93.26
Seizures	2,883	2.20	95.46
Showing a banner or narcomanta	1,772	1.35	96.81
Police or state intervention	1,579	1.21	98.02
General violence	1,071	0.82	98.83
Criminal violence between cartels	878	0.67	99.50
Posting a video	650	0.50	100.00
Total	131,025	100.00	

Notes: Absolute and relative frequency distribution of event types after classifying with NLI multilingual model all events recognized by GPT-4o in the universe of articles reported on the *Borderland Beat* narcoblog. From the most common (top) to the least common (bottom).

Table 2.B.2: Placebo – Upcoming growing season droughts and labor market participation

	Dep var: Employed			
	Any age		15-30	
	(1)	(2)	(3)	(4)
N droughts next growing season	-0.068	-0.060	-0.083	-0.112
	(0.051)	(0.043)	(0.096)	(0.085)
Observations	1,067,398	1,067,398	294,035	294,035
N. municipalities	1,623	1,623	1,622	1,622
Mean	48.57	48.57	58.46	58.46
R^2	0.009	0.295	0.024	0.220
Municipality Time Trend	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Individual controls	No	Yes	No	Yes

Notes: This table shows the coefficient β obtained by estimating Equation (2.1) for different samples: column 1 and 2 only restrict to non-disabled individuals, columns 3 and 4 further restrict to non-disabled individuals aged 15 to 30. Municipality time trends and year fixed effects are included throughout all specifications. Individual controls in columns 2 and 4 include age, gender, and a dummy for secondary education. The variable for number of droughts in the next growing season captures the number of months with droughts from April to August in the year following the survey. The outcome variable is a dummy equal to 1 (multiplied by 100 for ease of interpretation) whenever individual i declares they are working. Robust standard errors in parentheses. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 2.B.3: Droughts and employment, by irrigation technology

	Dep var: Employed (15-30 years old)							
Irrigation technology:	Any		Rainfall	Artificial	Any		Rainfall	Artificial
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Droughts last 9 months	-0.094*	-0.006	-0.299***	-0.236***				
	(0.054)	(0.068)	(0.099)	(0.083)				
— × Irrigation via rainfall only		-0.246**						
		(0.111)						
Droughts last growing season					-0.181**	0.034	-0.604***	-0.383***
					(0.086)	(0.109)	(0.150)	(0.136)
— × Irrigation via rainfall only						-0.586***		
						(0.174)		
Observations	294,035	294,035	156,853	137,181	294,035	294,035	156,853	137,181
N. municipalities	1,622	1,622	1,269	491	1,622	1,622	1,269	4,91
Mean	58.46	58.46	59.29	57.51	58.46	58.46	59.29	57.51
R^2	0.220	0.220	0.222	0.222	0.220	0.220	0.222	0.222
Municipality Time Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the coefficient β obtained by estimating Equation (2.1) for different samples of 15-30 year old individuals. Irrigation technology is "Rainfall" if in the summer before the survey the entirety of maize was grown with rainfall-based irrigation, while it is "Artificial" if at least part of it (or the entirety) was grown with artificial irrigation systems. Individuals declaring any disabilities at the time of interview are excluded. Municipality time trends, year fixed effects, and individual controls are included throughout all specifications. Individual controls include age, gender, and a dummy for secondary education. The variable for number of droughts in the last 9 months captures the number of months with droughts reported at the municipal-level where the individual was residing at the moment of the survey in the 9 months leading to the interview (from January to September). The variable for number of droughts in the last growing season captures the number of months with droughts from April to August before the survey. The outcome variable is a dummy equal to 1 (multiplied by 100 for ease of interpretation) whenever individual i declares they are working. Robust standard errors in parentheses. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 2.B.4: Droughts and number of jobs, conditional on being employed

	Dep var: Number of jobs (conditional on being employed)					
	All		15-30		30-65	
	(1)	(2)	(3)	(4)	(5)	(6)
Droughts last 9 months	0.000		0.001***		-0.000	
	(0.000)		(0.000)		(0.000)	
Droughts last growing season		0.001*		0.001**		0.000
		(0.000)		(0.001)		(0.001)
Observations	518,409	518,409	171,886	171,886	316,476	316,476
N. municipalities	1,623	1,623	1,616	1,616	1,623	1,623
Mean	1.097	1.097	1.073	1.073	1.111	1.111
R^2	0.071	0.071	0.077	0.077	0.086	0.086
Municipality Time Trend	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the coefficient β obtained by estimating Equation (2.1) for three different samples, with a different outcome variable, namely number of jobs, and a different sample selection, focusing only on people employed at the time of the survey. Each pair of columns focuses then on a (sub)sample of these individuals: all, 15-30 years old, and 30-65 years old. Individuals declaring any disabilities at the time of interview are excluded. Municipality time trends, year fixed effects, and individual controls are included throughout all specifications. Individual controls include age, gender, and a dummy for secondary education. The variable for number of droughts in the last 9 months captures the number of months with droughts reported at the municipal-level where the individual was residing at the moment of the survey in the 9 months leading to the interview (from January to September). The variable for number of droughts in the last growing season captures the number of months with droughts from April to August before the survey. Robust standard errors in parentheses. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 2.B.5: Droughts and criminal activity – Conley standard errors

	Dep var: Blog mentions		
	Count	ln(Count+1)	Dummy
	(1)	(2)	(3)
$Drought_{t-1}$	0.036**	0.013***	0.010***
	(0.019)	(0.004)	(0.003)
Observations	61,400	61,400	61,400
N. municipalities	2,456	2,456	2,456
Mean	0.254	0.0824	0.0721
Distance cutoff	50 km	50 km	50 km
Time lag	2	2	2
Municipality FE	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes

Notes: This table shows coefficients from different versions of a TWFE regression. In all columns the variable $Drought$ is a dummy = 1 for the semesters with a drought occurring. Municipality and semester fixed effects are included throughout all specifications. The outcome variable is the sum of mentions regarding the municipality in column 1, the logarithmic transformation of the same variable + 1 in column 3, and a dummy = 1 for each semester with at least one mention in column 5. Conley standard errors with a spatial lag of 50Km and serial correlation (time lag = 2) are reported in parentheses. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 2.B.6: Heroin demand and access to water

	Dep var: Water concessions			
	Extensive (dummy)		Intensive (ln)	
	Surface	Ground	Surface	Ground
	(1)	(2)	(3)	(4)
US heroin overdoses × Poppy suitability	-0.002	0.001	0.181*	0.105**
	(0.006)	(0.007)	(0.100)	(0.052)
Observations	44,190	44,190	6,001	15,104
N. municipalities	2,455	2,455	1,176	1,620
Mean	0.148	0.347	11.40	12.02
R^2	0.301	0.524	0.471	0.515
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls × Year FE	Yes	Yes	Yes	Yes
State × Time Trend	Yes	Yes	Yes	Yes

Notes: This table shows the coefficients from Equation (2.5) across different specifications. In columns (1) and (2), the dependent variable is a dummy = 1 in each year in which at least one concession is released by authorities, for surface water or groundwater respectively. In columns (3) and (4), the dependent variable is the log transformation of volume given access to through via these concessions, for surface and groundwater respectively. The variable for US heroin overdoses is normalized by total US citizens (every 100,000 inhabitants), and it is provided by the U.S. National Center for Health Statistics. The variable for poppy suitability is the one constructed in and provided by Daniele, Le Moglie, and Masera, 2023. Municipality and year FE, controls measured at baseline in 2010 and interacted with year fixed effects, and state-specific yearly time trends are included throughout all specifications. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Appendix 2.C Prompt GPT-4o

From the following text from an online article, extrapolate the following information:
1) who (Mexican cartel, individual criminal, police, etc.) performed an action or was involved in an event (try to find the Mexican cartel, if possible);
2) which event happened / which action they performed (action);
3) where (give me both Mexican municipality and state where this municipality is located, if available) (location);
4) when (approximate date).
Gather this information for each event / action separately.
Then, once gathered the information, give me for each separate event the information organized as follows:
subject => action => location => date
Give me back only this output, not any other comment. If no info is available for a specific category, give me "NA" for that (e.g., if we don't know the location, give me "action => NA => date"). For the action, please be as concise as possible.
For example, if one sentence in the text is "Sinaloa Cartel killed two people on the 15th April 2023 in Tijuana, Baja California", I want the output for this to be "Sinaloa Cartel => killing => Tijuana, Baja California => 15/04/2023".
For the location, explicitly indicate the city/municipality, whenever the location indicated is a town/village or something else within the city/municipality.
Example: La Pila in Mexico − > Give me the name of the corresponding city/municipality containing La Pila, namely San Luis Potosí.
If the article is talking about a place within a city/municipality, only report the city/municipality (e.g., "the municipal council in Tijuana" −− > only report "Tijuana").
Also, if more than one location is reported for the same event/action, report all these as separate events, so that I can see the locations as distinct one from another. To understand the date, consider that the article was published on the `"date"`*, so if it says "yesterday", it's the day before the* `"date"`*.*
The full text of the article is the following:
`"text"`
If it helps for the context, the title of the article is the following:
`"title"`

Chapter 3

Green Collars at the Voting Booth

Material Interest and Environmental Voting

with Italo Colantone, Piero Stanig, and Francesco Vona

3.1 Introduction

Protecting the environment and fighting climate change are key challenges for policy makers worldwide. In democracies, effective climate action requires political support for parties proposing environmentalist platforms. It is then crucial to understand the determinants of environmental voting. In this respect, a growing stream of studies is providing evidence on the role of individual demographic and cultural characteristics (e.g., Drews and Bergh, 2016), personal experiences of extreme events (e.g., Hazlett and Mildenberger, 2020), and on the impact of green policies (e.g., Stokes, 2016). In this paper, we focus on the role of individual material interest in the labor market, as related to occupational profiles. Specifically, in our analysis material interest hinges on the extent to which individual occupational profiles are expected to benefit vs. lose as the transition towards a greener economy unfolds. The underlying intuition is that the green transition generates distributional consequences in the labor market, with winners and losers, at least in relative terms. We study to what extent these distributional consequences shape voting behavior.

The labor market consequences of the green transition have become increasingly politically salient in Western democracies in recent years. This is not surprising, given the pervasive influence of green policies on the labor market, and the great deal of public funding and regulation involved by the green transition (e.g., IMF, 2022; OECD, 2023). For instance, US President Donald Trump repeatedly claimed that job security for people at risk of losing their jobs due to environmental policies, as per the so-called "job killing argument", was

one of the top priorities for his administration, unlike climate change. Labor market concerns related to the green transition have also featured prominently as campaign issues in recent European elections, for instance in Germany, the Netherlands, and the UK.[1] These issues have also been central in the 2024 EU Parliament elections, which witnessed a significant setback for Green parties.[2] In parallel, responding to growing criticism from public opinion and political leaders, the President of the EU Commission, Ursula von der Leyen, scaled back some ambitious Green Deal proposals in a successful bid to secure a second term in office.

Several studies, as reviewed by Bosetti et al. (2025), are starting to provide evidence of a "green backlash" against climate policies that generate high and unevenly distributed costs. This entails reduced support for parties proposing more environmentalist platforms, and rising support for environmental-skeptic parties, especially of the populist right. In this paper, we study to what extent voter support for parties proposing environmentalist platforms is related to their occupational profile, which determines how likely they are to benefit from the green transition, as opposed to be penalized by it. More specifically, we investigate how economic material interest, as inferred from the greenness and brownness of occupational profiles, affects support for Green parties and for parties with relatively pro-environment policy platforms.

The analysis focuses on 14 western European countries, over the period 2010-2019. We employ individual-level data from the European Social Survey (ESS) containing information on voting behavior and occupational status. To characterize individual occupational profiles in relation to the green transition, we start from information on job characteristics sourced from the O*NET database (US Bureau of Labor Statistics). In particular, following the labor economics literature on the green transition (Vona, Marin, Consoli, and Popp, 2018; Vona, Marin, and Consoli, 2019), we compute occupation-specific indicators of *greenness* and *brownness*. These are, respectively, measures of compatibility/complementarity and incompatibility/substitutability of each specific occupation with respect to the ecological transition, based on the task content of occupations. To give an idea, a worker employed in an occupation featuring a strong role of green tasks, such as performing building weatherization or designing wind farm collector systems, is more likely to benefit from the transition, while the opposite holds for

[1] See, for instance, "How climate policies are becoming focus for far-right attacks in Germany" in The Guardian; "Nitrogen wars: the Dutch farmers' revolt that turned a nation upside-down" in the The Guardian; "What Starmer's clean energy strategy means for investors" in the Financial Times.

[2] See, for instance, "Europe's green backlash" in the Financial Times.

a worker in an occupation where pollution-intensive activities are more prevalent. Importantly, the measures of greenness and brownness of occupations that we employ are complementary and not redundant: each occupation can be classified according to both a greenness and a brownness scale. In fact, the two measures capture different aspects of the labor market impact of the green transition (Vona et al., 2021), allowing to assess the role of material interest along two different, and complementary, dimensions.

Importantly, we reckon that the greenness and brownness of an individual occupational profile cannot be properly assessed by measuring the greenness and brownness of the current observed occupation of the individual, for several reasons. For instance, two individuals in the same occupation, which has a high level of brownness and is therefore penalized by the green transition, may differ in terms of age, gender, and skill profile. These characteristics influence their outside options in the labor market as the green transition unfolds and threatens their current job. In this respect, the greenness and brownness of the current occupation provide only a partial, and potentially noisy, proxy for the greenness and brownness of an individual occupational profile. An analysis based on the current occupation of individuals would also necessarily exclude unemployed workers, a very interesting segment of the electorate in this context. Moreover, there could be confounding factors related at the same time to both vote and current occupation, which could be problematic as we aim to study the effects of the greenness and brownness of occupational profiles on voting. For instance, relatively more environmentally-conscious individuals could be more likely to self-select into relatively greener (vs. browner) occupations, and by the same token they could be more likely to support more environmentalist parties.

To fully capture the greenness and brownness of individual occupational profiles, in a way that is not prone to endogeneity bias in vote regressions, for each individual we compute predicted greenness and brownness scores that do not rely on current occupation. These predicted scores are computed as a weighted average of all the occupation-specific greenness and brownness scores, where the weights are given by the individual-specific probabilities of employment in each possible occupation. In turn, these probabilities are predicted based on individual demographic characteristics: age, gender, education, and region of residence, leveraging pre-sample EU Labor Force Survey data from 2005-2006.

Our measures of predicted greenness and brownness assign higher scores to individuals who, based on their characteristics, are more likely to be employed in occupations characterized by higher greenness or brownness scores. In other words, they are counterfactual measures of material interest for individual

respondents. They do not reflect the compatibility of a respondent's current occupation with the ecological transition. Rather, they capture the average compatibility of the occupations that individuals with the same characteristics, in the same regional labor market, would more likely be employed in.

This counterfactual methodological approach is inspired by a strategy originally proposed by Anelli, Colantone, and Stanig (2021) for studying the political implications of robot adoption. This approach allows us to assess in a comprehensive way the positioning of individuals in the labor market, capturing the role of green-related job opportunities and outside options beyond the current occupation. It also allows us to assign predicted greenness and brownness scores to individuals who are currently unemployed, as we exploit information on individual demographic characteristics combined with labor market features of the region of residence. In so doing, we are capturing individual occupational profiles independently of the current occupational status. This is also a strategy to isolate plausibly exogenous variation in individual material interest, without hinging on the observed current occupation, which could be influenced by confounding factors in vote regressions.

We find that an increase in predicted brownness decreases the probability of voting for Green parties and for parties with a more environmentalist agenda, while the opposite holds for predicted greenness. The regressions include controls for age, gender and education, along with fixed effects for regions and elections (i.e., country-year pairs). The results hold across a wide range of robustness checks. These include controlling for the greenness and brownness of the current occupation, and for the current industry of employment. In line with the evidence on voting, we also document that individuals with higher greenness scores are significantly more supportive of higher taxes on fossil fuels and more generous subsidies for renewable energy. In contrast, individuals with higher brownness scores exhibit lower support for fossil fuel taxes.

To further characterize the implications of occupation-related material interest on voting, we assess the effects of predicted greenness and brownness on support for parties belonging to different party families. In the right camp, higher predicted brownness scores are related to higher support for radical-right parties and lower support for mainstream-right parties. In the left camp, they are related to less support for Green parties and more support for mainstream-left parties. Higher predicted greenness scores are related to lower support for both radical-right and mainstream-left parties, and to higher support for Green parties.

In an extension of the analysis, we augment the baseline specifications by

interacting predicted greenness and brownness scores with region-specific, time-varying shifters that capture variation in the opportunities stemming from the ecological transition. To build these shifters, we first measure the suitability of regions for solar and wind energy production, based on geographic characteristics and on the local intensity of solar radiation and wind speed, respectively. Then, we interact these time-invariant regional features with the growth of green patents issued in the US over time. We use green patents to proxy for global trends in green investments and green technologies adoption, which capture the salience of the ecological transition. We find that individuals residing in regions that are better placed to gain from the green transition tend to have greener vote preferences as the green transition becomes more salient. This is true in particular for individuals with brown profiles, whose preferences get closer to those of green profiles in such contexts. These findings further corroborate the relevance of occupation-based material interest for voting.

This study contributes to a growing stream of research that investigates the drivers of green voting and environmental attitudes. A first strand of this literature has initially focused on individual characteristics driving environmental attitudes, such as gender, age, cultural traits, and education (for a review, see Drews and Bergh, 2016). These studies typically provide descriptive evidence on the role of these factors, while a recent contribution by Angrist et al. (2024) provides the first causal evidence on the effect of education on green voting, exploiting compulsory schooling law data across 16 European countries. A second, and more recent, strand of this literature has highlighted the role of personal experiences with temperature anomalies and extreme events (e.g., Baccini and Leemann, 2021; Hazlett and Mildenberger, 2020; Hoffmann et al., 2022; Pianta and Rettl, 2025).

Less attention has been paid to the economic determinants of environmental voting. Some recent contributions have started to investigate the role of the distributional consequences of climate policies (Bolet, Green, and González-Eguino, 2023; Colantone, Di Lonardo, et al., 2024; Duijndam and Beukering, 2021; Gaikwad, Genovese, and Tingley, 2022; Stokes, 2016; Voeten, 2025). Other studies have focused on the distributional consequences of trade shocks (Bez et al., 2023; Vona, 2019), on cross-sectoral dynamics (Bayer and Genovese, 2020; Bechtel, Genovese, and Scheve, 2019; De Sario, Marin, and Sacchi, 2023), on region-specific impacts of the green transition (Rodríguez-Pose and Bartalucci, 2023; Gazmararian and Krashinsky, 2023), and on the general economic context (Duijndam and Beukering, 2021; Kenny, 2020). The role of individual occupational dynamics in affecting environmental voting has remained largely unexplored thus far. One exception is Heddesheimer, Hilbig, and Voeten (2024), who find that a targeted

campaign by the AfD in Germany against energy transition policies increased support for the far right among workers employed in a brown job.

In this paper, we contribute to this literature by providing the first cross-country evidence on the role of material interest as related to individual positions in the labor market, exploiting plausibly exogenous variation in occupational profiles, and evaluating them along both a greenness and a brownness scale. We argue that this comprehensive occupational perspective is key when it comes to exploring the political consequences of the green transition, given its heterogeneous implications on different segments of the population. In this respect, our work is also connected to the broader stream of literature on the political consequences of structural changes with winners and losers, which has thus far mostly focused on globalization and automation (Colantone and Stanig, 2018; Colantone, Ottaviano, and Stanig, 2022; Gallego and Kurer, 2022; Walter, 2021). We contribute to this literature by focusing on an additional dimension of structural change: the green transition. This is arguably the most relevant structural transformation ongoing world-wide, and something with which governments of all countries will need to deal with.

3.2 Labor market and environmental voting

The green transition has pervasive implications for the labor market. As the economy moves away from polluting activities and decarbonization progresses, jobs in emission-intensive occupations are threatened, while new opportunities become available in green occupations (e.g., Vona, 2019; Xie et al., 2023). Individuals with green occupational profiles are more likely to benefit from this transition, while individuals with brown profiles are more likely to be penalized by it. These are the distributional consequences of the green transition, which tends to create cleavages in the labor market between winners and losers. In this paper, we study the political effects of these distributional consequences. Specifically, we investigate to what extent holding greener vs. browner occupational profiles has an impact on vote for Green parties, and more generally for parties with more vs. less environmentalist policy platforms.

Material interest has been shown to matter for the political effects of environmental and climate policies. Citizens negatively affected by these policies have been shown to display diminished support for environment-friendly parties, and higher vote for environmental-skeptic parties, especially of the radical right. Evidence of such effects has been found, for instance, with respect to the losers of: traffic bans on polluting vehicles (Colantone, Di Lonardo, et al., 2024); the

installation of renewable energy facilities at a very local level (Germeshausen, Heim, and Wagner, 2023; Isaksson and Gren, 2024; Mitsch and McNeil, 2022; Stokes, 2016); and carbon taxes (De Groote, Gautier, and Verboven, 2024; Voeten, 2025).[3]

In this paper, we focus on material interest from a different angle, that is, occupational positioning in the labor market as related to the green transition. A large literature on the economic drivers of voting behavior has provided evidence on the role played by an individual's occupation in shaping voting behavior. Key factors at the occupation level include unemployment risk (e.g., Rehm, 2009) and broader contract conditions (e.g., Häusermann, 2020); decision autonomy and authority relations (e.g., Oesch and Rennwald, 2018); as well as direct exposure to economic shocks, particularly import competition, offshoring, and automation (e.g., Gallego and Kurer, 2022; Margalit, 2019). One key pattern documented by the literature is that voters can have quite sophisticated and multi-dimensional policy preferences, which in turn are shaped by their labor market experience and situation (Häusermann and Kriesi, 2015). In light of this, it is plausible to think that considerations regarding whether one stands to gain or lose from the green transition are consequential for vote choice in the context of advanced democracies.

In line with much of the literature on class politics, we start with the assumption that positioning in the labor market acts as a central material factor shaping policy preferences and political allegiances. Importantly, we reckon that the individual considerations that might ultimately be most consequential go beyond current employment. How individuals form preferences and react to economic shocks is shaped by their labor market experience, which includes not only the occupation they are currently employed in, but also the occupations that people like them tend to have and, relatedly, the type of occupations in which they could realistically be employed, in the near future or in the longer span of their career. We posit that voters can become cognizant of their interests, and make choices as a consequence of objective labor market opportunities. In turn, comprehensive empirical measures of these objective conditions, such as the ones we propose, can be used to study this issue.

Some contributions investigating the effects of occupation-based material interest assign to survey respondents an objective characteristic specific to the occupation in which they are currently employed—e.g., employment rate as in Rehm (2009), offshorability as in Rommel and Walter (2018), or routine-

[3] See Bosetti et al. (2025) for an extensive review.

task intensity as in Im, Mayer, et al. (2019) and Thewissen and Rueda (2019)—showing that this contributes to shaping policy preferences or vote choices. Other contributions, like ours, rely on more indirect objective measures, predicted or assigned based on observable individual characteristics that allow to reach beyond the current occupation. The underlying idea is that one can attribute to an individual an objective labor market condition based on observable characteristics of the individual themselves, combined with context-level data, e.g., at the local labor-market or occupation level.

For instance, Schwander and Häusermann (2013) create cells based on the combination of three individual features (social class, gender, and age) and for each cell they calculate the unemployment rate and the prevalence of atypical employment. They then attribute to individual survey respondents the measure for their cell. They discuss how individuals might develop political preferences depending on their expectations about labor market risks; these expectations, in turn, "are strongly linked to the labor market prospects of their social group or 'milieu"' (p. 251). In the same spirit, Anelli, Colantone, and Stanig (2021) introduce a measure of individual exposure to automation that is not based on the current occupation, but hinges upon individual demographic characteristics and the occupational composition of the region of residence. This objectively assigned measure of automation exposure predicts individual perceptions of unemployment risk, and labor market outcomes such as actual type of contract and salary. In turn, exposure to automation is found to affect individual voting behavior. In addition, recent work documents that individuals can be self-conscious about their objective labor market situation. For instance, Steiner, Mader, and Schoen (2024) show that, in Germany, the subjective perception of individuals as globalization losers is related to their objective position in social structure in terms of education, income, occupational class, sector of employment, and region. This subjective perception also predicts vote choice.

