

Getting a Hand By Cutting Them Off: How Uncertainty over Political Corruption Affects Violence*

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Abstract

What role do politicians have in bargaining with violent non-state actors to determine the level of violence in their districts? Although some studies address this question in the context of civil war, it is unclear whether their findings generalize to organizations that do not want to overthrow the state. Unlike political actors, criminal groups monopolize markets by using violence to eliminate rival firms from the marketplace. We argue that increased tenure in political office increases cartels' knowledge about local political elites' level of corruption. With bribes accepted and levels of police enforcement low, cartels endogenously ratchet up levels of violence. We formalize our claims with a model and then test its implications with a novel dataset on violent incidents and political tenure in Mexico. For one additional year of political tenure, the sum of this effect across all municipalities is an additional 2,300 homicides per year.

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1 Introduction

Are politicians able to determine the level of gang and criminal violence in their districts? The literature on the local dynamics of political violence is surprisingly quiet on this issue because it focuses on violent groups with clear political goals. Within the past decade, however, an alternate type of violence is increasingly prevalent in the developing world: that of criminal organizations (Bateson 2012; Rios 2014; Lessing 2014; Carreras 2013). Unlike politically-motivated organizations, cartels use violence strategically to maximize profits. Despite this incentive, most countries beset by criminal violence exhibit substantial subnational variation in the intensity of violence. Scholars have hitherto focused on variation in armed group’s military capabilities, drug-enforcement at the national level, or leadership decapitation to explain this variation (Cederman, et al. 2011; Buhaug and Gates 2002; Rios 2013; Dickenson 2014; Espinosa and Rubin 2015).

In this paper, we identify an alternate mechanism: political corruption. An increasing number of violent conflicts are not direct attempts to overthrow the state. Instead, they are among criminal organizations for control of criminal extraction.¹ In such conflicts, a substantial portion of violence is not directed at the state but instead at rival cartels. We show that cartels in these instances use bribery as a strategy to reduce police enforcement to maintain their local monopoly on crime. To do so, we develop a formal model of the bargaining process between political elites and cartels over the level of police enforcement in a district. In our model, a local cartel attempts to reduce that enforcement by offering a bribe to local political elites. Elites then weigh their desire to minimize violence against bribery’s monetary benefit. Finally, the local cartel uses violence—endogenously determined—to maintain control of valuable territory against a rival cartel.

Uncertainty plays a critical role in determining the outcome of the interaction and thus helps explain subnational variation. When the cartel knows the politician’s level of corruption, it can choose a precise bribe and ensure that enforcement will be lax. Consequently, levels of violence rise. In contrast, when the cartel faces great uncertainty about the politician’s corruptibility, it may offer smaller bribes that the politician might reject. This time, we expect levels of violence to be comparatively lower because the politician is more likely to enforce the law. Thus, counter to standard models of costly conflict, we expect uncertainty to *decrease* levels of violence.

We then argue that regions where local political machines have more recently taken control will see lower levels of violence. This might seem counterintuitive because experience

¹In this paper, we use data from the ongoing Drug War in Mexico. Other examples include gang violence in the United States as well as Central and South America (Kronick 2014) and drug smuggling in the Caribbean and West Africa.

seemingly should increase skill and thus decrease violence. Indeed, standard theories of retrospective voting would predict the opposite (Fiorina 1981; Kinder and Kiewiet 1979, 1981), and Cummins (2009) finds that American governors and their parties suffer at the polls for high crime rates. The model indicates that the expected negative correlation makes sense *when levels of corruption are low*, as in the United States. Leaders simply cannot serve for long if they are ineffective.

However, the model also shows that a positive correlation can exist when levels of corruption are generally high. Drawing from recent theoretical and empirical conceptualizations of uncertainty (Wolford 2007; Rider 2013), we argue that cartels know less about leaders' preferences earlier in political tenure. Cartels facing greater uncertainty are more likely to see their offers fail, leading to properly enforced laws and less violence. As tenure progresses, though, the cartels can better narrow their suppositions about leader preferences. Bribery is more likely to succeed here, leading to laxly enforced laws and more violence. Thus, although retrospective voting may hurt a corrupt political party to some degree, our empirical results suggest that the uncertainty effect predominates.