Along these lines, we suggest that individuals form expectations about the direct consequences of environmental policies on their occupational prospects, and support or oppose parties with specific policy platforms based on the effect that these policies are expected to exert on their occupational experience. In this respect, the overall labor market context matters. For instance, an individual in a local labor market where brown jobs are common among people with their characteristics, and green jobs seem out of reach, might feel particularly threatened by green transition policies. A similar individual, operating in a local labor market in which people with their characteristics tend to have green jobs, might instead be more positive about these policies. The measures of predicted

greenness and browness are designed to capture these types of considerations. That is, they are meant to take into account in a comprehensive way the full spectrum of occupational opportunities that are available to individuals beyond the current occupation.

Recent findings by Egli, Schmid, and Schmidt (2022) corroborate the importance of considering outside options and broader local labor market conditions when assessing the political implications of green policies. Their analysis focuses on the electoral effects of coal phasing-out in the Appalachian region of the US, where 54% of coal mining jobs were lost between 2011 and 2016 (32k out of 60k). This led to an increase in Republican vote reaching around three times the number of jobs lost. The effect was stronger in counties where coal mining jobs constituted an important share of total employment, and alternative job opportunities were scarcer. Overall, these findings suggest that individuals tend to react not just to own job loss, but to the overall labor market reshuffling as a consequence of green policies.

We expect individuals with browner occupational profiles to display less electoral support for Green parties, and to support on average parties featuring less environmentalist elements in their platforms. Conversely, individuals with greener occupational profiles should hold more favorable stances regarding the green transition, and therefore be more supportive of Green parties and environmentalist platforms.

A link between employment conditions and preferences for green policies has been documented in the literature. For instance, Bechtel, Genovese, and Scheve (2019) find that individuals employed in polluting industries are in general less supportive of climate cooperation, and more sensitive to cost considerations when evaluating climate policies. De Sario, Marin, and Sacchi (2023) find that individuals employed in emission-intensive activities tend to be against stringent climate measures, whereas people in jobs that require high levels of green skills are in favor of them. We extend this type of analysis by broadening the assessment of occupation-related material interest, and by considering the impact on voting behavior.

Green transition initiatives are "steering" policies, by which government intervention directs, shapes, and influences the speed of structural change. Seen in this way, they are similar to trade policy, which is a clear instance of a policy that steers structural change. Specifically, green transition policies aim at shaping economic incentives that in turn affect the occupational structure of the economy, in particular by promoting the growth of greener sectors and encouraging the

downsizing or the demise of the most polluting or carbon-intensive ones. This is the core engine of the distributional consequences we focus on in the analysis. Indeed, the measures of predicted greenness and predicted brownness are connected to what has been identified as the "industrial" element of the green transition (e.g., Zimmermann and Gengnagel, 2023). In other words, they focus on the first-order effects of green policies, net of any compensation policies.

In fact, there is also a second, more "social" element of the green transition, that entails compensation of negatively affected individuals and communities, along with retraining schemes for displaced workers. These initiatives are a key component of the so-called "just transition" approach (e.g., Im, Porte, et al., 2024). While compensation has been found to be politically consequential in the short run in some specific contexts (e.g., Bolet, Green, and González-Eguino, 2023), a vast literature in labor economics has documented the long-term negative consequences of involuntary occupational separation (e.g., Jacobson, LaLonde, and Sullivan, 1993; Davis and Von Wachter, 2011). For instance, Autor et al. (2014) find that US workers displaced due to globalization faced permanent income losses, even upon finding new jobs. In light of this, even if environmental platforms are paired with compensation or retraining plans, it is fully understandable that voters might be opposed to policies that penalize them in the first place. For instance, in a study of coal phasing-out in Germany, Stutzmann (2025) finds that, in spite of generous compensation (especially in the form of early retirement schemes), plant closures reduced vote for the SPD, and increased abstention. These results are in line with evidence by Heddesheimer, Hilbig, and Voeten (2024) pointing to a shift of German brown workers towards the environmental-skeptic AfD party. That said, voter considerations about compensation policies—and their combination with environmentalist stances in party bundles—are going to be reflected in the analysis of how predicted greenness and browness affect vote for different party families.

3.3 Data and measurement

We employ individual-level data from five waves of the European Social Survey (ESS). We focus on 14 countries of Western Europe.[4] This is a particularly interesting context to investigate this research question, as it is the area of the world, along with North America, where the climate movement is most active and environmental issues have become most salient in national politics, as reported

[4]These are: Austria, Belgium, Switzerland, Germany, Spain, Finland, France, United Kingdom, Ireland, Italy, Netherlands, Norway, Portugal, Sweden.

for instance by a recent survey of the Pew Research Center.[5]

The ESS is carried out every two years. It collects an extensive range of data at the individual level. These include demographic characteristics such as age, gender, education, and region of residence, along with occupation and industry of employment. Crucially for our purposes, the ESS provides information on the party voted in the last national elections before the interview date. Elections covered in the sample span the period 2010-2019.

3.3.1 Environmental voting

In the econometric analysis we investigate the impact of green vs. brown occupation-based material interest on voting. Specifically, we focus on two main outcome variables, described in what follows.

The first outcome variable is an indicator variable taking value one if the individual reports voting for a Green party. To construct this variable, we define as Green any party belonging to the European Green Party, the political group including the majority of European parties committed to environmental values. In addition, we also consider as Green all the remaining parties classified as members of the Green family by the Manifesto Project (MP, Volkens et al., 2016). The full list is provided in Table 3.C.2 of the Appendix.

The second outcome variable is the environmentalism score of the party voted by the respondent, based on MP data. In fact, the MP provides human coding of statements made in party manifestos, allowing to compute measures of the ideological leaning of parties along several dimensions. We use the MP environmental protection item of Domain 5 (501), which captures the number of environmentalist claims contained in each party manifesto. Specifically, this item counts all quasi-sentences in favor of protecting the environment, fighting climate change, and other green policies.[6] We scale the item following the methodology proposed by Lowe et al. (2011), i.e., we take the log of $(0.5 + \frac{\text{per501}}{100} \cdot \text{total})$, where *per501* is the percentage of claims classified in the category, and total is the overall number of quasi-sentences in the manifesto. Figure 3.1 shows the distribution of this environmentalism score for Green vs. non-Green parties. Green parties tend to have higher scores, as one would expect. Yet focusing on the environmentalism score, on top of the indicator variable for supporting a Green party, allows us

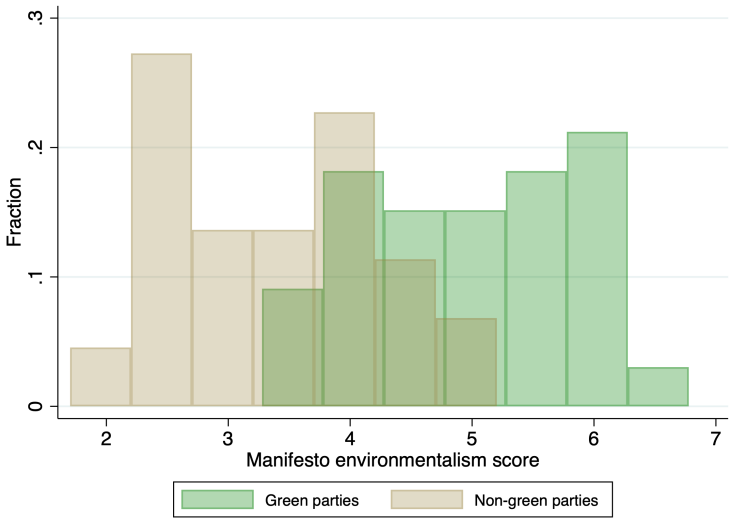
[5] Pew Research Center, *Climate Change Remains Top Global Threat Across 19-Country Survey* (link).

[6] More in detail, item 501 of the MP captures the number of quasi-sentences on *"General policies in favour of protecting the environment, fighting climate change, and other "green" policies. For instance: General preservation of natural resources; Preservation of countryside, forests, etc.; Protection of national parks; Animal rights. May include a great variance of policies that have the unified goal of environmental protection."*

to provide a more comprehensive, non-binary characterization of party choice along the environmental dimension.

In an extension of the analysis, we also consider a broader score of environmentalism. This combines the environmentalism item considered above with other MP scores regarding anti-growth policies and regulation of economic activity.[7] This broader index of environmentalism is highly correlated with the baseline environmentalism score (0.91, significant at 1%), but captures additional nuances in party stances that are worth taking into account in the analysis.[8]

Figure 3.1: Distribution of environmentalism score by type of party



Notes: The figure shows environmentalism score distributions for Green vs. non-Green parties.

3.3.2 Conceptual considerations on job greenness and brownness

Measuring workers' exposure to the green transition is not a trivial task. As a matter of fact, there is no widespread agreement on which occupations should be considered "green" vs. "brown", perhaps with the exception of some cases that appear obvious at a first glance. For instance, uncontroversial examples of brown occupations would be coal miners or chemical engineers, that are concentrated in heavily-polluting industries. In contrast, wind turbine technicians or roofers provide prototypical examples of green occupations, since their activities are contributing to greenhouse gas emission reductions. Beyond such polar

[7] Specifically, the index aggregates claims in support of environmentalism (item 501), market regulation (item 403), and anti-growth/sustainable growth policies (item 416). It is computed following the approach by Lowe et al. (2011).

[8] See Table 3.C.5 of the Appendix for the full correlation matrix of the outcome variables. See Figure 3.C.1 for the distribution of the broad environmentalism score.

examples, though, most occupations cannot be uncontroversially considered as dichotomically green or brown (Vona et al., 2021).

Against this backdrop, the prevalent approach in labor economics research dealing with the green transition evaluates occupations along two different dimensions, the green and the brown one (Vona, Marin, and Consoli, 2019; Vona et al., 2021). The green dimension, based on the task content of jobs, captures the association of occupations with the production of goods and services that reduce harmful environmental impacts, and thus highlights the potential job creation effect of the green transition. The brown dimension, based on the pollution content of jobs, underscores the potential loss of job opportunities associated with the green transition. In this approach, each occupation can be potentially considered to some degree both green and brown at the same time. We adopt this bi-dimensional approach in the empirical analysis, measuring separately both greenness and brownness scores for each occupation.

3.3.3 Greenness

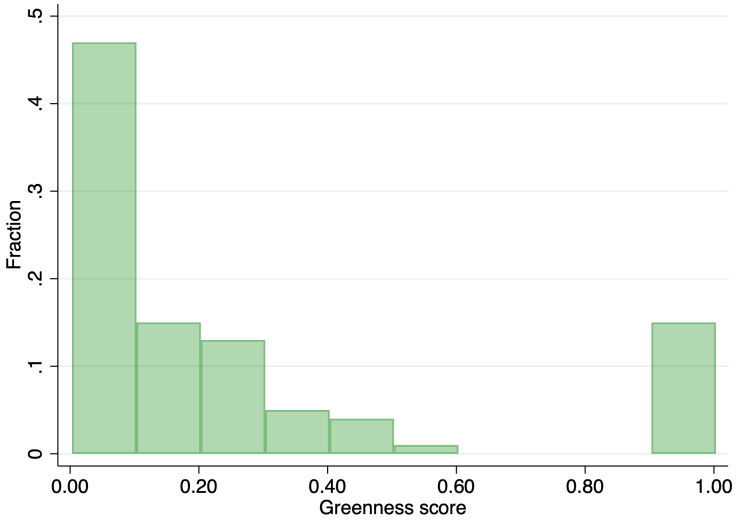
To assign a greenness score to occupations, we rely on the Occupational Information Network (O*NET) database of the US Bureau of Labor Statistics. This provides detailed information on the tasks performed by workers in each occupation, and on their relative importance. Crucially, the green economy program of O*NET makes it possible to identify, out of all the tasks performed within each occupation, those that are green. Based on this information, we follow the state-of-the-art labor economics approach (i.e., Vona, Marin, Consoli, and Popp, 2018 and Vona, Marin, and Consoli, 2019) and measure the greenness of each occupation j as:

$$\text{greenness}_j = \sum_{k=1}^{n} w_{jk} \times 1(k \in \text{green}) \tag{3.1}$$

where k denotes tasks; w_{jk} are occupation-task-specific weights, given by the importance scores attributed to each of the n occupation-specific tasks and normalized to sum up to 1; and $1(k \in \text{green})$ is an indicator equal to 1 if task k is green. The resulting measure is a continuous score ranging between 0 and 1. This captures the relative importance of green tasks for individuals working in occupation j.

O*NET provides data on occupations according to the Standard Occupational Classification System (SOC), at the 6-digit level of disaggregation. Hence, as a first step, we obtain greenness scores for each 6-digit SOC occupation code.

Figure 3.2: Distribution of greenness score



Notes: The figure shows the distribution of greenness score across ISCO08 occupations, for occupations with a score greater than zero.

We then convert them into the classification of occupations employed in the ESS data, the International Standard Classification of Occupations (ISCO), at the 4-digit level of disaggregation. For the conversion, following common practice in the literature (e.g., Goos, Manning, and Salomons, 2014), we rely on official crosswalks, complemented by a one-by-one manual revision to ensure that the resulting classification is coherent with the European labor market framework.

We have a total of 813 ISCO 4-digit occupations observed in the ESS. Across these occupations, the greenness measure has a simple average of about 0.06. It ranges between zero, e.g., for livestock and dairy producers, and 1, e.g., for environmental engineers. Figure 3.2 plots the distribution of the greenness score across occupations with score greater than zero. These are around 24% of the total. A full list with scores is reported in Table 3.C.1 of the Appendix.

3.3.4 Brownness

To measure the brownness of occupations, we rely on recent work that classifies as brown those occupations that are likely to be negatively affected by the ecological transition in the labor market. While for the measurement of greenness the characterization of occupations is based on their task content, for brownness the focus is on their pollution content. In particular, brown occupations are identified as those that are more prevalent in the most polluting industries.

Specifically, we adopt the approach developed by Vona, Marin, Consoli, and

Popp (2018). They first define the most polluting industries, at the NAICS 4-digit level, as those above the 95th percentile of pollution intensity for at least three pollutants among CO2, CO, VOC, NOx, SO2, PM10, PM2.5, and lead. They then compute, for each 6-digit SOC occupation, the share of total employees employed in any of the most polluting industries. This computation is based on US data (BLS-OES) for the years 2006-2014. They define as brown all the 6-digit SOC occupations for which the share of employment in polluting industries is at least 7 times higher than the average share across all occupations.[9]

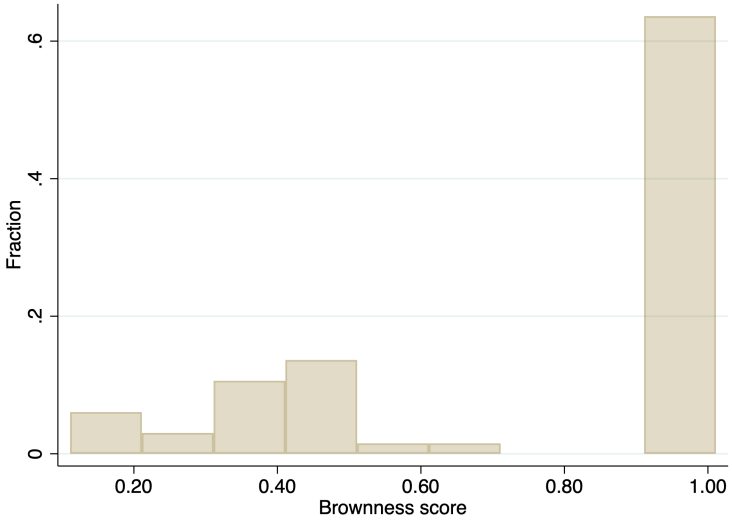
We adapt this binary measure of brownness to the European context using appropriate crosswalks from the SOC to the ISCO classification used in the European data. Given the *m*-to-*n* correspondence between the 6-digit SOC and the 4-digit ISCO occupations, we obtain a continuous score of brownness for each occupation in the ISCO classification. This continuous score essentially captures the unweighted probability for workers within a given occupation of being employed in a polluting industry.

The brownness score has a simple average of around 0.13 across all occupations. It ranges between zero, e.g., for bicycle and related repairers, and 1, e.g., for miners and quarriers, or petroleum and natural gas refining plant operators. Importantly, relatively high brownness scores are observed not only for occupations related to fossil fuels, but also for occupations in livestock farming and the food industry. For instance, livestock and dairy producers, along with poultry producers and food machine operators, get a brownness score of 1.

Figure 3.3 plots the distribution of the brownness score across occupations with score greater than zero. These are around 16% of the total. Their list is reported in Table 3.C.1 of the Appendix, which shows the greenness and brownness scores for all occupations with at least one of the two scores being greater than zero. For a robustness check, we also employ a discrete measure of brownness, with an indicator variable equal to one if the brownness score is greater than 0.3. The choice of this threshold is based on the distribution of brownness scores reported in Figure 3.3. Through this approach we end up labeling around 17% of all occupations as brown. These occupations, flagged in Table 3.C.1, account for 6.7% of employment in the sample.

[9] More details are provided in Section 2.5 and Web Appendix C of Vona, Marin, Consoli, and Popp (2018).

Figure 3.3: Distribution of brownness score



Notes: The figure shows the distribution of brownness score across ISCO08 occupations, for occupations with a score greater than zero.

3.4 Empirical strategy

Our aim is to investigate whether occupation-related material interest matters for environmental voting. In particular, we want to study to what extent voter support for parties proposing environmentalist platforms is related to the greenness vs. brownness of their occupational profile: two measures capturing how likely individuals are to benefit from the green transition, or be penalized by it in the labor market.

As we previewed, focusing on current occupation may deliver only a partial, and potentially imprecise, measure of the greenness and brownness of an individual's occupational profile. For instance, two workers currently employed in the same occupation may differ in terms of age, gender, education, and region of residence. These factors have a strong influence on their likelihood of employment in different occupations, and therefore on their labor market opportunities beyond the current one. These are very important in terms of outside options in case the current job is lost, and in general for any job switches in search of better career opportunities. Our conceptualization of occupational profile encompasses the full spectrum of opportunities, which allows to assess individual material interest in a comprehensive way.

Besides capturing only partial, and potentially noisy, information on the occupational profile, focusing on the current occupation of individuals would also be problematic for two additional reasons. First, it would necessarily

lead to the exclusion of unemployed individuals from the analysis. Yet this is a very interesting social group to be included in the investigation of the impact of occupational material interest on environmental voting. Second, there may be confounding factors that simultaneously influence both voting behavior and current occupation. For example, individuals with a relatively greener disposition might be more inclined to self-select into greener (rather than browner) occupations, and by the same token they may also be more likely to support more environmentalist parties.

For these reasons, we compute a measure of predicted greenness and one of predicted brownness that do not depend on the current observed occupation, but are based on a vector of predicted probabilities for each individual to be employed in each occupation. These probabilities are predicted from a multinomial logit model of occupational choice that is estimated, country by country, from pre-sample labor force survey data.

We predict occupation probabilities based on individual characteristics and region fixed effects, which account for the composition of employment at the occupation level in the different regions. Specifically, we first estimate the parameters of an occupation model as a function of age, gender, education, and region of residence, using European Labor Force Survey (EU-LFS) data from 2005-2006. We then use such estimates to make out-of-sample predictions of the probabilities of working in each occupation for the ESS respondents included in the analysis, who are interviewed between 2010 and 2020.[10] Predicted greenness and brownness are then obtained as the scalar product between this vector of probabilities and the vector of greenness or brownness scores for each occupation. In other words, the predicted greenness (brownness) of a given individual is a weighted average of the greenness (brownness) scores of each occupation, where the weights are given by the individual-specific predicted probabilities of employment in each occupation.

Formally, we define:

$$\text{predicted greenness}_i = \sum_{j=1}^{N} \hat{Pr}(o_i = j|\text{age}, \text{gender}, \text{edu}, \text{reg}) \times \text{greenness}_j \tag{3.2}$$

$$\text{predicted brownness}_i = \sum_{j=1}^{N} \hat{Pr}(o_i = j|\text{age}, \text{gender}, \text{edu}, \text{reg}) \times \text{brownness}_j \tag{3.3}$$

[10] More details on this empirical approach are available in Section 3.A of the Appendix.

where i indexes individuals, j occupations (at the ISCO 2-digit level), and r regions (NUTS-2). $\hat{Pr}(o_i = j|\text{age, gender, edu, reg})$ is individual i's probability of working in occupation j. The variables $greenness_j$ and $brownness_j$ are the continuous measures for occupation j presented in Sections 3.3.3 and 3.3.4. Since employment probabilities are predicted at the ISCO 2-digit level, the measures of greenness and browness are also aggregated at the same level.[11]

The resulting variables, $predicted\ greenness_i$ and $predicted\ brownness_i$, assign higher values to individuals with a higher probability of employment in occupations with higher greenness or brownness scores, respectively. They capture the average (in)compatibility with the green transition of the occupations that individuals with the same characteristics, in the same regional labor market, would more likely be employed in.

This counterfactual methodological approach, which borrows from Anelli, Colantone, and Stanig (2021), allows to capture variation in individual material interests in a broader way compared to the information provided by the individual current occupation. In fact, it takes into account the whole structure of available opportunities for individuals in the labor market, which shapes the greenness and brownness of their occupational profiles. Predicted greenness and brownness scores can be assigned also to unemployed individuals, as they do not hinge on information about the current occupation of employment. Moreover, by the same token, they provide plausibly exogenous variation in material interest to be exploited in the vote regressions. In fact, employment probabilities are based on plausibly pre-treatment individual characteristics—i.e., age, gender, education, and region of residence—combined with pre-sample labor market characteristics.

3.4.1 Specifications

The baseline specifications that we estimate have the following form:

$$\text{green voting}_{icrt} = \beta_1 \text{ predicted brownness}_i + \mathbf{X}_i' \lambda + \omega_{ct} + \delta_r + \varepsilon_{irct} \tag{3.4}$$

$$\text{green voting}_{icrt} = \beta_2 \text{ predicted greenness}_i + \mathbf{X}_i' \lambda + \omega_{ct} + \delta_r + \varepsilon_{irct} \tag{3.5}$$

where i indexes individuals, c countries, r NUTS-2 regions, and t election years. The variable $green\ voting_{icrt}$ is either a dummy for voting a Green party

[11] To obtain greenness and brownness scores for each occupation at the 2-digit level, we take the weighted average of the 4-digit level scores within each 2-digit occupation. We use as weights the relative frequency of each 4-digit occupation in the countries under study, based on ESS data and taking into account post-stratification weights.

or the environmentalism score of the party voted, as introduced in Section 3.3.1. $predicted\,brownness_i$ and $predicted\,greenness_i$ are the scores for individual i, as introduced above. $\mathbf{X}_i$ is a vector of (plausibly) pre-treatment individual-level controls: age group, gender, and years of education. ω_{ct} are country-election year (i.e., election) fixed effects, while δ_r are region fixed effects. The estimation sample includes individuals in the voting and working age population at the time of the elections, i.e., between 16 (which is the minimum voting age in Austria) and 64. It includes both employed and unemployed individuals.[12]

In an extension of the analysis, we interact greenness and brownness with region-specific, time-varying shifters that capture variation in the salience of the ecological transition and in the opportunities stemming from it. The intuition is that these contextual conditions may moderate the relationship between the predicted greenness and brownness of occupational profiles and voting behavior. Specifically, we estimate:

$$\begin{aligned}\text{green voting}_{icrt} = {} & \beta_1 \text{ predicted brownness}_i + \\ & + \beta_2 \text{ predicted brownness}_i \times \text{S}_r \times \Delta \text{ green patents}_t + \\ & + \mathbf{X}_i' \lambda + \omega_{ct} + \delta_r + \varepsilon_{irct}\end{aligned} \tag{3.6}$$

$$\begin{aligned}\text{green voting}_{icrt} = {} & \beta_3 \text{ predicted greenness}_i + \\ & + \beta_4 \text{ predicted greenness}_i \times \text{S}_r \times \Delta \text{ green patents}_t + \\ & + \mathbf{X}_i' \lambda + \omega_{ct} + \delta_r + \varepsilon_{irct}\end{aligned} \tag{3.7}$$

where S_r is the regional suitability for either solar or wind energy production, depending on the estimated model. We compute such measures of suitability based on geographic characteristics and on the local intensity of solar radiation and wind speed, respectively. Full details on the methodology are provided in Section 3.D of the Appendix. These measures of suitability are interacted with $\Delta\text{green patents}_t$, that is the change in the number of patents in environment-related technologies issued in the United States. This is computed as $\Delta\text{green patents}_t = \ln\left(\sum_{s=t-10}^{t-1} \text{new green patents}_s\right) - \ln\left(\sum_{s=t-20}^{t-11} \text{new green patents}_s\right)$. We use green patents to proxy for global trends in green investments and green technologies adoption, which capture the salience of the ecological transition.

[12] Specifically, the estimation sample includes these categories of the ESS *mnactic* variable: paid work; unemployed looking for job; unemployed not looking for job; community or military service; housework, looking after children, other. Excluded categories are: education; permanently sick or disabled; retired; and other.

We focus on US green patents as these are not directly related to potentially endogenous policy decisions specific to the sample countries.

3.5 Results

Table 3.1 displays the baseline estimates of Equations (3.4) and (3.5). In the odd-numbered columns the outcome variable is a dummy equal to 1 if the individual reports voting for a Green party; in the even-numbered columns the outcome is the environmentalism score of the party voted. In columns 1-2 we focus on predicted brownness; in columns 3-4 on predicted greenness; in columns 5-6 we include both scores jointly.

Higher predicted brownness leads to less environmentalist voting, while higher predicted greenness leads to more environmentalist voting. These findings are consistent across the two different outcome variables. In terms of magnitudes, considering fixed effects and using variation in the residualized variables following Mummolo and Peterson (2018), according to the estimates in columns 1-2 an increase by one standard deviation in the predicted brownness score decreases the probability of voting for a Green party by 0.95 percentage points, and the environmentalism score of the party voted by 4.6% of a standard deviation. According to the estimates in columns 3-4, an increase by one standard deviation in the predicted greenness score increases the probability of voting for a Green party by 3.7 percentage points, and the environmentalism score of the party voted by 11.9% of a standard deviation.

In the baseline specifications we include predicted greenness and predicted brownness separately. In fact, as discussed above, these scores reflect two alternative ways of evaluating occupational profiles as related to the green transition, along the green vs. brown dimension. If anything, including both scores jointly in the same regression leads to stronger results in absolute value, as can be seen in columns 5-6. Yet, in the model including both scores the coefficients are identified only from variation in either predicted score conditional on the other. This is potentially problematic in terms of the effective sample on which the estimation is based (Aronow and Samii, 2016). Therefore we prefer to adopt a conservative approach and focus on the baseline specifications in the rest of the analysis.

3.5.1 Robustness

In Table 3.2 we augment the baseline specifications with controls for the brownness and greenness scores of the current occupation. The estimation sample is therefore

restricted to individuals in paid work. The baseline results on predicted brownness and greenness are essentially unaffected in terms of significance and magnitude. As for current brownness and greenness, there is only one association that is close to statistical significance, in column 2 (p-value=0.109), suggesting that a higher brownness score of the current occupation is negatively associated with the environmentalism score of the party voted. Overall, these results point to the importance of focusing on occupational profiles, rather than on current occupation, for assessing the role of material interest in the context of the green transition.

Table 3.1: Baseline estimates

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Green party	Environ	Green party	Environ	Green party	Environ
Pred. brownness	-0.325***	-1.829***			-0.511***	-2.552***
	(0.090)	(0.403)			(0.094)	(0.420)
Pred. greenness			1.485***	5.543***	1.705***	6.645***
			(0.197)	(0.832)	(0.205)	(0.866)
Observations	40,060	39,968	40,060	39,968	40,060	39,968
R^2	0.091	0.338	0.092	0.338	0.093	0.339
Individual controls	✓	✓	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓
Mean	0.083	3.573	0.083	3.573	0.083	3.573

Notes: Individual controls include age group, gender, and years of education. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In Table 3.C.6 we perform a number of additional robustness checks. All of them confirm the main results. Specifically, in row 1 we include fixed effects for the current industry of employment, at the NACE 2-digit level. By doing so, we are identifying the effects of predicted brownness and greenness from variation across individuals within the same industry. The sample is therefore restricted to individuals in paid work. In row 2, we expand the estimation sample and replicate the baseline regressions including retired people.

Next, we address the potential concern that the region of residence might be endogenous to labor market opportunities, as individuals may migrate across regions in search of (better) jobs. Specifically, in row 3 we exclude region fixed effects from the multinomial logit models that we estimate for the prediction of individual probabilities of employment in each occupation. This entails

Table 3.2: Controlling for current brownness and greenness

	(1)	(2)	(3)	(4)
VARIABLES	Green party	Environ	Green party	Environ
Pred. brownness	-0.338***	-1.849***		
	(0.100)	(0.434)		
Brownness	-0.010	-0.076		
	(0.008)	(0.048)		
Pred. greenness			1.406***	4.651***
			(0.217)	(0.914)
Greenness			0.007	-0.020
			(0.011)	(0.050)
Observations	32,961	32,889	32,961	32,889
R^2	0.092	0.339	0.093	0.339
Individual controls	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓
Region FE	✓	✓	✓	✓
Mean	0.087	3.596	0.087	3.596

Notes: Individual controls include age group, gender, and years of education. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

estimating such probabilities based on the pre-sample *national* composition of the labor market, rather than on the regional one. In the same spirit, in row 4 we exclude migrants from the sample. We define migrants as individuals who were born in a country that is different from their current country of residence (international migration), or individuals who were born in a region different from their current region of residence within the same country (internal migration). While identifying international migrants is relatively straightforward, isolating internal migrants is more complicated, as the ESS does not provide information on the region of birth. We then use self-reported ethnic identification and exclude from the sample individuals who identify as members of an ethnic group that is not the majority in their current region of residence. For instance, we exclude Walloons living in Flanders, Catalans living in the Madrid region, or Scots living in the London region.

In rows 5 and 6, we use older labor force survey data to estimate the occupational models. Specifically, in row 5 we use EU-LFS data from 2000-2001, while in row 6 we use EU-LFS data from 1995-1996. In row 7, we control for (NUTS-2)

region-specific time trends, while in row 8 we include region-year fixed effects, thus allowing for region-specific trajectories in a more flexible way. In row 9, we exclude individuals born after 1980, who might have adjusted their educational choices foreseeing the challenges and opportunities brought by the green transition. In row 10, we include as control an indicator variable for unionized workers. In row 11, we cluster the standard errors at the occupation-country level. In row 12 we account for the uncertainty of predicted brownness and greenness scores deriving from the estimation of employment probabilities in the occupational models. The posterior simulation approach for uncertainty propagation is explained in Section 3.B of the Appendix.

Row 13 presents an additional robustness check on predicted brownness, where we employ a discrete version of the predicted brownness score. This is obtained by multiplying the individual probabilities of employment by the indicator variable for brown occupations, instead of the continuous measure of brownness employed in the main analysis. Results are substantively unaffected. Finally, in row 14 we show that results are robust to using the broad environmentalism score introduced in Section 3.3.1 as outcome variable.

3.5.2 Party families and policy preferences

To further characterize the implications of environmental material interest for voting behavior, in Table 3.3 we assess the effects of predicted brownness and greenness on support for parties belonging to different party families. Specifically, panel A focuses on predicted brownness, while panel B focuses on predicted greenness. In column 1, the dependent variable is a dummy equal to 1 if the individual reports voting for a radical-right party. In columns 2-4 the focus is on parties of the radical left, mainstream right, and mainstream left, respectively. For completeness of exposition, column 5 replicates the baseline results on Green parties.[13]

Individuals with higher predicted brownness scores are more likely to support radical-right parties, and less likely to support mainstream-right parties. At the same time, they are less likely to support Green parties and more likely to support mainstream-left parties. These results are consistent with a re-shuffling

[13]Radical-right parties are identified based on consensus in the literature; their list is reported in Table 3.C.3 of the Appendix. Radical-left parties are those classified as communist and socialist by the Manifesto Project, plus others according to the classification by Rooduijn et al. (2024); their list is reported in Table 3.C.4 of the Appendix. We classify as mainstream left all parties that, according to the Manifesto Project, belong to the Social-Democratic party family. Similarly, we classify as mainstream right all parties that, according to the Manifesto Project, belong to the Liberal, Christian-Democratic, and Conservative party families, and are not classified as radical-right parties.

of preferences within the right camp and the left camp, respectively, and are in line with existing evidence by Dickson and Hobolt (2024) on the link between climate attitudes and vote choice. Individuals with higher predicted greenness scores are less likely to support radical-right and mainstream-left parties, and more likely to support Green parties.

Table 3.3: Party families

Panel A					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	Radical right	Radical left	Mainstream right	Mainstream left	Green
Pred. brownness	1.311***	-0.116	-1.452***	0.366**	-0.325***
	(0.101)	(0.091)	(0.177)	(0.160)	(0.090)
Observations	40,060	40,060	40,060	40,060	40,060
R^2	0.099	0.065	0.080	0.077	0.091
Individual controls	✓	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓
Mean	0.072	0.071	0.429	0.267	0.083
Panel B					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	Radical right	Radical left	Mainstream right	Mainstream left	Green
Pred. greenness	-0.521***	-0.048	0.154	-0.998***	1.485***
	(0.163)	(0.205)	(0.353)	(0.320)	(0.197)
Observations	40,060	40,060	40,060	40,060	40,060
R^2	0.093	0.065	0.078	0.077	0.092
Individual controls	✓	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓
Mean	0.072	0.071	0.429	0.267	0.083

Notes: All specifications include individual controls (age group, gender, and years of education), country-year FE, and region FE. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As a further extension of the analysis, in Table 3.4 we focus on policy preferences related to the green transition. In particular, we use two items in wave 8 of the ESS. The first item measures support for increases in fossil fuel taxes to reduce climate change; the second measures support for subsidies in favor of renewable energy to reduce climate change. Answers to both items are provided on a 5-point Likert scale, from "strongly against" to "strongly in favor". The specifications are the same as in the baseline analysis but country-year fixed effects are not included since the analysis is cross-sectional. Individuals with higher predicted

greenness scores are significantly more supportive of both higher taxes on fossil fuels and higher subsidies for renewables. Conversely, individuals with higher predicted brownness scores are significantly less supportive of increases in fossil fuel taxes. These results are in line with the evidence on voting behavior, and provide a further validation of our measures of material interest in the context of the green transition.

Table 3.4: Policy preferences

	(1)	(2)	(3)	(4)
VARIABLES	Pro fossil fuel tax		Pro subs. renewable	
Pred. brownness	-4.815***		-0.714	
	(0.715)		(0.628)	
Pred. greenness		3.279**		3.818***
		(1.364)		(1.107)
Observations	15,883	15,883	15,962	15,962
R^2	0.130	0.127	0.075	0.075
Individual controls	✓	✓	✓	✓
Region FE	✓	✓	✓	✓
Mean	2.876	2.876	4.035	4.035

Notes: Individual controls include age group, gender, and years of education. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

3.5.3 Analysis including shifters

In this section, we augment the baseline specifications with region-specific, time-varying shifters that capture variation in the opportunities stemming from the ecological transition. By interacting these shifters with predicted scores of greenness and brownness, we explore heterogeneous effects related to residing in regions that are better or worse placed to gain from the green transition, as this becomes more salient.

Tables 3.5 and 3.6 present estimates of Equations (3.6) and (3.7). Table 3.5 uses regional suitability for solar energy as a proxy for S_r, while Table 3.6 uses regional suitability for wind energy. The two tables provide very similar evidence. The baseline results on the linear terms of predicted brownness and greenness are confirmed. In both tables, the interaction terms are significant in columns 1 and 3, i.e., where the outcome variable captures voting for a Green party. In

particular, the interactions with predicted greenness are positive, suggesting that the positive link between predicted greenness and environmentalist voting is stronger in regions that are better placed to gain from the green transition, as the green transition becomes more salient. Interestingly, the interactions with predicted brownness are also positive. This suggests that individuals with browner occupational profiles display voting preferences that are closer to those of less brown profiles in contexts where the positive effects of the green transition are more likely to be tangible.

Table 3.5: Regional shifters – Solar suitability

	(1)	(2)	(3)	(4)
VARIABLES	Green party	Environ	Green party	Environ
Pred. brownness	-0.667***	-1.743***		
	(0.105)	(0.451)		
Pred. brownness $\times S_r \times \Delta$ green patents$_t$	0.006***	-0.001		
	(0.001)	(0.004)		
Pred. greenness			1.171***	6.053***
			(0.216)	(0.877)
Pred greenness $\times S_r \times \Delta$ green patents$_t$			0.004***	-0.006
			(0.001)	(0.004)
Observations	39,939	39,849	39,939	39,849
R^2	0.092	0.339	0.092	0.339
Individual controls	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓
Region FE	✓	✓	✓	✓
Mean	0.083	3.574	0.083	3.574

Notes: Individual controls include age group, gender, and years of education. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To get a sense of the substantive implications, the average change in (log) patents is approximately equal to 2. In a low suitability region (i.e., at the 10th percentile of the distribution of solar suitability), the probability of supporting a Green party is 1.5 percentage points lower for individuals a one standard deviation higher in terms of predicted brownness. In a higher suitability region (i.e., at the 90th percentile) the effect of higher brownness is essentially zero and not statistically significant. That is, higher suitability attenuates, and mutes in the limit, the effect of differences in brownness. The divergence between high and low suitability regions in terms of how much brownness matters would be amplified in years characterized by higher changes in patents. The same exact

Table 3.6: Regional shifters – Wind suitability

VARIABLES	(1) Green party	(2) Environ	(3) Green party	(4) Environ
Pred. brownness	-0.603***	-1.410***		
	(0.105)	(0.452)		
Pred. brownness $\times S_r \times \Delta$ green patents$_t$	0.007***	-0.009		
	(0.001)	(0.006)		
Pred. greenness			1.183***	6.041***
			(0.216)	(0.878)
Pred. greenness $\times S_r \times \Delta$ green patents$_t$			0.006***	-0.007
			(0.001)	(0.006)
Observations	39,939	39,849	39,939	39,849
R^2	0.091	0.339	0.092	0.339
Individual controls	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓
Region FE	✓	✓	✓	✓
Mean	0.083	3.574	0.083	3.574

Notes: Individual controls include age group, gender, and years of education. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

pattern emerges with wind suitability.[14] These findings offer additional evidence highlighting the relevance of occupation-based material interest in shaping voting behavior in the context of the green transition.

3.6 Conclusion

We investigate the role of material interest in shaping environmental voting, using individual-level data from 14 Western European countries over 2010–2019. Our focus is on occupation-related material interest. This is measured by the greenness vs. brownness of occupational profiles, which capture the extent to which individuals are expected to benefit rather than be penalized as the green transition impacts the labor market.

[14]These results are robust to including all the double interaction terms. According to those estimates, at the mean of change in log patents, in a low-suitability region the probability of supporting a Green party is 2.3 percentage points lower for individuals one standard deviation higher in brownness. In a high-suitability region the effect is negligible in size and not statistically significant at conventional levels. The implications regarding the effects of greenness and brownness at low and high levels of renewable suitability are always identical in the models with and without the two-way interaction terms.

We argue that current occupation alone does not fully characterize an individual's occupational profile, as it fails to account for the broader job market opportunities available to individuals based on their demographic characteristics and the composition of the labor market in their region of residence. Moreover, relying on current occupation excludes unemployed individuals and introduces endogeneity concerns in vote regressions, as occupational choices and voting behavior may share common confounders.

To address these issues, we propose a novel approach that isolates plausibly exogenous variation in occupation-related material interest. We compute predicted greenness and brownness scores that reflect labor market opportunities without relying on the current observed occupation. Specifically, we estimate each individual's probability of employment in all occupations by combining individual characteristics with pre-sample employment data in their region of residence. Predicted greenness and brownness are then constructed as weighted averages of occupation-specific greenness and brownness scores, with weights given by individual employment probabilities.

We find that individuals with higher predicted brownness are less likely to vote for Green parties and for parties with more environmentalist agendas, while those with higher predicted greenness show the opposite pattern. Studying vote choice by party family, we find that in the right camp higher predicted brownness increases support for radical-right parties and reduces support for mainstream-right parties. In the left camp, it is associated with less support for Green parties and more support for mainstream-left parties. Conversely, higher predicted greenness reduces support for both radical-right and mainstream-left parties, while increasing support for Green parties. We also document how policy preferences for green subsidies and fossil fuel taxes are shaped by the greenness and browness of one's occupational profile, in a direction fully consistent with the voting behavior results: browner profiles oppose fossil fuel taxes, while greener profiles favor green subsidies and fossil fuel taxes.

We further interact predicted greenness and brownness with region-specific, time-varying shifters that capture variation in opportunities from the green transition. We document that individuals in regions better positioned to gain from the green transition tend to develop greener preferences as the transition becomes more salient. In particular, individuals with higher predicted brownness scores display voting preferences that converge towards those of less brown profiles. These results corroborate the significance of occupation-based material interest for voting behavior in the context of the green transition.

Appendix 3.A Estimation of individual greenness and brownness

In the individual-level analysis, we use data from waves 5-9 of the European Social Survey (ESS), covering elections spanning the period 2010-2019. For each individual, we observe voting behavior along with demographic characteristics and region of residence. The computation of predicted greenness and predicted brownness scores relies on estimates of the individual probabilities of employment in each occupation. To obtain these estimates, we proceed in two steps.

We first estimate multinomial logit models of occupational choice based on European Labor Force Survey (EU-LFS) data for 2005-2006. These models have the set of all occupations as outcome variable, while the predictors are age, gender, educational attainment, and region of residence. Occupations are defined at the 2-digit level of the International Standard Classification of Occupations (ISCO). We estimate the models separately for each country. The parameter estimates obtained from these models reflect the occupational outcomes of workers with a given profile in each country and region, in the labor market immediately prior to the study period.

We then calculate predicted probabilities of being in each occupation for the ESS respondents, based on their observables and the parameter estimates obtained from the LFS estimation. These probabilities are then used as weights to calculate the predicted brownness and predicted greenness of each respondent, based on Equations (3.2) and (3.3).

Appendix 3.B Uncertainty propagation

In row 12 of Table 3.C.6, we incorporate the uncertainty regarding the parameters of the occupational models in the estimation of the voting models. In practice, we want to account for the fact that the measures of individual greenness and brownness are based on predicted probabilities derived from parameters that are themselves estimated.

Formally, the probabilities $\widehat{Pr}(o_i = j|\text{age, gender, edu, reg})$ that appear in Equations (3.2)-(3.3) of the main manuscript are based on the estimates of the multinomial logit models: for each country, we estimate a vector of parameters $\hat{\gamma}$ that link observable characteristics of the individuals in the EU-LFS sample to their observed occupation. At a subsequent stage, we predict, out of sample, the $\widehat{Pr}(o_i = j)$ for each individual $i \in$ ESS, and for all occupations j, based on these $\hat{\gamma}$ estimates. These probabilities are used in turn to compute individual predicted greenness and brownness scores, which are the main explanatory variables in the voting models.

To account for the uncertainty of the occupational model estimates, we implement the following algorithm:

For $m \in 1, 2, \ldots, M$ with $M = 100$,

1. draw a vector of parameters $\tilde{\gamma}^{(m)}$ from the posterior distribution of γ;
2. predict $\widetilde{Pr}^{(m)}(o_i = j)$ for all j and for each $i \in$ ESS based on $\tilde{\gamma}^{(m)}$;
3. compute predicted greenness$_i^{(m)}$ and predicted browness$_i^{(m)}$ for each $i \in$ ESS following Equations (3.2)-(3.3) of the main manuscript, using the simulated $\widetilde{Pr}^{(m)}(o_i = j)$ instead of the $\widehat{Pr}(o_i = j)$ estimate;
4. get a point estimate $\tilde{\beta}^{(m)}$ and variance estimate $\tilde{V}_\beta^{(m)}$ for the parameters β_1 and β_2 in the voting models of Equations (3.4)-(3.5) in the main text, using predicted greenness$_i^{(m)}$ and predicted browness$_i^{(m)}$ as predictors.

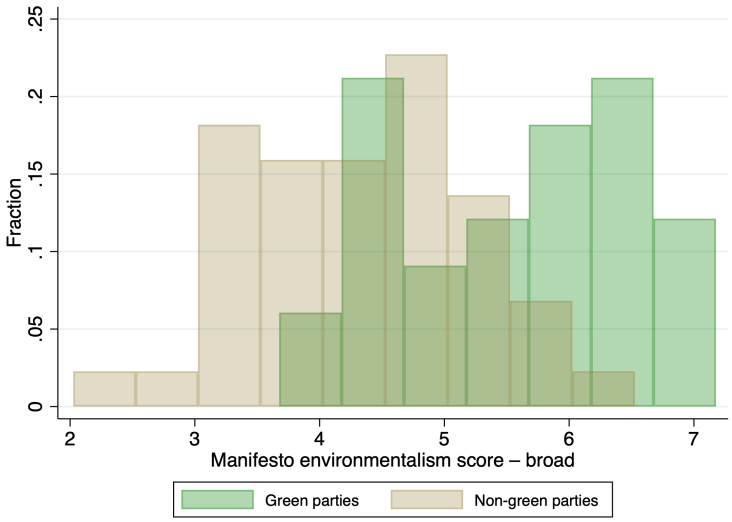
This procedure yields M estimates $\tilde{\beta}^{(m)}$ of the voting model parameters for each of predicted brownness and predicted greenness. We then compute (and report) the average $\overline{\beta} = \frac{1}{M}\sum_m \tilde{\beta}^{(m)}$, and the standard errors for β_1 and β_2 based on the formula:

$$\text{SE}_\beta^{\text{sim}} = \left(\frac{1}{M}\sum_m \tilde{V}_\beta^{(m)} + (1 + \frac{1}{M})\frac{1}{M-1}\sum_m (\tilde{\beta}^{(m)} - \overline{\beta})^2\right)^{\frac{1}{2}}$$

We perform this exercise for the baseline regressions of columns 1-4 in Table 3.1. Incorporating this additional source of uncertainty turns out to be fundamentally inconsequential for the findings, with only slightly wider confidence intervals. A full data package with the simulated coefficients of the occupational model and the simulated individual vulnerabilities will be made available in the replication package.

Appendix 3.C Additional information

Figure 3.C.1: Distribution of broad environmentalism score by type of party



Notes: The figure shows broad environmentalism score distributions for Green vs. non-Green parties.