In sum, our model shows that attempts to understand criminal behavior by treating governing institutions as mere bystanders misses important bargaining dynamics. By focusing on political corruption and institutions, we contribute to an expanding literature in the political economy of development and political violence. Due to their coding rules, most previous studies of civil war restrict their analysis to contestation among armed groups over control of state institutions.² Paradoxically, this excludes one of the most common and destructive forms of political violence: conflict between criminal organizations.³ We choose to model the effect of institutions on violence because actors in these conflicts leave many institutions intact, which could impact the conflict process. Whether this is the case, and the mechanism through which these effects might occur, is currently little understood. Further, we focus on bribery to explore another key difference between criminal and civil wars: nearly unlimited access to rents. As we demonstrate below, criminal groups likely prefer to bribe politicians than fight them as a profit-maximizing strategy (Weinstein 2007).

We draw evidence from the drug war in Mexico to test our model's empirical implications. Using data from the Mexican Census Authority from 2000 to 2011 on all extralegal deaths reported to Mexican police, we show that political tenure is positively correlated with a district's homicide rate and this result is robust to a variety of model specifications. The

²For more on these rules, see Sambanis 2004 and Singer and Small 1982.

³Although their internal dynamics are less studied than civil wars, criminal violence currently affects a number of developing countries throughout the world. Particularly violent examples include the ongoing drug wars in Mexico and Colombia and gang violence in Brazil, Venezuela, and Central America (Rios 2012; Osorio 2013; Kronick 2014).

estimated marginal effect of an additional year of tenure in Congress is associated with one additional death in every municipality in our dataset. Although every homicide is tragic, one additional death might seem substantively insignificant. Across all 2,371 municipalities in our dataset, each additional year of tenure increases Mexico's homicide rate by the the same number. Substantively, this increase is equivalent to the total number of homicides committed in 2011 in France, Germany, the United Kingdom, the Netherlands, and Belgium *combined* (UNODC 2014). This finding shows that criminal violence is neither apolitical nor is national enforcement policy a sufficient explanation of this subnational variation (Resa Nestares 2001; Sabet and Rios 2009, 5-12; Osorio 2013).

Our argument differs from prior work on criminal violence in several key regards. First, by focusing on subnational variation, we control for changes in enforcement priorities set by the President and international donors. In the case of Mexico, several scholars use the anti-cartel rhetoric and refusal to accept bribes among presidents elected since 2000 to explain the increase in violence (Resa Nestares 2001; Sabet and Rios 2009, 5-12; Osorio 2013). While this certainly increased violence nationally, the preferences of the president cannot explain subnational variation in levels of violence. Second, by modeling the strategic interactions between politicians and cartels, we explore how politicians can create conditions that are conducive to increases in violence. Accounting for variation in the level of corruption among political elites, we stand apart from prior research that assumes that law enforcement and politicians always pursue cartels (Rios 2013, 2014).

That bribery is an effective strategy for violent actors has several implications for our understanding of conflict processes and economic development. We show that political elites can determine the level of violence within their district. While the literature on the political economy of development has long emphasized the role elites have in supporting economic growth and improving public health, we know relatively little about how rent-seeking behavior affects normatively bad outcomes (Keefer and Knack 1997; Clague, et al. 1996). As civil war disincentivizes economic investment and destroys property rights, local violence is a poverty trap (Varese 2011; Dell Forthcoming; Acemoglu, et al. 2001; Collier, et al. 2003). Our empirical results, moreover, suggest that competitive elections do not ameliorate this problem. Instead, strong domestic anti-corruption agencies must credibly threaten politicians from accepting bribes and allowing violence. This has important implications not just for Latin America, but even highly developed states such as the United States that have large criminal gang problems.

These results also have implications for our understanding of clientelism. Previous work on this topic typically focuses on the strategies politicians employ to influence elections and vote choice (Stokes 2005; Gans-Morse, et al. 2014). As elections do not reflect the true will

of the people, clientelism inverts the accountability between politicians and voters. Yet, the American literature on lobbying and campaign donations shows that money is a powerful tool that influences politicians’ behavior (Bonica 2014; Romer and Snyder 1994). Surprisingly little research applies this insight into understanding politicians’ incentives in new democracies. We show here that even if voters use elections to hold politicians accountable for crime, cartels can still use bribery to influence policy decisions. This shows that clientelist relationships can occur both between politicians and voters as well as politicians and financial interests.

This paper proceeds as follows. We begin by introducing our formal model of an interaction between two cartels and a local politician. Second, we test the empirical implications of the model using a novel dataset of violence and voting patterns. Finally, we conclude with suggestions for future research.

2 The Model

The game consists of three players: two cartels (denoted 1 and 2) and a local party.⁴ Cartel 1 has status quo control over the local district and needs to use violence to keep Cartel 2 from encroaching on its territory. Without loss of generality, we standardize the economic value of control of the territory to 1. Cartel 2, meanwhile, can use violence to challenge Cartel 1’s control. The party wishes to keep the level of violence down, though it is willing to permit violence at the right price.