Table 3.C.1: Greenness and brownness scores by occupation

ISCO08 Title	ISCO08 Code	Greenness	Brownness	Brown dummy
Agricultural and forestry production managers	1311	.0481256	0	0
Agricultural and industrial machinery mechanics and repairers	7233	.1111111	.3333333	1
Agricultural technicians	3142	.0550568	0	0
Air conditioning and refrigeration mechanics	7127	.0657744	0	0
Air traffic safety electronics technicians	3155	.100273	0	0
Animal producers n.e.c.	6129	0	1	1
Aquaculture and fisheries production managers	1312	.0481256	0	0
Bicycle and related repairers	7234	1	0	0
Biologists, botanists, zoologists and related professionals	2131	.0690929	.1111111	0
Blacksmiths, hammersmiths and forging press workers	7221	0	1	1
Bleaching, dyeing and fabric cleaning machine operators	8154	0	1	1
Bricklayers and related workers	7112	0	.5	1
Building and related electricians	7411	.5	0	0
Building architects	2161	.2682825	0	0
Building construction labourers	9313	.0263455	0	0
Building frame and related trades workers n.e.c.	7119	.5887991	0	0
Bus and tram drivers	8331	1	0	0
Business services agents n.e.c.	3339	.0615079	0	0
Business services and administration managers n.e.c.	1219	.0660316	0	0
Butchers, fishmongers and related food preparers	7511	0	.25	0
Cement, stone and other mineral products machine operators	8114	0	1	1
Chemical and physical science technicians	3111	.0572719	1	1
Chemical engineering technicians	3116	.1064441	1	1
Chemical engineers	2145	0	1	1
Chemical processing plant controllers	3133	0	1	1
Chemical products plant and machine operators	8131	0	1	1
Chemists	2113	0	.5	1
Civil engineering technicians	3112	.0446421	0	0
Civil engineers	2142	.3267401	0	0
Commercial sales representatives	3322	.055	0	0
Construction managers	1323	.2260342	0	0
Crane, hoist and related plant operators	8343	0	.2	0
Customs and border inspectors	3351	.0062789	0	0
Dairy-products makers	7513	0	1	1
Database and network professionals n.e.c.	2529	.0030657	0	0
Earthmoving and related plant operators	8342	0	.4	1
Electrical engineering technicians	3113	.089361	0	0
Electrical engineers	2151	.1606959	0	0
Electrical line installers and repairers	7413	1	0	0
Electrical mechanics and fitters	7412	.1348	.1538462	0
Electronics engineering technicians	3114	.100273	0	0
Electronics engineers	2152	.0491788	0	0
Electronics mechanics and servicers	7421	.1348	.1428571	0
Engineering professionals n.e.c.	2149	.1423095	0	0
Environmental and occupational health and hygiene professionals	2263	1	0	0
Environmental and occupational health inspectors and associates	3257	.1198021	0	0
Environmental engineers	2143	1	0	0
Environmental protection professionals	2133	1	0	0
Farming, forestry and fisheries advisers	2132	.2072786	0	0
Fibre preparing, spinning and winding machine operators	8151	0	1	1
Financial analysts	2413	.0672838	0	0
Financial and insurance services branch managers	1346	.0566944	0	0
Financial and investment advisers	2412	.1563042	0	0
Food and related products machine operators	8160	0	1	1
Forestry and related workers	6210	1	0	0
Forestry labourers	9215	1	0	0
Forestry technicians	3143	1	0	0

ISCO08 Title	ISCO08 Code	Greenness	Brownness	Brown dummy
Garbage and recycling collectors	9611	.5	0	0
Garden and horticultural labourers	9214	0	0	0
Gardeners, horticultural and nursery growers	6113	1	0	0
Garment and related pattern-makers and cutters	7532	0	.3333333	1
Geologists and geophysicists	2114	.2149376	1	1
Glass and ceramics plant operators	8181	0	1	1
Glass makers, cutters, grinders and finishers	7315	0	1	1
Government licensing officials	3354	.0094184	0	0
Government social benefits officials	3353	.0094184	0	0
Heavy truck and lorry drivers	8332	.0427818	0	0
House builders	7111	.2260342	0	0
Incinerator and water treatment plant operators	3132	.240863	.5	1
Industrial and production engineers	2141	.05	0	0
Information and communications technology sales professionals	2434	.055	0	0
Information technology trainers	2356	.0862385	0	0
Insulation workers	7124	.3	0	0
Journalists	2642	.0193069	0	0
Landscape architects	2162	.260082	0	0
Legal professionals n.e.c.	2619	.0382507	0	0
Life science technicians (excluding medical)	3141	.5	0	0
Livestock and dairy producers	6121	0	1	1
Locomotive engine drivers	8311	1	0	0
Manufacturing labourers n.e.c.	9329	.25	.25	0
Mechanical engineering technicians	3115	.0462233	0	0
Mechanical engineers	2144	.2947051	0	0
Mechanical machinery assemblers	8211	.0647683	0	0
Metal finishing, plating and coating machine operators	8122	0	1	1
Metal moulders and coremakers	7211	0	.5	1
Metal polishers, wheel grinders and tool sharpeners	7224	0	1	1
Metal processing plant operators	8121	0	1	1
Metal production process controllers	3135	0	1	1
Metal working machine tool setters and operators	7223	.005985	.3636364	1
Meteorologists	2112	.4329176	0	0
Meter readers and vending-machine collectors	9623	0	.5	1
Mineral and stone processing plant operators	8112	0	1	1
Miners and quarriers	8111	0	1	1
Mining and metallurgical technicians	3117	0	1	1
Mining and quarrying labourers	9311	0	1	1
Mining engineers, metallurgists and related professionals	2146	0	1	1
Mining managers	1322	0	1	1
Mining supervisors	3121	0	1	1
Mobile farm and forestry plant operators	8341	1	0	0
Motor vehicle mechanics and repairers	7231	.0340898	0	0
Odd job persons	9622	.13	0	0
Other cleaning workers	9129	0	1	1
Packing, bottling and labelling machine operators	8183	0	1	1
Paper products machine operators	8143	0	1	1
Petroleum and natural gas refining plant operators	3134	0	1	1
Philosophers, historians and political scientists	2633	.0449735	0	0
Physical and engineering science technicians n.e.c.	3119	.1584036	0	0
Physicists and astronomers	2111	.05	0	0
Plastic products machine operators	8142	0	.5833333	1
Plumbers and pipe fitters	7126	.1206143	0	0
Policy administration professionals	2422	.3333333	0	0
Policy and planning managers	1213	.3961895	0	0
Potters and related workers	7314	0	.5	1
Poultry producers	6122	0	1	1
Power production plant operators	3131	.119538	.5	1
Product graders and testers (excluding foods and beverages)	7543	.0613655	0	0
Professional services managers n.e.c.	1349	.3961895	0	0
Public relations professionals	2432	.2130159	0	0
Pulp and papermaking plant operators	8171	0	1	1

ISCO08 Title	ISCO08 Code	Greenness	Brownness	Brown dummy
Railway brake, signal and switch operators	8312	1	0	0
Refuse sorters	9612	1	0	0
Research and development managers	1223	.0893194	0	0
Retail and wholesale trade managers	1420	.1133889	0	0
Roofers	7121	.3009046	0	0
Rubber products machine operators	8141	0	1	1
Sales and marketing managers	1221	.0860184	0	0
Securities and finance dealers and brokers	3311	.006681	0	0
Senior government officials	1112	.0377963	0	0
Senior officials of special-interest organizations	1114	.1698594	0	0
Sewing, embroidery and related workers	7533	0	.3333333	1
Sheet-metal workers	7213	.0713787	.3333333	1
Shotfirers and blasters	7542	0	1	1
Software and applications developers and analysts n.e.c.	2519	.0061315	0	0
Sports, recreation and cultural centre managers	1431	.1980947	0	0
Spray painters and varnishers	7132	0	.5	1
Stationary plant and machine operators n.e.c.	8189	0	.5	1
Stock clerks	4321	.0284543	0	0
Subsistence livestock farmers	6320	0	1	1
Supply, distribution and related managers	1324	.2216368	0	0
Technical and medical sales professionals (excluding ICT)	2433	.055	0	0
Telecommunications engineering technicians	3522	.100273	0	0
Telecommunications engineers	2153	.0983575	0	0
Tobacco preparers and tobacco products makers	7516	0	.6666667	1
Toolmakers and related workers	7222	0	.3333333	1
Town and traffic planners	2164	.3604269	0	0
Trade brokers	3324	.004454	0	0
Training and staff development professionals	2424	.0862385	0	0
Transport conductors	5112	1	0	0
Upholsterers and related workers	7534	0	1	1
Weaving and knitting machine operators	8152	0	1	1
Well drillers and borers and related workers	8113	.0083476	1	1
Wood processing plant operators	8172	0	1	1
Wood treaters	7521	0	1	1
Woodworking-machine tool setters and operators	7523	0	1	1

Notes: The table shows greenness and brownness scores (including the brown discrete measure) for all ISCO08 occupations with at least one of the scores greater than 0.

Table 3.C.2: List of Green parties

Party name	Country
Grüne	Austria
Agalev/Groen!	Belgium
Ecolo	Belgium
Green League	Finland
EELV (Europe Ecologie Les Verts)	France
Les Verts	France
Other ecologists movements	France
Alliance 90/The Greens	Germany
Green Party	Ireland
Green Left	Netherlands
Miljøpartiet De Grønne	Norway
PAN - Pessoas-Animais-Natureza	Portugal
PACMA	Spain
Miljöpartiet de gröna	Sweden
Green Liberal Party	Switzerland
Green Party	Switzerland
Green Party	United Kingdom

Notes: Parties are labelled as green either because they belong to the European Green Party or because of the Manifesto Project classification (see Section 3.3.1). Each of these parties ran for office in at least one election over the sample period while satisfying at least one of these two conditions.

Table 3.C.3: List of radical-right parties

Party name	Country
Alliance for the Future of Austria	Austria
Austrian Freedom Party	Austria
Team Stronach for Austria	Austria
Belgian National Front	Belgium
Flemish Interest	Belgium
True Finns	Finland
National Front	France
Alternative for Germany	Germany
National Democratic Party of Germany	Germany
Brothers of Italy	Italy
Casapound	Italy
Northern League	Italy
Forum for Democracy	Netherlands
Party for Freedom	Netherlands
Progress Party	Norway
Vox	Spain
Sweden Democrats	Sweden
Swiss People's Party	Switzerland
United Kingdom Independence Party	United Kingdom

Notes: Radical-right parties are identified based on consensus in the literature.

Table 3.C.4: List of radical-left parties

Party name	Country
Workers' Party of Belgium	Belgium
Left Wing Alliance	Finland
French Communist Party	France
Left Front	France
Die Linke	Germany
Sinn Féin	Ireland
Civil Revolution	Italy
Left Ecology Freedom	Italy
Socialist Party	Netherlands
Socialist Left Party	Norway
Left Bloc	Portugal
Portuguese Communist Party	Portugal
En Marea	Spain
Galician Nationalist Bloc	Spain
Izquierda Unida	Spain
Podemos	Spain
Unidas Podemos	Spain
Left Party	Sweden
Swiss Labour Party	Switzerland

Notes: Radical-left parties are those classified as communist and socialist by the Manifesto Project, plus others according to the classification by Rooduijn et al. (2024).

Table 3.C.5: Correlation between environmental vote measures

	Green party dummy	Environ score	Broad environ score
Green party dummy	1		
Environ score	0.315***	1	
Broad environ score	0.249***	0.914***	1

Notes: Pairwise correlation coefficients. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.C.6: Robustness checks

	(1)	(2)	(3)	(4)
Dependent Variable:	Green party	Environ	Green party	Environ
Explanatory Variable:	Pred. brownness		Pred. greenness	
1) Including current industry FE	-0.223**	-1.518***	1.420***	4.754***
	(0.100)	(0.440)	(0.219)	(0.927)
2) Including the retired	-0.281***	-0.823***	1.429***	4.111***
	(0.058)	(0.291)	(0.141)	(0.625)
3) Excluding region FE from occupational models	-0.564***	-2.192***	1.527***	5.829***
	(0.102)	(0.440)	(0.207)	(0.911)
4) Excluding migrants	-0.327***	-1.848***	1.551***	5.648***
	(0.093)	(0.418)	(0.204)	(0.863)
5) Using EU-LFS data from 2000-2001	-0.312***	-1.648***	1.245***	5.512***
	(0.084)	(0.393)	(0.199)	(0.849)
6) Using EU-LFS data from 1995-1996	-0.224***	-2.119***	0.800***	4.509***
	(0.084)	(0.398)	(0.171)	(0.794)
7) Controlling for region-specific time trends	-0.329***	-1.859***	1.485***	5.599***
	(0.091)	(0.402)	(0.197)	(0.829)
8) Controlling for region-year FE	-0.325***	-1.828***	1.483***	5.675***
	(0.091)	(0.402)	(0.197)	(0.830)
9) Excluding born after 1980	-0.312***	-1.461***	1.500***	4.980***
	(0.102)	(0.452)	(0.220)	(0.953)
10) Controlling for union membership	-0.322***	-1.805***	1.459***	5.467***
	(0.092)	(0.407)	(0.200)	(0.846)
11) Clustering at occupation-country level	-0.325***	-1.829***	1.485***	5.543***
	(0.095)	(0.430)	(0.230)	(0.894)
12) Accounting for uncertainty in occupational models	-0.332***	-1.845***	1.480***	5.574***
	(0.091)	(0.407)	(0.204)	(0.846)
13) With discrete measure of brownness	-0.144***	-1.137***	-	-
	(0.049)	(0.220)		
14) Using broad environmentalism score	-	-1.448***	-	6.108***
		(0.347)		(0.698)

Notes: All specifications include individual controls (age group, gender, and years of education). Country-year FE and region FE are always included, except for rows 7-8. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix 3.D Measuring wind and solar suitability at the regional level

We calculate two indicators of suitability for renewable energies at the regional level, separately for wind and solar (photovoltaic) power generation, adapting the general lines of the approach suggested by Castillo, Silva, and Lavalle (2016) and taking some inspiration from the report by the European Topic Centre for Air and Climate Change (2009). The suitability is based on three types of information: the intensity of the phenomenon that produces energy (solar radiation, or wind speed); constraints present in areas (e.g., dense urban areas) where installation of equipment is not possible; and geographic characteristics, like elevation of the terrain and distance from existing transportation infrastructure, that affect the cost of setting up and operating a power conversion plant.

Geographic data. We collect the following geographic data for the constraints. From the Harmonized World Soil Database (Fischer et al., 2008)[15], we obtain data about urbanization, forests, and water bodies from the Land Use and Land Cover data at the 5′ grid-cell resolution (less than 10km side). We classify as urbanized those cells that are more than 15% builtup, and we classify as forest those cells that are more than 80% covered by forest. From the Common Database on Designated Areas (CDDA) of the European Environment Agency we identify all areas that are classified as "national parks" (type II) according to the International Union for Conservation of Nature classification. Based on these, we defined as constrained those areas that are either urban, forests, national parks, or covered by a water body (also relying on the Fischer et al. (2008) data). For wind power generation, there is one additional constraint highlighted in Baseer et al. (2017): airports. We start with the shapefile of airport locations from GISCO Airports. This is a geographical dataset developed by the European Commission based on Corine Land Cover 2000 and Eurocontrol data. We retain only major ones: those classified as "main" and open to commercial traffic with at least 150,000 passengers as of 2004, or to military traffic. We then classify an area of radius 5km around the listed location of the airport as constrained.

We then collect further geographic data to capture suitability short of all-or-nothing constraints. We collect the Terrain slope classes of the world (FGGD)[16] at the 5′ resolution. We rescale them so that 100 corresponds to the minimum and zero to the maximum slope (within the whole set of European countries

[15] Available at https://www.fao.org/soils-portal/data-hub/soil-maps-and-databases/harmonized-world-soil-database-v12/en/.

[16] http://www.fao.org:80/geonetwork/srv/en/resources.get?id=14131&fname=Map4$_6$.zip.

we consider). Population density in the year 2000 (also at the 5′ resolution) comes from CIESIN. Population density is first logged and then scaled so that the minimum corresponds to a value of 100 and the maximum to a value of zero (hence higher values indicate lower population density).

We prepare the data on electrical transmission lines starting from the vector data in SciGRID (Medjroubi and Matke, 2015), which we convert to a shapefile. We calculate, for each 5′ cell in the grid, the distance from the closest electrical transmission line located in the same country. We then rescale the distances so that 100 corresponds to the minimum distance and 0 to the maximum distance (over the entire set of countries we consider).

Solar suitability: aggregation. The measure of radiation intensity comes from PVGIS. Specifically, we use the yearly average global irradiance on an optimally inclined surface (W/m2), over the period 2007-2016.[17] We rescale the values so that 0 corresponds to the minimum and 100 to the maximum, and coarsen the original data to the 5′ resolution used in the geographic data.

The solar suitability is calculated at the level of the individual 5′ cell as the weighted average of the rescaled values of radiation, slope, population density, and distance to transmission lines, where radiation, following Castillo, Silva, and Lavalle (2016), is assigned twice the weight of the others. We then assign suitability zero to all cells that are classified as constrained based on urbanization, forests, national parks, and water bodies. The cell-level suitability thus calculated is then aggregated at the NUTS-2 level by overlaying the Eurostat shapefile and taking the average suitability by region.

Wind suitability: aggregation. The measure of wind speed comes from ERA5. Neutral wind speeds at 10 meters are reported at the monthly level, decomposed into a north-south and an east-west component, at the resolution of one-tenth of a degree. It is the horizontal speed of air, at a height of ten metres above the surface of the Earth, in metres per second. We first calculate the wind speed for each location and each month, and then take the yearly average by location. We then re-rasterize at the 5′ resolution.

As before, we take the weighted average of the wind speed and the geographic features for each cell, assigning double weight to wind speed. We then set suitability equal to zero in all areas that are constrained (including all the constraints for solar but, this time, also areas that are in proximity of a main

[17] https://joint-research-centre.ec.europa.eu/photovoltaic-geographical-information-system-pvgis/pvgis-data-download/cm-saf-solar-radiation$_e n$

airport). We then aggregate the data at the NUTS-2 level by overlaying the Eurostat shapefile and taking the average suitability by region.

Chapter 4

Carpe Diem

Economic Shocks, Electoral Cycles, and Violence Against Politicians

with Livio Di Lonardo and Nicola Mastrorocco

> "In a way, the Mafia is the best example of capitalists we have."
>
> — Marlon Brando, 1972

4.1 Introduction

Organized criminal groups are no longer confined to illicit markets. Increasingly, they operate at the boundary with—and within—the legal economy, pursuing revenue streams that are predictable, contractible, and scalable—features underground trade rarely provides (Acemoglu, De Feo, and De Luca, 2019; Barone and Narciso, 2015; Pinotti, 2015b). Legal markets can be at least as profitable, especially where public regulation and procurement generate concentrated rents. Across countries and over time, criminal organizations have targeted sectors such as public works and construction, waste management, local transport concessions, cleaning and security for public buildings, healthcare and social-service procurement, and energy and utilities (including renewable-energy incentives)—domains that combine high margins with administrative barriers to entry.

Access to these rents typically requires proximity to political decision-making. Municipal, provincial, and regional politicians set procurement rules, award and monitor contracts, issue licenses, and calibrate enforcement. By adjusting eligibility thresholds, prioritizing projects, or relaxing oversight, they can materially reshape the distribution of rents. While the presence of criminal organizations in

local politics is well documented (Buonanno, Prarolo, and Vanin, 2016; Daniele and Dipoppa, 2017; Pinotti, 2015b; Di Cataldo and Mastrorocco, 2022; Fenizia and Saggio, 2024), fundamental questions remain: When do these groups resort to violence against politicians, and how does such violence vary with the political and economic environment?

In this paper, we argue that attacks on politicians are not constant or random, nor fully determined by the electoral cycle (Alesina, Piccolo, and Pinotti, 2019; Daniele, 2019): they arise in response to the availability of economic rents. Violence and intimidation represent tools criminal organizations can deploy to influence local governments, whether by deterring unfavorable behavior or by facilitating the election of more compliant officials. The timing and nature of these attacks respond systematically to local opportunities for rent extraction. When unexpected inflows of public resources create the opportunity to extract substantial rents, criminal organizations intensify violent pressure on politicians. Crucially, this pressure varies not only in intensity but also in form, depending on the electoral cycle. When lucrative opportunities arise close to an election, intimidation is more likely to target candidates and campaigns, in an effort to shape the incoming administration. When they arise earlier in the term, pressure is more likely to be exerted directly against incumbents, without waiting for the next election.

We build a simple theoretical framework to formalize these intuitions. In our model, combining some of the features present in Alesina, Piccolo, and Pinotti (2019) and Dal Bó, Dal Bó, and Di Tella (2006), a criminal group, who seeks to extract some economic rents from a local municipality, can influence electoral outcomes through pre-election violence and coercion, and/or intimidate the elected incumbent through post-election violence. The criminal group is characterized by a privately known level of strength, which determines how costly for the elected politician would be to deny the criminal group the economic rents it seeks. Politicians are characterized by a privately known level of honesty, which determines the cost of giving in to the mafia's demands. The two candidates competing from office are drawn for two different parties, with party A having a pool of politicians with an expected level of honesty which is lower than party B.

We consider two different scenarios, which closely align with the empirical setting we use to test our theoretical predictions. First, we analyze the post-electoral interaction between the elected politicians and the mafia. The mafia can engage in violence to signal strength to the politician, thereby increasing the likelihood of obtaining the rents. Second, we analyze a full two-stage interaction that includes both the pre-electoral and post-electoral stages, where only the

newly elected incumbent can deliver the economic rents to the mafia.

For each of these two scenarios we characterize the effect on violence of an increase in the size of economic rents that can be extracted by the mafia in a given municipality. We show that, in both scenarios, greater economic rents increase both the likelihood of observing and the severity of criminal violence against politicians. In particular, when the expected rents from political capture are modest–or when the costs of violence, such as increased law enforcement scrutiny, are high–the equilibrium is peaceful: violence does not occur, either before or after the election. As economic opportunities increase, however, the stakes of intimidating an elected politician and of electing a politician more likely to acquiesce to the mafia's demands become larger and larger, and the peaceful equilibrium becomes harder and harder to be sustainable. Moreover, as these stakes increase, the mafia is willing to go to greater lengths to signal their strength or elect the right candidate, and thus the severity of the violence increases in the size of the economic rents at stake.

What differs between the two scenarios is the timing of the violence. While in the post-electoral interaction engaging in violence against the elected politician to intimidate them into conceding the economic rents is the only available option, this is not the case in the full model. There, even if post-electoral violence is still an available option, the emphasis shifts to pre-electoral violence, which serves a dual role. First, it helps tilting the electoral result in the mafia's preferred direction by facilitating the election of candidates who are ex ante less likely to be honest. Second, pre-electoral violence signals the mafia's strength, and there is no need to add inefficient post-electoral violence, which has no direct benefit other than signaling strength. Thus, in the full model with the pre-electoral stage, an increase in economic opportunities for the mafia lead to a higher likelihood of observing and higher severity of violence, but only before the election, and not after.

We test these predictions using a dataset of violent episodes against Italian politicians in three southern regions—Campania, Calabria, and Sicily—between 2010 and 2020. We study violent episodes against politicians as revealed-preference evidence of attempts to affect the decision-making of local administration, and relate their timing and modality to the pattern of local economic opportunities. We leverage exogenous variation in local economic opportunities arising from earthquakes.[1] In Italy, earthquakes trigger substantial transfers from

[1]Similarly to earthquakes, floods and landslides represent another source of shock to the economic opportunity for a criminal group within a certain municipality. However, relative to earthquakes, these other natural disasters might be, at least partially, caused by the infiltration of

the central government to affected municipalities, and thus provide a natural laboratory to study when and how criminal organizations intensify their political interventions.

Our empirical analysis yields several findings. First, we confirm that even earthquakes of modest magnitude lead to substantial increases in municipal transfers from the central state: municipalities struck by an earthquake in a given year receive, on average, around 9,000€ in current transfers for natural disasters from the central government, which corresponds to a 54% increase relative to the mean. The size of transfers scales with earthquake magnitude, and this result holds even when conditioning on years in which at least one earthquake occurs. Secondly, and more importantly, we find that these shocks lead to a significant rise in mafia-related political violence. In legislatures experiencing at least one earthquake, we observe an increase of 0.2 violent episodes on average—an increase of more than 50% over baseline levels. Year-level regressions and event study analyses show that the effect emerges quickly, peaking in the second month after the event. Third, both the frequency and severity of violence increase with the magnitude of the earthquake. To capture this, we construct a violence severity index that distinguishes between low-level intimidation (e.g., threats or property damage) and high-impact events (e.g., arson, shootings, or homicide). We show that more severe earthquakes systematically lead to more severe acts of violence, consistent with a rent-maximizing strategy on the part of criminal groups. Fourth, consistent with theoretical predictions, we find that violence patterns vary depending on when economic opportunities emerge within to the electoral cycle. An earthquake occurring in the two years following municipal elections increases the probability of observing violence during that same post-electoral period, consistent with the model's prediction that economic opportunities arising early in the term—when the next election is distant—incentivize mafia organizations to signal strength to extract benefits from incumbents. Conversely, an earthquake occurring immediately before elections increases the probability of observing violence only in the pre-electoral period without affecting post-electoral violence, as the mafia focuses effort on influencing electoral outcomes rather than post-electoral extraction. Taken together, our results provide compelling evidence that violence against politicians by organized crime is shaped by economic incentives and by the timing of their emergence within the electoral cycle. By linking exogenous variation in public resource flows to observed patterns of violence

criminal organizations in a local government. As already argued, criminal organizations reinvest parts of the profits raised through illicit affairs in the construction business. In turn, exploitation of the territory might lead to a higher risk of landslides and floods, preventing the empirical analyst from isolating the causal effect of natural disasters on infiltration.

and intimidation, we offer a new understanding of how and when criminal organizations seek to bend local democratic institutions to their advantage.

Our work contributes to the extensive literature on how the presence of criminal organizations affects political institutions and economic activities. In particular, there exists a growing body of literature documenting the criminal organizations increasing efforts to capture politicians and participate in the legal economy, through intimidation, threats and, in extreme cases, violence and homicides. Alesina, Piccolo, and Pinotti (2019) exploit historical variation in Italian mafia-related murders and regional homicide rates to investigate the use of strategic political violence by the mafia and the effect that this has on Italian national elections and on the anti-mafia behavior of national politicians. They show that violence increases in the pre-electoral period, especially in areas with mafia presence, like Sicily, Campania and Calabria, traditional mafia strongholds.[2] Violence is strategically directed against parties that do not have any ties with the mafia, in an attempt to funnel votes away from them and towards the party with whom the mafia has had a more amicable relationship. Moreover, violence is tailored to the specific electoral rules, occurring in competitive districts under proportional rule and marginal districts under majoritarian rule. These results, however, are at odds with the ones in Daniele and Dipoppa (2017), who find that the Italian mafia engages in political violence primarily after the elections, but not before.

Leaning on the theoretical framework in Dal Bó, Dal Bó, and Di Tella (2006), researchers have also examined the effect of the presence of criminal organizations on the quality of elected politicians. Pinotti (2013) and Daniele (2019) observe that murders of politicians by the mafia result in the election of lower-quality politicians, characterized by less social capital and lower education levels. Daniele and Geys (2015b) show that when a local municipal government is dissolved for proven ties with criminal organizations, this has a positive effect on the quality of politician elected, while Daniele and Geys (2015a) show that municipal government dissolutions cause persistent falls in turnout for local elections and collection of tax revenue, and that incumbents, local and conservative parties lose ground to left-wing and national parties.

The ability of criminal groups to capture politicians and infiltrate institutions does not affect only the political sphere, but also economic activities. Pinotti (2015b) and Pinotti and Stanig (2016) use an influx of the mafia members into new regions, respectively through changing smuggling routes or forced relocation of

[2]These findings are in line with the ones in Pinotti (2013).

suspected mafia members by the Italian government, to measure the impact of mafia presence on the economy. They report drastically negative effects of mafia presence for both GDP and productivity. More specifically, Fenizia and Saggio (2024) document that, following the dissolution of a municipal government, there is an increase in employment, business formation, and property values due lower organized crime's influence and higher public confidence in governance.

Much recent work has focused on infiltration of criminal organizations into the legal economy. Using a difference-in-difference approach, Di Cataldo and Mastrorocco (2022) show that municipalities that were infiltrated allocated more spending to, and collected less tax from sectors associated with and vulnerable to mafia control, namely construction and waste management. Pinotti (2015a) argues that decreased economic development may be due in part to poor policy decisions made by captured politicians, possibly reflecting the impact of Mafia violence on the quality of politicians elected (Daniele, 2019; Pinotti, 2013). Marcolongo (2021) conducts a natural experiment using exogenously determined earthquake relief funds to show that firms connected to the Mafia are more likely to participate in bids for public procurements during a state of emergency and with lowered monitoring, while Barone and Narciso (2015) show how transfers from the national governments increase as a result of mafia presence. Le Moglie and Sorrenti (2022) show that in provinces with mafia presence the shock to credit markets caused by the 2007 financial crisis led to a less severe fall in the number of new enterprises. The relationship between organized crime and politics flows both ways, with actions taken by governments and policy makers having profound consequences on the way in which criminal organizations operate and behave. Within the Mexican context, Dell (2015) demonstrates that narrow mayoral victories by the Conservative National Action Party result in crackdowns by law enforcement, territorial conflicts and relocation of trafficking routes, causing an uptick in violence by drug trafficking organizations in both the municipality where the election took place as well as in neighboring municipalities. Tulli (2024) focuses on the spillover effect of dissolutions of local governments in Italy. He shows that following a government dissolution, in the neighboring municipalities there is an increase in the number of public procurements issued below a certain threshold above which the requirements in terms of documentation and the monitoring effort from the authorities would be greater. On top of this, there is a decrease in the number of renegotiated contracts, as these municipalities attempt to limit or conceal behavior associated with corruption to avoid suspicion.

The remainder of the paper proceeds as follows. Section 4.2 presents the model; Section 4.3 covers the empirical and institutional setting; we highlight our

empirical analysis in Section 4.4 and we conclude in Section 4.5.

4.2 Theory

We analyze the strategic interaction between an incumbent politician I, two candidates, one from party A and one from party B, a criminal organization or mafia, M, and a representative voter V. The criminal organization is interested in receiving from the winner of the election an economic benefit, denoted by π. This can take the form of, among other things, rigged tenders, ghost projects, favorable measures in urban planning and construction permits, delegating waste management and other public services to mafia-linked firms etc.

In the first stage, there is an electoral campaign where the candidates from party A and party B compete for office. Candidates are characterized by a privately known level of honesty, which is drawn from a uniform distribution on the interval $[-h + \varepsilon_j, h + \varepsilon_j]$, with $j \in \{A, B\}$ denoting whether each politician belongs to party A or party B. For convenience, we denote $\underline{h}_j \equiv -h + \varepsilon_j$ and $\overline{h}_j \equiv h + \varepsilon_j$.

M does not know the honesty of any of the candidates, and chooses a level of effort e to help party A win the election. We think of this effort as mainly illegal actions, such as threats to the voting population and intimidation and violent acts against unwanted candidates. The effort comes at cost that is determined by their privately known level of strength $\gamma \in \{\gamma_w, \gamma_s\}$. Specifically, a stronger mafia has a lower cost of engaging in effort. Denoting by $k_i(e)$ the cost of exerting effort e, with $i \in \{w, s\}$, we have $k_w(e) > k_s(e)$ and $k'_w(e) > k'_s(e)$ for all e. We assume that for $i \in \{w, s\}$, $k_i(0) = 0$ and $k'_i(0) = 0$. Additionally, regardless of the chosen level of effort chosen, M pays an additional fixed cost ω, which captures the increased level of scrutiny from law enforcement triggered by the violent acts. Both politicians believe that $\gamma = \gamma_s$ with probability μ.

A level of effort e produces electoral returns in terms of added incentives for V to vote for the candidate from party A according to the twice continuously differentiable function $r(e)$, with $r'(e) > 0$, $r''(e) < 0$, $r(0) = 0$, and $\lim_{e \to 0^+} r'(e) = \infty$.

In the second stage, both candidates and the representative voter observe the level of effort exerted by M, and then V decides whether to vote for the candidate from party A, which we refer to as candidate A, or from party B, which we refer to as candidate B. At the electoral stage, V casts a ballot in favor of the candidate of party A or the candidate of party B. V is characterized by a parameter x_V

that captures her partisan preferences, namely how much V prefers candidate B over candidate A. M does not know the true value of x_V, which, for simplicity, is distributed according to a standard normal distribution, Φ.

The game then proceeds to the third stage, where M chooses a level of violence v against the winner of the election (or incumbent), denoted by I, either from party A or from party B. Violence is costly for both I to endure and for M to carry out. More specifically, I pays a cost given by $c(v)$, where c is increasing in v. For M, the cost is given again by $k_i(v)$, with $i \in \{w, s\}$.

In the final stage, after observing the level of violence v conducted by the mafia, I chooses whether to grant M the economic benefit π. If I decides to grant M the economic benefit π, she pays a cost equal to her honesty, h_I. If instead she decides not to give π to M, she pays a cost that captures the level of violence she expects to endure from M going forward. Specifically, if the incumbent faces a strong M, she will pay a cost γ_s, whereas if she faces a weak M, she will pay a cost γ_w.

We solve for the pure-strategy Perfect Bayesian Equilibria that survives the Intuitive Criterion, which we call equilibria.

4.2.1 Post-Electoral Interaction

We begin by analyzing the post-electoral interaction as a stand-alone game. The game starts immediately after the election—there is no pre-electoral stage. The winner, whether from party A or B, holds prior belief $Pr(\gamma = \gamma_s) = \mu$.

At the final stage of this reduced game, I has observed v and formed a posterior belief about $\gamma = \gamma_s$, denoted by $\mu(v)$. I then has to decide whether or not to grant π to M. For an incumbent I from party j, granting π to M has a (moral) cost equal to h_I. Not giving in to M's demands implies that the incumbent expects retaliation from M, which has an expected cost equal to $\mu(v)\gamma_s + (1 - \mu(v))\gamma_w$. Hence, she will grant π to M if

$$h_I \leq \mu(v)\gamma_s + (1 - \mu(v))\gamma_w,$$

which means that, from M's standpoint, the probability of obtaining π following a level of violence v is given by

$$Pr(h_I \leq \mu(v)\gamma_s + (1 - \mu(v))\gamma_w) = \frac{\mu(v)\gamma_s + (1 - \mu(v))\gamma_w + h - \varepsilon_j}{2h}.$$

Before we move on the the analysis of the post-electoral game, let us define some quantities that will be useful going forward. Denote by $\overline{v}_i(v)$ the level of

violence $v' > v$ that, conditional on facing an incumbent from party j, solves

$$\pi\left(\frac{\gamma_w + h - \varepsilon_j}{2h}\right) - k_i(v) - 1_{\{v>0\}}\omega = \pi\left(\frac{\gamma_s + h - \varepsilon_j}{2h}\right) - k_i(v') - \omega,$$

which then becomes,

$$\frac{\pi}{2h}(\gamma_s - \gamma_w) = k_i(v') - k_i(v) + \omega - 1_{\{v>0\}}\omega.$$

That is, $\overline{v}_w(v)$ and $\overline{v}_s(v)$ are the levels of v such that the weak and the strong type of M respectively are indifferent between choosing v with $\mu(v) = 0$, and choosing $\overline{v}_w(v)$ and $\overline{v}_s(v)$, respectively, with $\mu(\overline{v}_w(v)) = \mu(\overline{v}_s(v)) = 1$. Notice that while for any $v > 0$ the existence of $\overline{v}_w(v)$ and $\overline{v}_s(v)$ is guaranteed, this is not the case for $v = 0$.

Similarly, denote by $\underline{v}_i(v)$ the level of violence $v' > v$ that, conditional on facing an incumbent from party j, solves

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_j}{2h}\right) - k_i(v) - 1_{\{v>0\}}\omega = \pi\left(\frac{\gamma_s + h - \varepsilon_j}{2h}\right) - k_i(v') - \omega,$$

which then becomes,

$$\frac{\pi}{2h}(1-\mu)(\gamma_s - \gamma_w) = k_i(v') - k_i(v) + \omega - 1_{\{v>0\}}\omega.$$

That is, $\underline{v}_w(v)$ and $\underline{v}_s(v)$ are the levels of v such that the weak and the strong type of M respectively are indifferent between choosing v with $\mu(v) = \mu$, and choosing $\underline{v}_w(v)$ and $\underline{v}_s(v)$, respectively, with $\mu(\underline{v}_w(v)) = \mu(\underline{v}_s(v)) = 1$. Once again, the existence of $\underline{v}_w(v)$ and $\underline{v}_s(v)$ is guaranteed for $v > 0$, not for $v = 0$. Moreover, it is immediate to see that, whenever they exist, $\overline{v}_s > \overline{v}_w$ and $\underline{v}_s > \underline{v}_w$.

For convenience, we are going to call $\hat{\pi} \equiv \frac{\pi}{2h}(\gamma_s - \gamma_w)$. We can now characterize the equilibrium behavior of M in the post-electoral game.

Proposition 1 *There exists a unique*

(i) non-violent equilibrium *where* $v_s^* = v_w^* = 0$ *iff*

$$\omega \geq (1-\mu)\hat{\pi};$$

(ii) violent equilibrium *where* $v_s^* = \overline{v}_w(0)$ *and* $v_w^* = 0$ *iff*

$$\omega < \hat{\pi}.$$

When the fixed cost of engaging in violence is large enough, both types abstain from committing any violence. This is the only case in which we do not have violence on the path of play. If the fixed cost of committing violence were to decrease, then, if a deviation to a positive level of violence were to be interpreted by the incumbent as a sign of strength, both types would have an incentive to engage in violence to obtain π with higher probability. But then, there is no possibility of having a non-violent equilibrium, since the strong type of M is willing to engage in levels of violence that the weak type does not want to mimic.

When the fixed cost of engaging in violence against the incumbent is low enough, we observe violence in equilibrium, committed by is the strong type of M. Specifically, in the unique separating equilibrium that survives the Intuitive criterion the strong type chooses the level of violence $\overline{v}_w(0)$, which is the level of v that makes the weak type indifferent between choosing 0 and revealing to the incumbent they are the weak type, and mimicking the strong type.

Having characterized the equilibria of the post-electoral game, we can see how the probability of observing violence on the path of play and the severity of the violence observed (if any) are affected by a change in π.

Proposition 2 *An increase in π leads to*

(i) a smaller set of parameter values sustaining the non-violent equilibrium;

(ii) a larger set of parameter values sustaining the violent equilibrium;

(iii) a higher level of violence, whenever positive.

When the economic benefit that M can extract after the election increases, it becomes more important for M to signal its strength to the newly elected politician, so as to convince her to grant the available economic benefits. As a consequence, M's is more likely to engage in violence, and when this happens, the level of violence becomes more severe. This is because in the violent equilibrium, an increase in π leads to an increase in the level of violence that makes the weak type of M indifferent between revealing its weakness by not engaging in violence, and pooling with the strong type of M by engaging in violence. As such, to sustain separation in equilibrium, the strong type of M has to increase the level of violence.

4.2.2 Pre-Electoral Interaction

We now move to the analysis of the full model, including the pre-electoral interaction between M, V, and the two candidates. Recall that before the election M chooses e to influence the electoral result in its preferred direction, which means in favor of the candidate from party A. This pre-electoral effort will (partially) shape the representative voter's preferences for one candidate or the other. At the election stage, V is going to cast a ballot for the candidate from party A if

$$r(e) - x_V \geq 0$$

Therefore, the probability that candidate A wins the election is $Pr(A\ wins) = \Phi(r(e))$.

Denoting by γ the expected cost for winner going forward at the time in which she moves, the expected benefit for M of electing candidate A rather than candidate B is

$$\Delta \equiv \pi\Big(\frac{\gamma + h - \varepsilon_A}{2h}\Big) - \pi\Big(\frac{\gamma + h - \varepsilon_B}{2h}\Big) = \pi\Big(\frac{\varepsilon_B - \varepsilon_A}{2h}\Big).$$

Let us now pin down the level of e that maximizes M's expected utility, assuming that M will choose a positive level of e. Denoting again by γ the expected cost for winner going forward, and ignoring for a moment any post-electoral violence, the optimal level of e for $i \in \{w, s\}$ solves the following problem,

$$\max_{e>0} \pi\Big(\frac{\gamma + h - \varepsilon_B}{2h}\Big) + \Phi(r(e))\Delta - k_i(e) - \omega.$$

Thus, the optimal level of e, denoted by $\hat{e}_i$, solves

$$\phi(r(e))r'(e)\Delta - k_i'(e) = 0,$$

since the function is concave,

$$\Big(\phi'(r(e))(r'(e))^2 + \phi(r(e))r''(e)\Big)\Delta - k_i''(e) < 0$$

which follows from the fact that $r(e) \geq 0$ for all $e \geq 0$ and $\phi'(r(e)) \leq 0$ for all $r(e) \geq 0$. It is immediate to see that the optimal effort for the strong type is larger than the one for the weak type, i.e. $\hat{e}_s > \hat{e}_w$, and that both are increasing in π, since by the Implicit Function Theorem,

$$\frac{d\hat{e}_i}{d\pi} = -\frac{\phi(r(e))r'(e)\frac{\varepsilon_B - \varepsilon_A}{2h}}{\Big(\phi'(r(e))(r'(e))^2 + \phi(r(e))r''(e)\Big)\Delta - k_i''(e) < 0} > 0.$$

Before characterizing the equilibria of the game, it is useful to define the following functions. Call $\overline{e}_i(e)$ the level of $e' > e$ such that

$$\pi\left(\frac{\gamma_w + h - \varepsilon_B}{2h}\right) + \Phi(r(e))\Delta - k_i(e) - 1_{\{e>0\}}\omega = \pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\underline{e}_i(e)))\Delta - k_i(\underline{e}_i(e)) - \omega$$

which becomes

$$\pi\left(\frac{\gamma_s - \gamma_w}{2h}\right) + \Delta\left(\Phi(r(\underline{e}_i(e))) - \Phi(r(e'))\right) = k_i(\underline{e}_w(e)) - k_i(e) + 1_{\{e>0\}}\omega - \omega.$$

That is, $\overline{e}_s(e)$ and $\overline{e}_w(e)$ are the levels of effort such that the strong and weak type of M are indifferent between choosing e and generating a posterior belief for the winner equal to 0, and choosing, respectively, $\overline{e}_s(e)$ and $\overline{e}_w(e)$ generating a posterior belief $\mu(\overline{e}_s(e)) = \mu(\overline{e}_w(e)) = 1$. This is particularly useful to pin down the behavior of the weak type of M, since it defines how far they are willing to go in terms of effort to pool with the strong type.

Similarly, call $\underline{e}_i(e)$ the level of $e' > e$ such that

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_B}{2h}\right) + \Phi(r(e))\Delta - k_i(e) - 1_{\{e>0\}}\omega = \pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\underline{e}_i(e)))\Delta - k_i(\underline{e}_i(e)) - \omega$$

which becomes

$$\pi\left(\frac{(1-\mu)(\gamma_s - \gamma_w)}{2h}\right) + \Delta\left(\Phi(r(\underline{e}_i(e))) - \Phi(r(e'))\right) = k_i(\underline{e}_i(e')) - k_i(e) + 1_{\{e>0\}}\omega - \omega$$

That is, $\underline{e}_s(e)$ and $\underline{e}_w(e)$ are the levels of effort such that the strong and weak type of M are indifferent between choosing e and generating a posterior belief for the winner equal to μ, and choosing, respectively, $\underline{e}_s(e)$ and $\underline{e}_w(e)$ generating a posterior belief $\mu(\underline{e}_s(e)) = \mu(\underline{e}_w(e)) = 1$. This is useful to pin down the behavior of the strong type of M, since it defines how far they have to go in terms of effort to separate from the weak type.

For the remainder of the analysis, we will impose the following assumption.

Assumption 1 $\hat{e}_s > \max\{\overline{e}_w(0), \overline{e}_w(\hat{e}_w)\}$.

This assumption ensures that the optimal level of pre-electoral effort for the strong type is beyond what the weak type would be willing to choose in order to mimic the strong type. While this assumption does not alter significantly the strategic forces at play in the model, it helps reducing the number of qualitatively similar equilibria, but with slightly different levels of violence.

We now present a few intermediate results that will help narrow down the strategy profiles that are compatible with equilibrium behavior. To simplify the presentation of the results, call $g_i(e) \equiv \Delta\left(\Phi(r(e) - \frac{1}{2}\right) - k_i(e)$, and notice that g_i is maximized at $\hat{e}_i$.

Lemma 1 *There does not exist an equilibrium where the* $e_i^* > 0$ *for some* $i \in \{w, s\}$ *and* $v_j^* > 0$ *for some* $j \in \{w, s\}$.

The first thing we can rule out is that in equilibrium there cannot be violence *both* pre-election and post-election. This is because for $e_i^* > 0$, ω must be low enough. When that is the case, the strong type separates from the weak type, and it does so via the choice of pre-electoral effort. If the winner learns the type of M, any violence after the election is inefficient, ruling out the possibility of observing violence both before and after the election.

Lemma 2 *There does not exist an equilibrium where the* $e_s^* = e_w^* = 0$ *and* $v_i^* > 0$ *for some* $i \in \{w, s\}$.

Also, we can rule out the possibility of having, in equilibrium, violence *only* post-election. If the post-electoral violence was committed uniquely by the strong type, this type would have an incentive to deviate to a level of pre-electoral violence equal to $\hat{e}_s$, which the weak type is not willing to match. In fact, the strong type can signal their its both via $(0, v_s^*)$ and $(\hat{e}_s, 0)$, in both cases pays the cost ω, but by choosing $(\hat{e}_s, 0)$ manages to elect a more favorable candidate, whereas it does not derive any direct benefit from choosing $(0, v_s^*)$, beyond signaling strength. If the post-electoral violence was committed uniquely by the weak type, this type would have an obvious incentive to mimic the strong type, save on the cost of committing violence, and improving the chances of receiving π. Finally, it cannot be that both types choose only post-electoral violence, since the strong type would have an incentive to choose a level of violence that the weak type is unwilling to match.

Once we have ruled out the possibility of having violence both pre-election and post-election, and the possibility of having violence only post-election, we can characterize under what conditions we have either no violence at all, or violence *only pre-election*.

Proposition 3 *There exists an equilibrium where*

(i) $e_s^* = e_w^* = v_s^* = v_w^* = 0$ *iff*

$$\omega \geq (1 - \mu)\hat{\pi} + g_s(\hat{e}_s);$$

(ii) $e_s^* = \hat{e}_s$, $e_w^* = 0$, $v_s^* = v_w^* = 0$ *iff*

$$g_w(\hat{e}_w) \leq \omega \leq \hat{\pi} + g_s(\hat{e}_s);$$

(iii) $e_s^* = \hat{e}_s$, $e_w^* = \hat{e}_w$, $v_s^* = v_w^* = 0$ *iff*

$$g_w(\hat{e}_w) > \omega.$$

When the fixed cost ω is large enough, in equilibrium there is no violence, neither pre nor post election, from neither type of M. Also for the strong type of M, signaling strength is just too costly, with the costs being larger than the net benefit from separating from the weak type.

As the fixed cost ω becomes lower, in equilibrium we always have at least one type, the strong one, choosing a positive level of pre-electoral effort. When the cost is not too small, it is only the strong type of M who now has an incentive to engage in pre-electoral effort, which achieves two objectives: higher probability of electing a favorable candidate, and, by signaling strength, higher probability of receiving π, conditional on the winner.

Finally, as the fixed cost ω becomes low enough, in equilibrium both types engage in pre-electoral effort. The weak type, even if it cannot mimic the strong type, still finds it optimal to choose a positive level of e in order to increase the chances of dealing with a less honest politician, which in turn would imply a higher chance of receiving π.

Once we have characterized the equilibrium behavior of M, we can assess what happens to violence when π increases, once again both in terms of extensive and intensive margin.

Proposition 4 *An increase in π leads to*

(i) a smaller set of parameter values sustaining non-violent equilibrium;

(ii) a larger set of parameter values sustaining the violent equilibria;

(iii) higher level of violence, whenever positive.

As π increases, the conditions for the existence of the non-violent equilibrium become harder and harder to satisfy. The stakes of electing a candidate who is more likely to be intimidated into conceding the economic benefit π become too large, even taking into account the cost of engaging in violence. Additionally, for the same logic, the intensity of the violence also increases as the stakes increase.

While as π increases it becomes more likely to observe pre-electoral effort from M, the level of post-electoral violence is not affected by an increase in the economic benefit M aims to extract. Whenever the level of pre-electoral effort is

positive, the strong type is able to signal strength via that choice, and does not need to resort to the inefficient post-electoral violence.

4.3 Empirical Setting

We now bring our testable predictions to the data. In this section we provide more information about the data and the empirical setting, which is composed by the municipalities of Calabria, Campania and Sicily over the period 2010 to 2020.

Italian municipalities institutional setting. As of 2020, there were 7,903 municipalities in Italy, 1,344 of which were located within the regions of analysis[3], varying considerably by area and population. The institutional structure of these municipalities revolves around the role of the mayor, who heads the local government and leads alongside the legislative body (the local council) and the executive body (the local *giunta*). Both the mayor and the council members are elected by resident citizens. The *giunta* is chaired by the mayor, who appoints its members. Importantly for our setting, local council elections are staggered over time and are not held simultaneously across all municipalities. Mayors may serve a maximum of two consecutive terms, after which a change in government leadership is required. The term of office can last up to five years.
Municipal governments are responsible for numerous civil functions, including the management and provision of social services, transportation, welfare, and public works, as well as local policing. They generate revenue through specific local taxes, particularly property taxes and waste management fees. Additionally, they oversee the issuance of building permits and the management of sewage and waste, tasks which often involve handling substantial financial resources. Finally, municipalities are responsible for the tendering and awarding of public procurement contracts to contractors assigned to carry out various public works.

Measuring Mafia's violence. We collect data from *Avviso Pubblico*, an Italian NGO that systematically records reports of attacks on local Italian politicians. On a daily basis, volunteers from *Avviso Pubblico* consult and log news of attacks on Italian politicians and public officials at all levels of government, sourcing these incidents from national and local newspapers or direct reports to the NGO from firsthand sources.[4] We manually cleaned and coded the data to categorize various forms of threats and violence, capturing nuances in the strategies used by criminal

[3] Of these, 404 were in Calabria, 550 in Campania, and 390 in Sicily.

[4] Daniele and Dipoppa (2017) use the same source, focusing on the years 2010-2014. Importantly, we exclude all episodes that are clearly not linked to mafia violence.

groups to infiltrate political systems. Out of the 1,344 municipalities analyzed, 592 experienced at least one violent incident during the study period, resulting in a total of 1,704 distinct episodes of violence. These episodes of violence vary widely, encompassing actions such as sending bullets by mail, homicide, threatening phone calls, car arson, killing domestic animals, and bombing commercial properties. Figure 4.A.1 in the Appendix shows the frequency of violent episodes by category. The dataset spans the period from 2010 to 2020 across the three Italian regions of interest: Campania, Calabria, and Sicily. From 2010 onward, around 60 percent of all incidents of threats and violence in Italy occurred in these three regions.

Measuring economic opportunity. As outlined above, we measure shocks in economic opportunity by leveraging the unanticipated influx of transfers from the federal government to municipalities in response to earthquakes.

Earthquakes. We use the daily earthquake records from the Italian *National Institute of Geophysics and Volcanology* (INGV)[5], which provide comprehensive coverage of the entire country. This dataset includes precise information on each earthquake's time, epicenter coordinates (longitude and latitude), magnitude, swarm count, and depth.[6] Using latitude and longitude coordinates, we geolocated each earthquake, of magnitude greater or equal to ML 2.5, occurring in the three regions under study for the full period from 2010 to 2020. We then classified as affected by each earthquake all municipalities with territory within a 10 km radius of the earthquake's epicenter. During the study period, we observed 1904 earthquakes, with 989 out of the 1,344 municipalities experiencing at least one earthquake. There is also variation in the number of earthquakes across the regions: among the three regions we focus on, Campania experienced the fewest earthquakes (267), while Sicily experienced the most (1094).

Federal transfers. Our primary data source is Bank of Italy's *Information System of Public Entity Operations* (SIOPE)[7] database, which provides yearly statistics on the public finances of Italian municipalities across various categories.[8] We utilize information from Title 2, where current revenues are recorded. This dataset includes details on transfers received by municipalities from the Federal Government, the Region, the Province, and the European Union. Additionally, we

[5]Istituto Nazionale di Geofisica e Vulcanologia, in Italian.

[6]The data can be accessed here: `https://terremoti.ingv.it/en`. Last accessed on 16th June 2025.

[7]Sistema informativo delle operazioni degli enti pubblici, in Italian.

[8]The data can be accessed here: `https://www.siope.it/Siope/`. Last accessed on 16th June 2025.

have information on whether these transfers are for general use or designated for specific functions and events. Throughout the remainder of this paper, we focus on revenues recorded under category 2101, which represents "Current transfers from the Central State legally restricted to expenditure on natural-disaster relief." These are non-tax, non-capital revenues financing current expenditure subject to this specific restriction. We measure these transfers both in absolute terms (euros) and as a share of total revenues to ensure that changes in this category are not merely accounting shifts between revenue categories. The dataset is structured at the municipal level and covers the period up to 2016.[9]

Control variables. A number of municipal level time-invariant characteristics were obtained from the ISTAT 2011 Census including population, employment rate, vulnerability indicators, share of illiterate individuals among the population aged over 6 years, share of educated individuals, and share of improper dwellings. In most of our specifications, we interact these variables with year fixed effects, to allow for year-specific shocks affecting municipalities with same levels of these variables at baseline.

4.4 Empirical Analysis

4.4.1 Earthquakes and Economic Opportunity

To empirically test whether earthquakes of any magnitude systematically lead to observable increases in transfers, we implement a two-way fixed effects identification strategy. We utilize yearly data from the Bank of Italy's Information System of Public Entity Operations (SIOPE) to measure the amount of additional resources available to municipalities following an earthquake, focusing on budget line 2101, which records current transfers from the Central State for natural disasters.[10] Specifically, we estimate various forms of the following specification:

$$Transfers_{m,t} = \beta_1 Earthquake_{m,t-1} + \delta(X_m \times \gamma_t) + \mu_m \times \lambda_{o(t)} + \gamma_t \times \theta_p + \varepsilon_{m,t} \quad (4.1)$$

Here, $Transfers_{m,t}$ represents either the absolute amount of current transfers received by municipality m in province p from the Central State in year t, or

[9] After 2016, revenue classification changes; thus, for consistency, we restrict our analysis to the 2010–2016 period when examining transfers.

[10] While Italy's National Civil Protection Service (Law 225/1992) provides substantial funding for major earthquakes through formal emergency declarations, our analysis focuses on smaller seismic events that do not trigger such declarations. Large-scale disasters involve intensive central government monitoring and oversight, which may actually reduce criminal organizations' incentives to capture local politicians or resort to violence due to increased scrutiny from national authorities.

the same amount normalized by total municipal revenues. $Earthquake_{m,t-1}$ is a binary indicator equal to one if municipality m experienced at least one earthquake in year $t-1$. This is not an absorbing treatment: we focus on the immediate response in the year following the seismic event, allowing municipalities to move in and out of treatment status across different years in our panel. The model includes municipality-by-legislature fixed effects ($\mu_m \times \lambda_{o(t)}$), which absorb all unobserved heterogeneity across different local government terms. This choice reflects a central concern of our design: the unit of analysis most relevant for understanding the interaction between criminal groups and political institutions is the legislature—the term of office during which a given mayor and council are in power. Because each municipal government represents a distinct political and administrative entity, focusing on within-legislature variation allows us to isolate how shocks—such as earthquakes—alter the strategic incentives of criminal organizations under a given political leadership, holding fixed all time-invariant characteristics of that mandate.

We further control for year-by-province fixed effects ($\gamma_t \times \theta_p$) to account for year-specific shocks that may affect provinces heterogeneously. This is particularly important for our analysis for two reasons. First, Italian regions and provinces vary substantially in their degree of fiscal autonomy, both in tax collection and spending decisions. This variation is most pronounced for the "statuto speciale" regions (including Sicily), which enjoy the highest levels of autonomy in revenue generation and expenditure allocation. Second, each province hosts distinct criminal organizations with different organizational structures, infiltration strategies, and patterns of violence. The vector X_m includes baseline (2011)[11] socio-demographic controls—such as population, employment rate, literacy, education levels, housing quality, and vulnerability indicators—which we interact with year fixed effects to flexibly account for differential trends across municipalities. The idiosyncratic error term is denoted by $\varepsilon_{m,t}$, and standard errors are clustered at the municipal-by-legislature level. For this first part of the analysis, we restrict the sample to the period 2010–2016 due to changes in the reporting of public finance data after 2016, which would otherwise compromise consistency and comparability.[12]

Table 4.1 presents our main specification. Across the different models, the co-

[11]The baseline year is 2011, as this was the earliest year after the start year of the analysis when the Italian National Institute of Statistics (ISTAT) produced a Census.

[12]Additionally, for this part of the analysis we exclude the municipalities of Rodì, Milici, Serradifalco, Paolisi, Capizzi, and Basicò, as their time series in the SIOPE database is incomplete for various reasons.

efficients remain positive, significant, and robust to the inclusion of controls, and the effect size is substantial: in the year following an earthquake, municipalities receive approximately 54% more in current transfers from the Central State for natural disasters.

Table 4.1: The effect of an earthquake on federal transfers

	Dep var: Gov't transfers			
	€k		% tot	
	(1)	(2)	(3)	(4)
Any earthquake	12.92*	8.767*	0.0749**	0.0605**
	(6.740)	(4.473)	(0.0307)	(0.0243)
Observations	7,428	7,428	7,427	7,427
N. municipalities	1,338	1,338	1,338	1,338
Mean	16.28	16.28	0.154	0.154
Municipal x Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Year FE	Yes	Yes	Yes	Yes
Year x Province Dummies	No	Yes	No	Yes

Notes: Table reports two-way fixed effects estimates. The outcome variable is the current transfers from the Central State in absolute value (€) or normalized by municipalities' total revenues (and then multiplied by 100 for ease of interpretation). Any earthquake is a dummy variable taking value one if a municipality experiences an earthquake at time $t-1$. Controls include municipal socio-economic and demographic characteristics and are interacted with year FE. Municipality-by-legislature fixed effects are included. Year by province FE are included in columns 2 and 4. Standard errors are clustered at the municipality-by-legislature level. The units of analysis are municipalities and years. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

We then take the analysis one step further by testing the robustness of our main assumption using a more nuanced measure of earthquake intensity. The main explanatory variable is no longer a simple binary indicator for the occurrence of an earthquake, but instead captures the magnitude of the most disruptive earthquake experienced by each municipality in a given year. The rest of the model specification remains unchanged. Panel A of Table 4.A.1 presents results using the absolute value of current transfers received from the central government as the outcome variable, whereas Panel B uses the same measure normalized by the municipality's total revenues. In both panels, Columns 1 and 2 report estimates for the full sample, while Columns 3 and 4 restrict the sample to only those years in which at least one earthquake occurred, thereby allowing for a cleaner comparison across municipalities affected by earthquakes of varying severity. The consistently positive and statistically significant coefficients across all specifications suggest a clear relationship: the greater the magnitude of the earthquake, the higher the amount of central transfers received. Also the most demanding specifications, focusing on years with earthquakes and including

stringent year-by-province fixed effects, show a positive relationship, although less precise and not statistically significant. This finding reinforces the idea that more severe seismic events attract larger public resources. Importantly, it also supports the hypothesis that higher magnitude earthquakes may increase the potential rents available at the municipal level, thereby amplifying the incentives for criminal organizations to infiltrate local governance structures.

As a final robustness check, we examine whether municipalities dissolved during our analysis period systematically receive more funding for natural disasters than others. While we know from the literature that infiltrated municipalities exhibit different patterns in tax collection and resource allocation compared to non-infiltrated ones, transfers for natural disaster management and post-disaster relief should not be differentially predicted by infiltration status if we consider these events as exogenous shocks. To test this hypothesis, we regress the amount of current transfers received by municipalities in a given legislature on a dummy variable equal to one if the municipality was dissolved during the same legislature due to investigations related to criminal infiltration. Data on municipal dissolutions from 2010 to 2016 are sourced from Di Cataldo and Mastrorocco (2022). Table 4.A.2 reassuringly shows no relationship between dissolution status and the amount of transfers specifically related to natural disasters.

Given these first results, the reader may wonder why we have not implemented an instrumental variable strategy, where we would first instrument economic rents with earthquake incidence to study the effect on violence. The reason lies in the violation of the exclusion restriction in such an analysis. We do not believe, nor we argue, that the random occurrence of earthquakes affects mafia capture solely through federal transfers. However, we posit that most of the effects caused by an earthquake are then translated into some form of business opportunities for the criminal organizations.

4.4.2 Economic Opportunity and Political Violence

In this Section, we test the theoretical predictions of our model using the data described above. We examine the relationship between economic rents available and the probability of observing criminal violence against politicians, demonstrating how variation in earthquake timing relative to electoral cycles generates distinct patterns of violence.

In the spirit of Equation (4.1), we re-estimate the same model using measures of violence as a dependent variable. The new specification will then be as follows:

$$Violence_{m,t} = \beta_1 Earthquake_{m,t} + \delta(X_m \times \gamma_t) + \mu_m \times \lambda_{o(t)} + \gamma_t \times \theta_p + \varepsilon_{m,t} \quad (4.2)$$

where $Violence_{m,t}$ now refers to the number of attacks or threats carried out in municipality m in province p in year t or a dummy equal to one whenever at least one of these episodes was registered. Also here, we cluster standard errors at the municipal-by-legislature level, and include controls interacted with year fixed effects, and a battery of year-by-province and municipality-by-legislature fixed effects. The latter are particularly important here, as they absorb all municipal-by-legislature specific characteristics, including partisan variation in office. Indeed, as shown in Figure 4.A.2, we observe markedly different baseline violence levels against the incumbent (mayor or majority member in the municipal council) depending on whether the mayor belongs to a left, right, centrist, civic, or Five Star Movement list.

Table 4.2 confirms that earthquakes significantly elevate both the frequency and likelihood of violence: a quake increases the annual count of violent episodes by 0.02—approximately a 19 percent rise over the mean—and raises the probability of any violence by 1.4 percentage points.

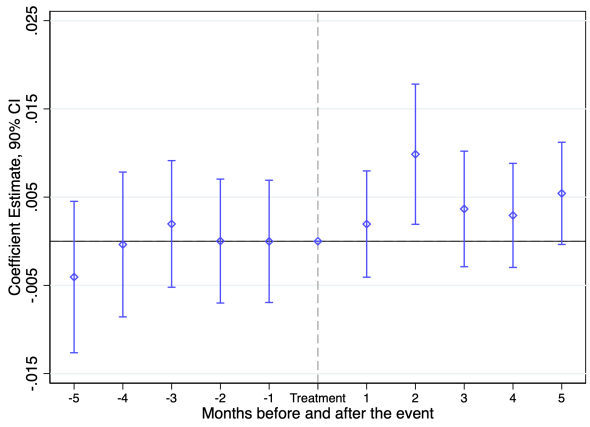
Table 4.2: Economic opportunity and violence

Panel A				
	Dep var: Number of violent episodes			
	(1)	(2)	(3)	(4)
Any earthquake	0.0121	0.0112	0.0176*	0.0214**
	(0.00932)	(0.0103)	(0.0101)	(0.0103)
Observations	14,762	14,259	14,259	14,259
N. municipalities	1,342	1,342	1,342	1,342
Mean	0.116	0.115	0.115	0.115
Municipal Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Municipal x Legislature Dummies	No	Yes	Yes	Yes
Controls x Year FE	No	No	Yes	Yes
Year x Province Dummies	No	No	No	Yes
Panel B				
	Dep var: Dummy for any violence			
	(1)	(2)	(3)	(4)
Any earthquake	0.00859	0.0111*	0.0115*	0.0138**
	(0.00540)	(0.00603)	(0.00605)	(0.00629)
Observations	14,762	14,259	14,259	14,259
N. municipalities	1,342	1,342	1,342	1,342
Mean	0.0742	0.0739	0.0739	0.0739
Municipal Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Municipal x Legislature Dummies	No	Yes	Yes	Yes
Controls x Year FE	No	No	Yes	Yes
Year x Province Dummies	No	No	No	Yes

Notes: Table reports two-way fixed effects estimates. The outcome variables refer to episodes of threat or violence in municipality m in year t (Panel A) or a dummy for any year in which at least one episode is reported (Panel B). Any earthquake is a dummy variable taking value one if a municipality experiences an earthquake in year t. Controls include municipal socio-economic and demographic characteristics and are interacted with year FE in columns 3 and 4. Municipality-by-legislature fixed effects are included from column 2 to 4. Year by province FE are included in column 4. Standard errors are clustered at the municipality-by-legislature level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

The identification assumption relies on the plausible exogeneity of the timing and location of an earthquake with respect to the likelihood of observing threats, violence and intimidation in a given municipality. We test this assumption more formally and rule out anticipatory adjustments by criminal organizations by implementing a month-level event study over a ten-month window around each municipality's first earthquake. The dependent variable is a dummy for any violence taking place, and we control for time and municipality fixed effects, together with socio-economic controls at baseline interacted with time fixed effects. Figure 4.1 displays the event study coefficients and 95% confidence intervals. Estimates reveal no pre-trend in violence and a positive spike two months after the earthquake, with higher levels of violence observed still five months after.

Figure 4.1: The effect of an earthquake on violence – Monthly dynamic analysis



Notes: Event study analysis, with first earthquake occurring in the municipality as treatment. The outcome is a dummy = 1 for the occurrence of any episode of violence. The analysis is conditional to a set of socio-demographic controls interacted with time FE, municipal FE and month-year time FE. The omitted category is the month of the earthquake. The analysis is at the monthly level and we assess a window of 10 months around the earthquake. Standard errors are clustered at municipal-level.

We then propose two-way fixed-effects models at the municipality-legislature level to quantify changes in violence within the mandate, which is a period during which criminal organizations strategically adjust their behavior. Thus, we estimate the following equation:

$$Violence_{m,t} = \beta_1 Earthquake_{m,t} + \delta(X_m \times \gamma_t) + \mu_m + \gamma_t + \varepsilon_{m,t} \tag{4.3}$$

where $Violence_{m,t}$ again refers to either number of violent episodes or a dummy for any violence occurring in municipality m in legislature t. Vector $X_{m,t}$

denotes the same set of control variables measured at baseline as in Section 4.4.1 and interacted with legislature fixed effects. The model is then completed by municipality fixed effects (μ_m) and legislature fixed effects (γ_t). Finally, $\varepsilon_{m,t}$ is an idiosyncratic error term, and we cluster standard errors at the municipal level. Table 4.A.3 presents these baseline results: in terms experiencing at least one earthquake, we observe an average increase of over 0.2 violent episodes over the whole mandate, equivalent to a roughly 60 percent rise relative to the sample mean, and a 6 percentage-point higher likelihood of observing any violence.

To reinforce the link between economic opportunity and incidence of violence, we re-estimate Equations (4.2) and (4.3), substituting the binary earthquake indicator with the magnitude of each earthquake. Tables 4.A.4 and 4.A.5 display the results. Consistent with Proposition 2, higher magnitude shocks significantly increase both the number of violent episodes and the probability of observing any violence the year of the earthquake and within that mandate.

Proposition 2 also predicts that, conditional on violence occurring, its severity should increase. To evaluate this, we fully exploit the richness of *Avviso Pubblico* data and construct a violence severity index going from 1 to 5 according to the following classification:

1. *Low severity*: minor intimidation, threats, or minimal property damage (threatening letters, bullets left at residences or municipal offices, verbal phone threats, graffiti messages, minor vandalism to private or public property, removal or killing of domestic animals without further harm).

2. *Moderate severity*: non-firearm physical assaults (direct physical assaults and assaults in public places without use of firearms).

3. *Moderate–high severity*: arson, incendiary acts, or use of improvised explosive devices (setting fire to vehicles, municipal buildings, or commercial premises; use or discovery of incendiary devices or unexploded ordnance; Molotov-type attacks).

4. *High severity*: shootings or other gun-related violence (shootings at cars, houses, municipal facilities, commercial activities, stray-bullet incidents outside public or private premises).

5. *Very high severity*: bombings, homicides, or other extreme forms of violence (bomb attacks on houses, city halls, commercial establishments, or public in-

frastructure; killing of domestic animals accompanied by graphic messages; other use of explosive devices causing significant harm; homicides).

Focusing on the legislature-level specification outlined in Equation (4.3), we regress the maximum severity score observed during each term on the magnitude of the largest earthquake within that period. Table 4.A.6 documents a positive, statistically significant relationship: larger quakes–hence larger economic shocks–are associated not only to more episodes of violence, but also with more severe attacks. Columns (3) and (4) in Table 4.A.6 restrict the sample to legislatures with at least one earthquake, isolating variation in shock intensity, and reaffirming that stronger shifts in economic opportunity provoke more extreme forms of violence.

Before discussing heterogeneities in timing of economic opportunity arising with respect to the electoral cycle, we propose one last consideration. In fact, a lot of work has been devoted to studying municipal dissolutions due to criminal infiltration in previous literature, so it is natural to ask whether our violence measures are simply capturing this institutional response rather than strategic signaling. As a final check, we test whether violence episodes during earthquake-affected legislatures predict municipal dissolutions for mafia infiltration. Table 4.A.7 presents the results. Across all specifications, we find no significant relationship between violence and dissolutions. Neither the presence of violent episodes nor their intensity predicts dissolution, with coefficients remaining small and statistically insignificant.

4.4.3 Timing of Violence

4.4.3.1 Post-Electoral Period

Crucially, our model predicts these results should be particularly pronounced in post-electoral periods, when mafias can signal their type to the incumbent. We exploit the precise timing of earthquakes relative to electoral cycles to test this prediction more directly. Our theoretical framework indicates that the violence-rent relationship should strengthen in periods distant from elections when only post-electoral motivations operate (Proposition 2).

For this purpose, we focus on earthquakes occurring within two years following municipal elections, when post-electoral incentives dominate. We estimate the legislature-level specification in Equation (4.3), where the main regressor $Earthquake_{m,t}$ now captures both the occurrence and timing of seismic events. Specifically, this variable equals one only in electoral terms where an earthquake

occurred in the two years after municipal elections, and zero otherwise.

The dependent variables also exploit the timing of violence, measuring again violent episodes (count and indicator) in the two years following elections. To address simultaneity concerns, we also examine violence occurring specifically in the second post-election year. Table 4.3 presents the results. The relationship between economic opportunity and violence is positive and highly significant across all specifications in the post-electoral scenario, confirming our theoretical predictions.

Table 4.3: The effect of economic opportunity after elections on violence after elections

	Violent episodes after elections		Any violence after elections	
	2 yrs after	2nd yr after	2 yrs after	2nd yr after
	(1)	(2)	(3)	(4)
Earthquake 2 yrs after	0.0810***	0.0410**	0.0290**	0.0235**
	(0.0297)	(0.0181)	(0.0146)	(0.0115)
Observations	4,305	4,305	4,305	4,305
N. municipalities	1342	1342	1342	1342
Mean	0.170	0.0885	0.0948	0.0557
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	Yes	Yes	Yes	Yes

Notes: Table reports two-way fixed effects estimates. Treatment is a dummy for at least one earthquake occurring in the 2 years after elections. The outcome variables refer to episodes of threat or violence in municipality m in a specific time during legislature t. In columns 1 and 3, the outcome is the count and a dummy for violence occurring in the 2 years after elections. In columns 2 and 4, the outcome is the count and a dummy for violence occurring in the 2nd year after elections. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in all columns. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

4.4.3.2 Pre-Electoral Period

We now turn to testing our theoretical predictions for the pre-electoral scenario presented in Prediction 4.

First, we study the relationship between economic opportunity and violence when the former arises before elections. Table 4.4 demonstrates that earthquakes occurring in the two years before elections significantly increase pre-electoral violence, measured in the 1 or 2 years before. The coefficients are economically meaningful and statistically significant across all specifications. Municipalities experiencing earthquakes before elections exhibit around 69% more violent episodes in the pre-electoral period, with substantial increases in both intensive

and extensive margins of violence. These results directly confirm the theoretical prediction that higher economic stakes π increase pre-electoral effort by criminal organizations, which respond to rent extraction opportunities by intensifying intimidation efforts before elections, when such actions can effectively signal strength and deter political opposition.

Table 4.4: The effect of economic opportunity before elections on violence before elections

	Violent episodes before elections		Any violence before elections	
	1 yr before	2 yrs before	1 yr before	2 yrs before
	(1)	(2)	(3)	(4)
Earthquake 2 yrs before	0.0637***	0.103***	0.0349***	0.0504***
	(0.0235)	(0.0318)	(0.0113)	(0.0127)
Observations	4,305	4,305	4,305	4,305
N. municipalities	1342	1342	1342	1342
Mean	0.0927	0.148	0.0595	0.0848
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	Yes	Yes	Yes	Yes

Notes: Table reports two-way fixed effects estimates. Treatment is a dummy for at least one earthquake occurring in the 2 years before elections. The outcome variables refer to episodes of threat or violence in municipality m in a specific time during legislature t. In columns 1 and 3, the outcome is the count and a dummy for violence occurring in the year before elections. In columns 2 and 4, the outcome is the count and a dummy for violence occurring in the 2 years before elections. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in all columns. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Critically, Table 4.5 shows that pre-electoral economic opportunities generate no spillover effects on post-electoral violence, which is a direct derivation from Proposition 4. All coefficients are statistically indistinguishable from zero, with also point estimates close to zero across specifications.

Table 4.5: The effect of economic opportunity before elections on violence after elections

	Violent episodes after elections		Any violence after elections	
	1 yr after	2 yrs after	1 yr after	2 yrs after
	(1)	(2)	(3)	(4)
Earthquake 2 yrs before	0.00908	0.00484	0.00863	-0.000108
	(0.0250)	(0.0368)	(0.0161)	(0.0187)
Observations	2,948	2,948	2,948	2,948
N. municipalities	1,327	1,327	1,327	1,327
Mean	0.128	0.247	0.0851	0.137
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	Yes	Yes	Yes	Yes

Notes: Table reports two-way fixed effects estimates. Treatment is a dummy for at least one earthquake occurring in the 2 years before elections. The outcome variables refer to episodes of threat or violence in municipality m in a specific time during legislature t. In columns 1 and 3, the outcome is the count and a dummy for violence occurring in the year after elections. In columns 2 and 4, the outcome is the count and a dummy for violence occurring in the 2 years after elections. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in all columns. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

This asymmetry in the relationship between pre-electoral economic opportunity and pre versus post-electoral violence is in line with our model's derivations: when pre-electoral economic opportunity increases, the conditions for a non-violent equilibrium before elections become harder to satisfy; at the same time, whenever the pre-electoral effort is positive, the strong type can simply resort to this, without using any unnecessary post-electoral violence to signal their type to newly elected politicians.

As a final piece of evidence to corroborate our theoretical considerations, we examine how earthquake-induced rent opportunities differentially affect electoral outcomes across parties with varying levels of perceived corruptibility. Our hypothesis is that mafia organizations strategically influence elections through violence to ensure the victory of more corruptible candidates when economic stakes are high.

We classify all candidates in municipal elections between 2010 and 2020 by party type: left wing, right wing, center, civic lists, and—crucially—the Five Star Movement. Founded in October 2009 by Beppe Grillo and Gianroberto Casaleggio, this movement's core platform emphasized anti-corruption and political transparency. The party's founding principles included prohibiting consecutive terms for representatives, disqualification of candidates with criminal

records, and promoting "zero-cost politics", namely the principle according to which politics should not be a source of money neither a career *per se*. Given these groundrules, we hypothesize that Five Star Movement candidates represent less corruptible options from the mafia's perspective. According to our theoretical framework, such candidates should be less likely to win elections when the mafia has an interest in infiltrating the administration–specifically, following earthquakes that increase extractable rents.

We re-estimate Equation (4.2) at the annual level, focusing on election years and the preceding year. The dependent variable is now the probability that a candidate from a specific party wins municipal elections in year t in municipality m. This specification includes election year fixed effects.

Table 4.A.8 presents the results. Five Star Movement candidates are 0.3 percentage points less likely to win elections in the year following an earthquake. This effect is economically significant given the low baseline probability of Five Star victories at the municipal level during this period. These findings suggest that candidates perceived as least corruptible face reduced electoral prospects when mafia organizations have higher economic incentives for political infiltration, consistent with our theoretical predictions.

4.5 Conclusions

This paper has examined the conditions under which organized criminal groups resort to violence against politicians, with particular attention to how the timing of economic opportunities interacts with electoral cycles. Building on a formal theoretical model, we argued that violence is not random but responds systematically to changes in available rents. Specifically, when unexpected inflows of resources expand the stakes of local political control, criminal organizations intensify coercive strategies, choosing between pre-electoral and post-electoral violence depending on the moment in the political cycle. Our empirical analysis, based on earthquakes as exogenous shocks to municipal transfers in southern Italy between 2010 and 2020, provided clear evidence in support of these predictions. We found that municipalities exposed to earthquakes experience significant increases in the frequency of violent episodes targeting politicians, with the timing of these attacks shifting in ways consistent with the theoretical framework. Taken together, these results advance our understanding of the political economy of criminal violence. First, they demonstrate that violence is not an indiscriminate tool of intimidation, but rather a strategic response to economic incentives that can be anticipated and modeled. Second, they show that the availability of economic

rents is central and that electoral timing is critical: when rents emerge before elections, violence is directed at shaping electoral outcomes; when rents emerge after elections, violence is more often directed at pressuring incumbents. This distinction highlights the importance of studying political violence not only as a function of structural conditions such as state weakness or criminal presence, but also as a dynamic process contingent on short-term shifts in opportunity.

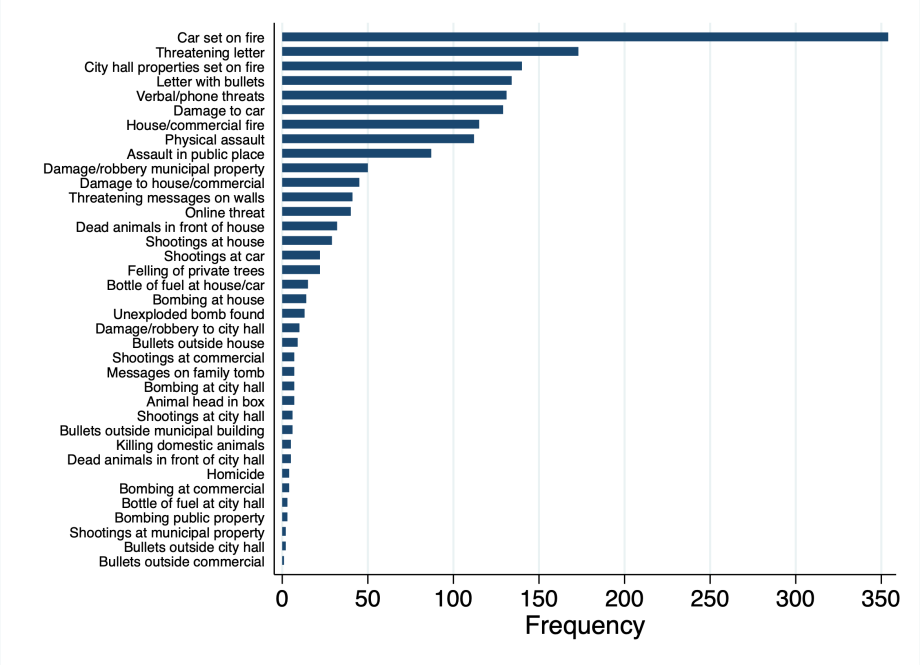
At a broader level, these findings contribute to debates on state capacity, institutional resilience, and the nature of political contestation in contexts where non-state actors wield coercive power. The results suggest that efforts to strengthen democratic institutions cannot focus solely on long-term structural reforms, but must also account for temporary surges in local resources that can alter incentives for violent intervention. Moreover, the evidence underscores the need for policies that mitigate vulnerabilities around elections, when political competition is heightened and the stakes of control are greatest.

Finally, the study invites further research in two directions. Empirically, more work is needed to disentangle the heterogeneity of violent strategies across regions, organizations, and types of political actors, as well as to assess the persistence of effects beyond single electoral cycles. Theoretically, future models could incorporate not only violence but also non-violent mechanisms of influence, in order to capture the full spectrum of strategies available to organized groups. By situating violence within a broader repertoire of political engagement, scholars can better understand how criminal organizations adapt to shifting institutional environments. In sum, this paper highlights that violence against politicians is not an aberration but a calculated strategy shaped by rents, timing, and political incentives. Recognizing this dynamic is essential for designing effective policies that limit opportunities for coercion and safeguard the integrity of democratic institutions.

Appendix 4.A Figures and Tables

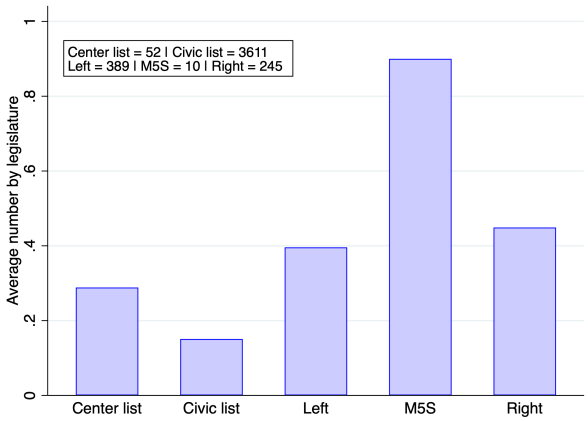
4.A.1 Figures

Figure 4.A.1: *Avviso Pubblico* data



Notes: Absolute frequency of violent episodes reported in the original *Avviso Pubblico* reports by category, 2010-2020.

Figure 4.A.2: Average number of violent episodes against mayor or majority member of the council in legislature, by incumbent party



Note: Average number of violent episodes against mayor or majority member of the municipal council during the legislature, by incumbent party. The incumbent party is the main party of affiliation of the mayor in office. Sample size for each incumbent party in office is shown in the legenda.

4.A.2 Tables

Table 4.A.1: The relationship between magnitude of economic opportunity and transfers

Panel A				
	Dep var: Transfers for disasters (€k)			
	(1)	(2)	(3)	(4)
Magnitude	3.755*	2.456*	2.391*	2.886
	(1.963)	(1.294)	(1.320)	(2.087)
Observations	7,428	7,428	1,383	1,375
N. municipalities	1,338	1,338	472	470
Mean	16.28	16.28	15.59	15.28
Municipal x Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Year FE	Yes	Yes	Yes	Yes
Year x Province Dummies	No	Yes	No	Yes
Sample	All years		Earthquake > 0	
Panel B				
	Dep var: Transfers for disasters (%)			
	(1)	(2)	(3)	(4)
Magnitude	0.0255***	0.0205**	0.0407***	0.0327
	(0.00986)	(0.00816)	(0.0138)	(0.0202)
Observations	7,427	7,427	1,382	1,374
N. municipalities	1338	1338	472	472
Mean	0.154	0.154	0.204	0.203
Municipal x Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Year FE	Yes	Yes	Yes	Yes
Year x Province Dummies	No	Yes	No	Yes
Sample	All years		Earthquake > 0	

Notes: Table reports two-way fixed effects estimates. The outcome variable is the current transfers from the Central State in absolute value (Panel A) or as a fraction of municipality's total revenues and multiplied by 100 for ease of interpretation (Panel B). The main regressor is the magnitude of the most disruptive earthquake happening in the municipality in year $t-1$. Municipal socio-economic controls are interacted with year FE. Municipality-by-legislature fixed effects are included. The sample only includes years with at least one earthquake in the last two columns. Year by province FE are included in columns 2 and 4. Standard errors are clustered at the municipality-by-legislature level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 4.A.2: Dissolutions and transfers for natural disasters

	Dep var: Transfers for disasters			
	€k		%	
	(1)	(2)	(3)	(4)
Dissolution	78.18	73.48	0.155	0.178
	(58.36)	(69.88)	(0.125)	(0.132)
Observations	3,173	3,173	3,172	3,172
N. municipalities	1,337	1,337	1,337	1,337
Mean	69.80	69.80	0.234	0.234
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	No	Yes	No	Yes

Notes: Table reports two-way fixed effects estimates. The outcome variable is the current transfers from the Central State in absolute value (Columns 1 and 2) or as a fraction of municipality's total revenues and multiplied by 100 for ease of interpretation (Columns 3 and 4). Dissolution is a dummy variable taking value one if a municipality is dissolved for criminal infiltration during the legislature. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in columns 2 and 4. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 4.A.3: The effect of economic opportunity on violence – Legislature level

	Violent episodes		Any violence	
	(1)	(2)	(3)	(4)
Any earthquake	0.249***	0.232***	0.0597***	0.0597***
	(0.0581)	(0.0493)	(0.0154)	(0.0156)
Observations	4,305	4,305	4,305	4,305
N. municipalities	1,342	1,342	1,342	1,342
Mean	0.399	0.399	0.179	0.179
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	No	Yes	No	Yes

Notes: Table reports two-way fixed effects estimates. The outcome variables refer to episodes of threat or violence in municipality m at time t. Any earthquake is a dummy variable taking value one if a municipality experiences an earthquake in the legislature. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in columns 2 and 4. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 4.A.4: Magnitude of economic opportunity and occurrence of violence – Year level

	Violent episodes		Any violence	
	(1)	(2)	(3)	(4)
Magnitude	0.00537	0.00675**	0.00398**	0.00459**
	(0.00332)	(0.00337)	(0.00202)	(0.00208)
Observations	14,259	14,259	14,259	14,259
N. municipalities	1,342	1,342	1,342	1,342
Mean	0.115	0.115	0.0739	0.0739
Municipal x Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Year FE	Yes	Yes	Yes	Yes
Year x Province Dummies	No	Yes	No	Yes

Notes: The outcome variables refer to episodes of threat or violence in municipality m at time t. Magnitude is a variable taking the value of the most disruptive earthquake happening in the municipality in year t. Controls include municipal socio-economic and demographic characteristics, interacted with year FE. Municipality-by-legislature FE are included in all specifications, while year-by-province FE in columns 2 and 4. Standard errors are clustered at the municipality-by-legislature level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 4.A.5: Magnitude of economic opportunity and occurrence of violence – Legislature level

	Violent episodes		Any violence	
	(1)	(2)	(3)	(4)
Magnitude	0.0761***	0.0733***	0.0181***	0.0179***
	(0.0175)	(0.0154)	(0.00483)	(0.00487)
Observations	4,305	4,305	4,305	4,305
N. municipalities	1,342	1,342	1,342	1,342
Mean	0.399	0.399	0.179	0.179
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	No	Yes	No	Yes

Notes: The outcome variables refer to episodes of threat or violence in municipality m at time t. Magnitude is a variable taking the value of the most disruptive earthquake happening in the municipality during the legislature. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in columns 2 and 4. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 4.A.6: Magnitude of economic opportunity and severity of violence

	Dep var: Violence severity index			
	(1)	(2)	(3)	(4)
Magnitude	0.0617***	0.0622***	0.133**	0.123*
	(0.0150)	(0.0151)	(0.0645)	(0.0671)
Observations	4,305	4,305	1,653	1,653
N. municipalities	1342	1342	666	666
Mean	0.447	0.447	0.482	0.482
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	No	Yes	No	Yes
Sample	All legislatures		Earthquake > 0	

Notes: The outcome variable refers to episodes of threat and violence in municipality m during legislature t. The severity index takes value = 1 for Low Severity (minor intimidation, threats, and low-level property damage), 2 for Moderate Severity (non-firearm direct physical assault), 3 for Moderate–High Severity (arson, incendiary acts, explosive potential), 4 for High Severity (shootings and gun-related violence), and 5 for Very High Severity (bombings, homicide, extreme violence). Magnitude is a variable taking the value of the most disruptive earthquake happening in the municipality during the legislature. In the last two columns, the sample is restricted to only municipality-by-legislature observations in which we observe at least one earthquake taking place. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in column 2 and 4. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 4.A.7: Violence and dissolutions in legislatures with earthquakes

	Dep var: Dummy for dissolution			
	(1)	(2)	(3)	(4)
Any violence	0.0118	0.00556		
	(0.0325)	(0.0335)		
Violent episodes			-0.00229	-0.0125
			(0.0116)	(0.0140)
Observations	949	949	949	949
N. municipalities	458	458	458	458
Mean	0.0263	0.0263	0.0263	0.0263
Municipal Dummies	Yes	Yes	Yes	Yes
Legislature Dummies	Yes	Yes	Yes	Yes
Controls x Legislature FE	No	Yes	No	Yes

Notes: The outcome variable is a dummy = 1 whenever the municipality was dissolved during the legislature. The regressors are either a dummy for any violence perpetrated during the legislature (Columns 1 and 2) or the count of these episodes (Columns 3 and 4). The sample is restricted to legislatures with at least 1 earthquake. Controls include municipal socio-economic and demographic characteristics and are interacted with legislature FE in column 2 and 4. Municipality and legislature fixed effects are included. Standard errors are clustered at the municipal level. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Table 4.A.8: The effect of economic opportunity on winning parties

	(1) Left wins	(2) Right wins	(3) Center wins	(4) M5S wins	(5) Civic list wins
Any earthquake	0.116	0.299	0.102	-0.252**	-0.264
	(0.442)	(0.295)	(0.188)	(0.115)	(0.532)
Observations	7,432	7,432	7,432	7,432	7,432
N. municipalities	1,342	1,342	1,342	1,342	1,342
Mean	2.287	1.130	0.215	0.135	34.07
Municipal Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes
Controls x Year FE	Yes	Yes	Yes	Yes	Yes
Municipal Elections FE	Yes	Yes	Yes	Yes	Yes

Notes: Table reports two-way fixed effects estimates. The outcome variables is the likelihood that in year t the indicated party wins an election in municipality m. The main regressor is a dummy taking value one if the municipality experiences an earthquake in $t-1$. Controls include municipal socio-economic and demographic characteristics and are interacted with year FE in all columns. Municipality and year fixed effects are included. Standard errors are clustered at the municipal level. The units of analysis are municipalities and year. Sample is restricted to only municipality-year observations in the 24 months before an election. p-value < 0.1 *, < 0.05 **, < 0.01 ***.

Appendix 4.B Appendix - Formal Results

Lemma 3 *If $\omega < (1-\mu)\hat{\pi}$, there does not exists a no-violence equilibrium that satisfies the Intuitive Criterion.*

Proof: Suppose that $\omega < (1-\mu)\hat{\pi}$, and that such an equilibrium exists. Since $\omega < (1-\mu)\hat{\pi}$, by the Intermediate Value Theorem, for a type $i \in \{w, s\}$, there exists a $\underline{v}_i(0)$ that solves the following

$$\pi\left(\frac{\hat{\gamma}+h-\varepsilon_j}{2h}\right) = \pi\left(\frac{\gamma_s+h-\varepsilon_j}{2h}\right) - k_i(v') - \omega.$$

It is easy to see that $\underline{v}_s(0) > \underline{v}_w(0)$. Therefore, for any $v' \in (\underline{v}_w(0), \underline{v}_s(0))$, deviating from $v = 0$ to v' is equilibrium dominated for the weak type, while it is not for the strong type. As such, in any equilibrium that satisfies the Intuitive Criterion, M has to believe that M is strong after seeing $v' \in (\underline{v}_w(0), \underline{v}_s(0))$. But then, in any such equilibrium, the strong type would have an incentive to deviate from $v = 0$ to any $v' \in (\underline{v}_w(0), \underline{v}_s(0))$, thus establishing a contradiction. ■

Lemma 4 *In any separating equilibrium, $v_w^* = 0$.*

Proof: Suppose not, and there exists a separating equilibrium where $v_w^* > 0$. If the weak type of M were to deviate to $0 < v' < v_w^*$, the worst possible payoff it would receive is

$$\pi\left(\frac{\gamma_w+h-\varepsilon_j}{2h}\right) - k_w(v') - \omega,$$

whereas in equilibrium it receives

$$\pi\left(\frac{\gamma_w+h-\varepsilon_j}{2h}\right) - k_w(v_w^*) - \omega.$$

It is easy to notice that the only difference is in the cost of violence, with $k_w(v') < k_w(v_w^*)$, implying that the weak type of M has an incentive to deviate, thus establishing a contradiction. ■

Lemma 5 *In any separating equilibrium, $v_s^* = \overline{v}_w(0)$.*

Proof: Suppose not, and there exists a separating equilibrium with $v_s^* \neq \overline{v}_w(0)$. Suppose first $v_s^* = v' < \overline{v}_w(0)$. By Lemma 4, we know $v_w^* = 0$. In this case, by definition of $\overline{v}_w(0)$, the weak type has an incentive to deviate and choose v' as well, a contradiction. Suppose now that $v_s^* = v' > \overline{v}_w(0)$. For any off-the-equilibrium violence level $v'' \in (\overline{v}_w(0), v')$, notice that v'' is equilibrium dominated for the

weak type (by definition of $\overline{v}_w(0)$), while it is not for the strong type. In fact, by choosing v'', the highest payoff the strong type can receive is

$$\pi\left(\frac{\gamma_s + h - \varepsilon_j}{2h}\right) - k_s(v'') - \omega,$$

whereas in equilibrium it receives

$$\pi\left(\frac{\gamma_s + h - \varepsilon_j}{2h}\right) - k_s(v') - \omega.$$

The only difference is in the cost of violence, with $k_s(v'') < k_s(v')$, implying that any off-the-equilibrium violence level v'' is not equilibrium dominated for the strong type of M. As such, the Incumbent's posterior belief after observing an off-the-equilibrium violence level $v'' \in (\overline{v}_w(0), v')$ is $\mu(v'') = 1$. Therefore, the minimal utility level the strong type of M can achieve from choosing an off-the-equilibrium violence level v'' is larger that its equilibrium payoff, again because $k_s(v'') < k_s(v')$. This means that the equilibrium posited does not survive the Intuitive criterion, establishing a contradiction. ■

Proof of Proposition 1: For part (i), suppose the Incumbent is from party j. Suppose there exists a non-violent equilibrium, where both types of M choose $v_w^* = v_s^* = 0$. After observing $v = 0$, the Incumbent believes that M is strong with probability $\mu(0) = \mu$. Suppose that, upon observing $v > 0$, the Incumbent believes that M is strong with probability $\hat{\mu}(v) = 1$. For a type i not to have an incentive to deviate to a $v' > 0$ we need

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_j}{2h}\right) \geq \pi\left(\frac{\gamma_s + h - \varepsilon_j}{2h}\right) - k_i(v') - \omega$$

which becomes

$$k_i(v') + \omega \geq \frac{\pi}{2h}\Big(\gamma_s - \mu\gamma_s - (1-\mu)\gamma_w\Big)$$

and further simplifies to

$$k_i(v') + \omega \geq (1-\mu)\hat{\pi}.$$

If $\omega \geq (1-\mu)\hat{\pi}$, even if v' would lead Incumbent to believe M is strong, no type has an incentive to deviate.

For part (ii), suppose such an equilibrium exists. For the weak type not to have an incentive to deviate to $v' < \overline{v}_w$, it has to be that, denoting by $\mu(v')$ the posterior belief of the Incumbent following v',

$$\pi\left(\frac{\gamma_w + h - \varepsilon_j}{2h}\right) \geq \pi\left(\frac{\mu(v')\gamma_s + (1-\mu(v'))\gamma_w + h - \varepsilon_j}{2h}\right) - k_w(v') - \omega$$

which reduces to

$$\mu(v') \leq \frac{k_w(v') + \omega}{\hat{\pi}}$$

.

It is also easy to see that the weak type does not have an incentive to deviate to $v = \overline{v}_w$, since the weak type is indifferent between pooling with the strong type by choosing $v = \overline{v}_w$ and choosing $v = 0$ with $\mu(0) = 0$. Again, by the definition of $\overline{v}_w$, the weak type receives a strictly lower payoff from choosing any $v' > \overline{v}_w$ then choosing $v = 0$, even if $\mu(v') = 1$ and $\mu(0) = 0$.

Finally, for the strong type, since $\overline{v}_w(0) < \overline{v}_s(0)$, there is no incentive to deviate to choosing $v = 0$ with $\mu(0) = 0$. For the strong type not to have an incentive to deviate to $v' < \overline{v}_w(0)$, it has to be that, denoting by $\mu(v')$ the posterior belief of the Incumbent following v',

$$\pi\left(\frac{\gamma_s + h - \varepsilon_j}{2h}\right) - k_s(\overline{v}_w) - \omega \geq \pi\left(\frac{\mu(v')\gamma_s + (1 - \mu(v'))\gamma_w + h - \varepsilon_j}{2h}\right) - k_s(v') - \omega$$

which reduces to

$$\mu(v') \leq 1 - \frac{k_s(\overline{v}_w(0)) - k_s(v')}{\hat{\pi}}$$

. Last, the strong type receives a strictly lower payoff from choosing any $v' > \overline{v}_w(0)$ then choosing $v = \overline{v}_w(0)$, even if $\mu(v') = \mu(\overline{v}_w(0)) = 1$, since $k_s(v)$ is increasing in v. ■

Proof of Proposition 2: For the first part, it is easy to see that $\hat{\pi}$ and $\overline{\omega}$ are both increasing in π, implying that the condition for existence of the violent equilibrium, i.e. $\omega < \overline{\omega}$, and the condition for existence of the non-violent equilibrium, i.e. $\omega > \hat{\pi}$, become, respectively, easier and harder to satisfy.
For the second part, by applying the Implicit Function Theorem to (4.2.1), we have

$$\frac{d\overline{v}_w}{d\pi} = -\frac{-(\gamma_s - \gamma_w)}{k'(v)} > 0.$$

■

Proof of Lemma ??: Suppose not, and there exists an equilibrium where $v_s^* = v_w^* > 0$. We have two cases, $e_s^* \neq e_w^*$ and $e_s^* = e_w^*$. Suppose first that $e_s^* \neq e_w^*$. Then, upon seeing (e_w^*, v_w^*), the winner knows she is dealing with the weak type of M. Then, the weak type has an incentive to deviate to $(e_w^*, 0)$. In fact, in the worst case, the winner believes that M is weak with probability 1 after observing an off-the-path-profile $(e_w^*, 0)$. Yet, the weak type achieves a higher expected utility after this deviation, since the probability of electing candidate A and,

conditional on the winner, the probability of obtaining π are unaffected, and the cost of violence after the election is lower.

Suppose second that $e_s^* = e_w^*$. In equilibrium, the strong and the weak type receive respectively:

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_B}{2h}\right) + \Phi(r(e_w^*))\Delta - k_s(e_w^*) - k_s(v_w^*) - 2\omega$$

and

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_B}{2h}\right) + \Phi(r(e_w^*))\Delta - k_w(e_w^*) - k_w(v_w^*) - 2\omega$$

Now,$\underline{v}_s(e_s^*)$ and $\underline{v}_w(e_w^*)$ make the strong and the weak type respectively indifferent between what they receive in equilibrium and what they would get by choosing respectively $\underline{v}_s(e_s^*)$ and $\underline{v}_w(e_w^*)$ inducing a posterior belief for the winner that M is strong with probability 1.

That is, $\underline{v}_s(e_s^*)$ and $\underline{v}_w(e_w^*)$ solve respectively,

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_B}{2h}\right) + \Phi(r(e_s^*))\Delta - k_s(e_s^*) - k_s(v_s^*) - 2\omega =$$
$$\pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(e_s^*))\Delta - k_s(e_s^*) - k_s(\underline{v}_s(e_s^*)) - 2\omega$$

and

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_B}{2h}\right) + \Phi(r(e_w^*))\Delta - k_w(e_w^*) - k_w(v_w^*) - 2\omega =$$
$$\pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(e_w^*))\Delta - k_w(e_w^*) - k_w(\underline{v}_w(e_w^*)) - 2\omega$$

We obtain that

$$(1 - \mu)\hat{\pi} = k_s(\underline{v}_s(e_s^*)) - k_s(v_w^*)$$

and

$$(1 - \mu)\hat{\pi} = k_w(\underline{v}_w(e_w^*)) - k_w(v_w^*)$$

Then we have that

$$k_s(\underline{v}_s(e_s^*)) - k_s(v_w^*) = k_w(\underline{v}_w(e_w^*)) - k_w(v_w^*) \tag{4.4}$$

We want to show that $\underline{v}_s(e_s^*) > \underline{v}_w(e_w^*)$. Suppose not and $\underline{v}_s(e_s^*) \leq \underline{v}_w(e_w^*)$. Then, from (4.4), we can write,

$$k_w(\underline{v}_w(e_w^*)) - k_w(v_w^*) = k_s(\underline{v}_s(e_s^*)) - k_s(v_w^*) \leq k_s(\underline{v}_w(e_w^*)) - k_s(v_w^*)$$

Hence,

$$k_w(\underline{v}_w(e_w^*)) - k_w(v_w^*) \leq k_s(\underline{v}_w(e_w^*)) - k_s(v_w^*),$$

which contradicts that $k'_w(v) > k'_s(v)$ for all $v > 0$.

Since $\underline{v}_s(e^*_s) > \underline{v}_w(e^*_w)$, then for all $v' \in (\underline{v}_w(e^*_w), \underline{v}_s(e^*_s))$, a deviation to (e^*_w, v') is equilibrium dominated for the weak type, but not the strong type. Thus, following from the definition of $\underline{v}_s(e^*_s)$, the strong type has an incentive to deviate to any $v' \in (\underline{v}_w(e^*_w), \underline{v}_s(e^*_s))$. ■

Proof of Lemma ??: Suppose not, and suppose first there exists an equilibrium where the winner learns M's type and $e^*_w \neq \hat{e}_w$. If the winner knows the type of M when she moves, then, for any given v_w, by definition, $\hat{e}_w$ is the level of e that maximizes the expected utility for the weak type. So now suppose that $e^*_w = \hat{e}_w$ but $v^*_w \neq 0$. Then, the weak type would have an incentive to deviate to $v^*_w = 0$. In the worst case scenario, the winner believes, upon seeing an off-the-path profile $(\hat{e}_w, 0)$ that M is weak with probability 1. Then, fixing $\hat{e}_w$, choosing $v^*_w \neq 0$ or 0 does not affect the probability of electing candidate A or the probability of obtaining π, conditional on a winner from either party A or B. But the, given that $k_w(\hat{e}_w) > 0 = k_w(0)$, the weak type has an incentive to deviate from any $v^*_w \neq 0$ to 0. ■

Lemma 6 *For $i \in \{w, s\}$, $g_i(\hat{e}_i) > 0$, and $g_s(\hat{e}_s) > g_w(\hat{e}_w) > 0$.*

Proof: By definition, $g_i(e) = \Delta\Big(\Phi(r(e)) - \frac{1}{2}\Big) - k_i(e)$. At $e = 0$ we have that $g_i(e) = 0$, since $\Phi(r(0)) = \frac{1}{2}$ and $k_i(0) = 0$. Taking the derivative with respect to e we have,

$$\Delta\phi(r(e)) - k'_i(e).$$

Now,

$$\lim_{e \to 0^+} \Delta\phi(r(e)) - k'_i(e) > 0$$

since $k'_i(0) = 0$ and $\phi(r(e)) > 0$ for all e.

Also, $g_i(e)$ is strictly concave,

$$\Big(\phi'(r(e))(r'(e))^2 + \phi(r(e))r''(e)\Big)\Delta - k''_i(e) < 0.$$

Therefore, since $g_i(e)$ is increasing as $e \to 0$ and is strictly concave, given that $g_i(\hat{e}_i)$ is maximized at $\hat{e}_i$, it must be that $g_i(\hat{e}_i) > 0$.

For the second part, by optimality of $\hat{e}_s$ we have

$$g_s(\hat{e}_s) > g_s(\hat{e}_w),$$

and since $k_w(e) > k_s(e)$ for all e, we have

$$g_s(\hat{e}_w) > g_w(\hat{e}_w),$$

thus obtaining

$$g_s(\hat{e}_s) > g_s(\hat{e}_w) > g_w(\hat{e}_w),$$

which establishes the result. ■

Lemma 7 *When both exist,* $\underline{e}_s(0) > \underline{e}_w(0)$.

Proof: By definition, we have

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta = \pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\underline{e}_w(0)))\Delta - k_w(\underline{e}_w(0)) - \omega$$

and

$$\pi\left(\frac{\hat{\gamma} + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta = \pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\underline{e}_s(0)))\Delta - k_s(\underline{e}_s(0)) - \omega$$

Combining these expressions we obtain

$$\Phi(r(\underline{e}_s(0)))\Delta - k_s(\underline{e}_s(0)) = \Phi(r(\underline{e}_w(0)))\Delta - k_w(\underline{e}_w(0)),$$

which can be expressed as

$$g_s(\underline{e}_s(0)) = g_w(\underline{e}_w(0))$$

Recall that $\underline{e}_i(0) > \hat{e}_i$, for $i \in \{w, s\}$. As such, $g_i'(\underline{e}_i(0)) < 0 = g_i'(\hat{e}_i)$.

$$g_s(\underline{e}_s(0)) = g_w(\underline{e}_w(0)) < g_s(\underline{e}_w(0)),$$

implying that $\underline{e}_s(0) > \underline{e}_w(0)$. ■

Lemma 8 *If* $\underline{v}_w(0)$ *exists, then there does not exist an equilibrium where* $e_s^* = e_w^*$ *and* $v_s^* = v_w^*$.

Proof: Suppose such an equilibrium exists and $\underline{v}_w(0)$ exists. Since $\underline{v}_s(0) > \underline{v}_w(0)$, any (e_w^*, v) with $v \in (\underline{v}_w(0), \underline{v}_s(0))$ is equilibrium dominated for the weak type, but not for the strong type. Therefore, upon observing an off-the-path pair (e_w^*, v), the winner will place probability 1 on such deviation coming from the strong type, who at that point has a profitable deviation to (e_w^*, v), since $v < \underline{v}_s(0)$, establishing a contradiction. ■

Lemma 9 *Consider a strategy profile where the strong type chooses* $(\hat{e}_s, 0)$. *The strong type does not have an incentive to deviate to any* $(0, v)$.

Proof: In a strategy profile where the strong type chooses $(\hat{e}_s, 0)$, it must be $\mu(\hat{e}_s, 0) = 1$, by Assumption 1. In the best case scenario, also $\mu(0, v) = 1$. For the strong type to have an incentive to deviate, it must be

$$\pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\hat{e}_s))\Delta - k_s(\hat{e}_s) - \omega > \pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta - k_s(v) - \omega$$

which becomes

$$g_s(\hat{e}_s) < -k_s(v)$$

, which contradicts Lemma 6 ■

Proof of Lemma 2: Suppose there exists an equilibrium where the $e_s^* = e_w^* = 0$ and $v_s^* > 0 = v_w^*$. Any $v_s^* \neq \overline{v}_w(0)$ would violate the Intuitive Criterion. Suppose then there exists an equilibrium where the $e_s^* = e_w^* = 0$ and $v_s^* = \overline{v}_w(0) > v_w^* = 0$. Since $\hat{e}_s > \overline{v}_w(0)$, to satisfy the Intuitive Criterion it must be that $\mu(\hat{e}_s, 0) = 1$. For the strong type not to have an incentive to deviate, we must have

$$\pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta - k_s(\overline{v}_w(0)) - \omega \geq \left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\hat{e}_s))\Delta - k_s(\hat{e}_s) - \omega$$

which becomes

$$-k_s(\overline{v}_w(0)) \geq g_s(\hat{e}_s)$$

which cannot hold, since $k_s(\overline{v}_w(0)) > 0$ and $g_s(\hat{e}_s) > 0$.

Suppose now there exists an equilibrium where the $e_s^* = e_w^* = 0$ and $v_w^* > 0$ and $v_s^* > 0$. If $v_w^* \neq v_s^* > 0$, then the weak type has an incentive to deviate to $(0, 0)$, since int he worst case scenario the deviation will be interpreted as coming from the weak type, but even in this case the weak type would receive a strictly higher level of expected utility than in equilibrium. If $v_w^* = v_s^* > 0$, then there exists a $\overline{v}_w(v_w^*)$ that makes the weak type indifferent between sticking with the equilibrium strategy profile, or deviating to $\overline{v}_w(v_w^*)$ provided that this deviation will be interpreted as coming from the strong type. However, similarly defined $\overline{v}_s(v_w^*)$ for the strong type will be larger, implying that any $v \in (\overline{v}_w(v_w^*), \overline{v}_s(v_w^*))$ will be equilibrium dominated for the weak type, and hence the posterior belief after any such deviation will be 1. This in turn implies that the strong type has a strict incentive to deviate.

Finally, suppose there exists an equilibrium where the $e_s^* = e_w^* = 0$ and $v_w^* > 0 = v_s^*$. Clearly, the weak type has a strict incentive to mimic the strong type. ■

Proof of Proposition 3: For part (i), suppose you have a an equilibrium where $e_s^* = e_w^* = v_s^* = v_w^* = 0$.

In equilibrium, both types' expected utility is

$$\pi\left(\frac{\hat{\gamma}+h-\varepsilon_B}{2h}\right)+\frac{1}{2}\Delta$$

By Lemma 8, it must be that $\underline{v}_w(0)$ does not exist. Hence, it must be that

$$\omega + k_w(v) \geq (1-\mu)\hat{\pi}$$

for all $v > 0$, which, since $k_w(0) = k'_w(0) = 0$, implies that

$$\omega \geq (1-\mu)\hat{\pi}.$$

Next, we consider two cases: $\underline{e}_w(0)$ exists or it does not exist.

If it does not $\underline{e}_w(0)$ exist, then any $(e, 0)$ with $e > 0$ would be equilibrium dominated for the weak type. As a consequence, for $e_s^* = e_w^* = v_s^* = v_w^* = 0$ to be part of an equilibrium that survives the Intuitive Criterion, it must be also that $\underline{e}_s(0)$ does not exist, otherwise the strong type would have an incentive to deviate, say to $\hat{e}_s$. Thus, it must be that

$$\pi\left(\frac{\hat{\gamma}+h-\varepsilon_B}{2h}\right)+\frac{1}{2}\Delta > \pi\left(\frac{\gamma_s+h-\varepsilon_B}{2h}\right)+\Phi(r(\hat{e}_s))\Delta - k_s(\hat{e}_s)-\omega$$

which becomes

$$\omega > (1-\mu)\hat{\pi} + g_s(\hat{e}_s).$$

If $\underline{e}_w(0)$ does exist, then we know it is smaller than $\hat{e}_s$. Thus a deviation to $(\hat{e}_s, 0)$ would be equilibrium dominated for the weak type. For the equilibrium to survive the Intuitive Criterion, it would have to be that the strong type does not have an incentive to deviate to $(\hat{e}_s, 0)$, which is true if

$$\omega > (1-\mu)\hat{\pi} + g_s(\hat{e}_s),$$

which however would imply that $\underline{e}_w(0)$ does not exist.

Therefore, it must be that $\underline{e}_s(0)$ does not exist, which implies that $\underline{e}_w(0)$ does not exist either. Since by Lemma 6 $g_s(\hat{e}_s) > g_w(\hat{e}_w)$, the relevant condition for the existence of the equilibrium in question is

$$\omega > (1-\mu)\hat{\pi} + g_s(\hat{e}_s),$$

which establishes the result.

For part (ii), the weak type does not have an incentive to pool with the strong type since $\hat{e}_s > \overline{e}_w(\hat{e}_w)$. Notice that for the strong type, by Lemma 9 and optimality

of $\hat{e}_s$, any deviation to (e, v), for $(e, v) \neq (0, 0)$, is equilibrium dominated, and thus there is no incentive to deviate. Therefore, beliefs for any off-the-path pair $(e, v) \neq (0, 0)$ must be $\alpha(e, v) = 0$. This, in turn, implies that the weak type has no incentive to deviate to any $(e, v) \neq (0, 0)$.

Consider now a deviation $(0, 0)$. Such a deviation is equilibrium dominated for the strong type if

$$\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\hat{e}_s))\Delta - k_s(\hat{e}_s) - \omega > \pi\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta$$

which becomes

$$g_s(\hat{e}_s) > \omega$$

If $g_s(\hat{e}_s) > \omega$, then to satisfy the Intuitive Criterion the posterior belief after observing $(0, 0)$ must be $\mu(0, 0) = 0$. Then, for the weak type not to have an incentive to deviate to $(0, 0)$, we must have

$$\left(\frac{\gamma_w + h - \varepsilon_B}{2h}\right) + \Phi(r(\hat{e}_w))\Delta - k_w(\hat{e}_w) - \omega \geq \pi\left(\frac{\gamma_w + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta$$

which becomes

$$g_w(\hat{e}_w) \geq \omega$$

If instead $g_s(\hat{e}_s) \leq \omega$, then a deviation to $(0, 0)$ is equilibrium dominated for the strong type. For the weak type not to have an incentive to deviate it must be

$$\left(\frac{\gamma_w + h - \varepsilon_B}{2h}\right) + \Phi(r(\hat{e}_w))\Delta - k_w(\hat{e}_w) - \omega \geq \pi\left(\frac{\mu(0,0)\gamma_s(1 - \mu(0,0))\gamma_w + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta$$

which becomes

$$g_w(\hat{e}_w) \geq \mu(0, 0)\hat{\pi} + \omega$$

which cannot hold, since $g_w(\hat{e}_w) < g_s(\hat{e}_s) \leq \omega$. Thus, it must be $g_s(\hat{e}_s) > g_w(\hat{e}_w) \geq \omega$.

Finally, for part (iii), any deviation to $(e, 0)$, with $e > 0$, is equilibrium dominated for the strong type. By Lemma 9, any deviation to $(0, v)$, with $v > 0$, is also is equilibrium dominated for the strong type.

The last deviation to check for the strong type is the one to $(0, 0)$. For the strong type not to have an incentive to deviate, we must have

$$\left(\frac{\gamma_s + h - \varepsilon_B}{2h}\right) + \Phi(r(\hat{e}_s))\Delta - k_s(\hat{e}_s) - \omega \geq \pi\left(\frac{\gamma_w + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta$$

which becomes

$$\hat{\pi} + g_s(\hat{e}_s) \geq \omega.$$

To satisfy the Intuitive Criterion, it must be that for any $(e, v) \neq (\hat{e}_s, 0)$, $\mu(e, 0) = 0$. Then, for the weak type not to have a profitable deviation to $(\hat{e}_w, 0)$, it must be that,

$$\left(\frac{\gamma_w + h - \varepsilon_B}{2h}\right) + \Phi(r(\hat{e}_w))\Delta - k_w(\hat{e}_w) - \omega \leq \pi\left(\frac{\gamma_w + h - \varepsilon_B}{2h}\right) + \frac{1}{2}\Delta$$

which becomes

$$g_w(\hat{e}_w) \leq \omega.$$

Any other deviation to $(0, v)$ is also not profitable. ■

Proof of Proposition 4: For part (i), notice that $\hat{\pi} \equiv \pi\frac{\gamma_s - \gamma_w}{2h}$ and so it is increasing in π. Similarly, $g_s(\hat{e}_s)$ is increasing in π, since

$$\frac{dg_s(\hat{e}_s)}{d\pi} = \frac{\varepsilon_B - \varepsilon_A}{2h}\left(\Phi(r(\hat{e}_s)) - \frac{1}{2}\right) + \left(\Delta\phi(r(\hat{e}_s))r'(\hat{e}_s) - k_s'(\hat{e}_s)\right)\frac{d\hat{e}_s}{d\pi} = \frac{\varepsilon_B - \varepsilon_A}{2h}\left(\Phi(r(\hat{e}_s)) - \frac{1}{2}\right).$$

For part (ii), notice that a violent equilibrium exists as long as $\omega \leq \hat{\pi} + g_s(\hat{e}_s)$, and, as we just showed, $\hat{\pi} + g_s(\hat{e}_s)$ is increasing in π.

For the last part, notice that both $\hat{e}_s$ and $\hat{e}_w$ are increasing in π. ■

Chapter 5

General Conclusion

This thesis examined three interconnected dimensions of how economic and environmental shocks shape criminal and political behavior. The three main central chapters explored criminal organizations' responses to climate shocks, voter reactions to the green transition on the labor market, and the strategic timing of violence by criminal groups. This concluding chapter summarizes the key findings and discusses their policy implications.

Chapter 2 demonstrated how climate shocks create new pathways for criminal expansion through resource scarcity and labor market disruptions. Using novel data on Mexican drug cartels' activities from 2010 to 2022, the study shows that droughts increase cartel activity by reducing legal employment opportunities for potential recruits. This effect weakens in municipalities with strong agricultural migration networks but intensifies in strategic smuggling locations. Importantly, in areas suitable for illicit crop cultivation, droughts have no effect on criminal activity, as in these places water scarcity can also undermine revenues from illegal agriculture. However, these same areas see surges in water concession volumes following a drought, but only where cartels are already established, suggesting targeted resource capture by criminal groups through policy manipulation. These findings point to two policy priorities. First, governments should design climate-resilient employment programs for young people in drought-prone areas where state capacity is weak and organized crime is widespread. Such programs could include vocational training and temporary work schemes, especially in the immediate aftermath of climate shocks. Second, oversight of natural resource management should be strengthened to prevent criminal capture during periods of severe scarcity. Policymakers can do so by increasing transparency in concessions and rights allocation and introducing expert review at multiple stages, preferably by experts independent of local decision makers.

In Chapter 3, we show that occupation-related material interest shapes

environmental voting, using survey data from 14 Western European countries from 2010 to 2019. Instead of using current jobs, the chapter builds novel measures of predicted greenness and predicted brownness for each individual, capturing individual-level labor market opportunities compatible or not with the green transition. These scores are obtained combining information on individuals' socio-demographic characteristics and pre-sample employment patterns in their region of residence, to alleviate endogeneity concerns. The results reveal that higher predicted brownness, i.e., labor market opportunities less in line with a green transition, predict lower support for Green parties and for parties with a stronger environmental agendas; the opposite holds for individuals with higher predicted greenness scores. Moreover, browner profiles are more likely to support the radical right and less likely to express a preference for the mainstream right; on the left, they strengthen support for the mainstream left. Policy attitudes align with these patterns: browner profiles oppose fossil fuel taxes, greener profiles favor green subsidies and fuel taxes. Political preferences also respond to shifts in local opportunities, with regions better placed to gain from the transition moving voters toward greener choices, including among relatively brown profiles. Two policy implications follow. First, just transition tools should target predicted exposure, not only observed occupations, using measures such as wage insurance and (re-)training. Second, a green transition on the labor market should be paired with visible place-based benefits to avoid potential political backlash.

Finally, Chapter 4 presents theoretical and empirical evidence on why and when criminal groups use violence against politicians, highlighting the role of extractable rents from political infiltration. In our model, resource inflows to local governments incentivize organized crime to use violence, with the choice between pre-electoral and post-electoral attacks determined by when opportunities arise in the electoral cycle. Using earthquakes as exogenous shocks to municipal transfers in Southern Italy between 2010 and 2020, the paper finds more violence against politicians in the aftermath of an earthquake, peaking two months after the shock. Timing shifts depending on when the earthquake takes place with respect to municipal elections, as suggested by the model: shocks after elections raise post-electoral violence; shocks before elections raise pre-electoral violence, with no spillovers after elections. Importantly for policy-makers, it is key to strengthen protections for politicians around elections, especially in places where the economic benefits that criminal groups can derive from infiltration are considerable. In addition, it is essential to limit discretionary control over the allocation and management of new funds, especially where criminal groups already have a documented presence.

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