Play begins with Cartel 1 taking advantage of its regional ties and familiarity to offer a bribe $b \geq 0$ the party to limit the enforcement of anti-violence laws. If the party accepts the bribe, the party implements a “no enforcement” policy of $\alpha = \underline{\alpha}$, where $\alpha \in (0, 1)$ reflects Cartel 1’s comparative advantage at producing violence relative to Cartel 2. Thus, higher levels of enforcement erode Cartel 1’s territory control of the territory, allowing Cartel 2 to encroach (Osorio 2013).⁵ In exchange, Cartel 1 pays b to the party.⁶ To analyze how the

⁴Although we ultimately care about police enforcement, we focus on party-level bribery because such large-scale corrupt behavior requires political consent, and these party leaders ultimately have control over police policies.

⁵An alternative interpretation is that our game is an approximation of a game in which the status quo actor has closer ties to the local political party, which appears generally true across Mexican municipalities. Thus, we focus on bargaining over selective enforcement at the local level rather than general enforcement of laws that federal troops tend to administer.

⁶We are therefore analyzing a bargaining game with *quid-pro-quo* offers. This might seem strange given that the very nature of bribery means that such deals are not enforceable through traditional legal mechanisms. However, we could instead think of this game as the reduced form of a longer-horizon exchange. Rather than paying the entire bribe up front, the cartel could make a number of smaller payments over time. Given this repetition, the party would not have incentive to defect on the deal when doing so would cancel the long-term gains from cooperation (Axelrod 1984). As such, another interpretation for the bribe value b is the total value of a large string of small bribes.

outcome varies as a function of the party's level of corruption, the party internalizes bc from the bribe payment, where $c > 0$. Thus, higher levels of c reflect higher levels of corruption; in turn, increasing c indicates that a politician increasingly values monetary bribes over sound public policy.

If the party rejects, it selects a level of enforcement $\alpha \in [\underline{\alpha}, 1)$.⁷ However, exerting such effort is costly. To reflect the enforcement cost, the party pays $k(\alpha)$, a function that is differentiable everywhere on the unit interval and where $-k'(\alpha) > 0$ and $-k''(\alpha) \leq 0$. This intuitively implies that effort harms Cartel 1's ability to commit violence but is costly to the party.

Both cartels see the level of enforcement and simultaneously choose respective levels of violence $v_1 \geq 0$ and $v_2 \geq 0$. A contest success function uses the violence levels to determine the distribution of the district at the end of the game.⁸ Specifically, Cartel 1 takes $\frac{v_1}{v_1+v_2}$ portion and Cartel 2 takes the remainder, or $\frac{v_2}{v_1+v_2}$.⁹ Each pays a cost for its effort. We therefore subtract v_2 from Cartel 2's payoff and αv_1 from Cartel 1's payoff.

Recapping, the timing is as follows:

1. Cartel 1 offers a bribe b to the party
2. The party accepts or rejects the bribe
3. If the party rejects the bribe, it sets a level of enforcement
4. The cartels simultaneously set violence levels v_1 and v_2
5. Payoffs are realized

Overall, those payoffs are as follows. If the bribe fails, the party suffers the total amount of violence minus its effort to reduce violence, or $-(v_1 + v_2) - k(\alpha)$. If the bribe succeeds, the party still suffers the total amount of violence but gains the value of the bribe multiplied by $c > 0$. Formally, this is $-(v_1 + v_2) + bc$. Thus, another way to interpret c is how much the party weighs self-enrichment versus good policy. Cartel 1 receives $\frac{v_1}{v_1+v_2} - \alpha v_1$ minus its bribe (if accepted), while Cartel 2 earns $\frac{v_2}{v_1+v_2} - v_2$.

⁷One might imagine that rejecting an offer leads to some costly punishment from the cartel. Incorporating such a negative payoff yields theoretically similar results.

⁸We thus assume that the cartels are already engaged in costly conflict at the start of the interaction. While this allows us to focus on the bargaining dynamics between cartels and politicians, one might imagine that we are studying a reduced-form game.

⁹One might imagine that enforcement does not hurt Cartel 1's comparative advantage in violence but rather directly diminishes its ability to win the contest. We have analyzed such a model. The results are there are similar but stronger than those we present here.

Table 1: Notation of the bribery game

Notation	Description
v_i	Cartel i 's weakly positive level of violence
α	Cartel 1's relative advantage in producing violence
$k(\alpha)$	Party's strictly decreasing cost of enforcement function
c	Party's strictly positive level of corruption
b	Cartel 1's weakly positive bribe to the party

2.1 Assumptions

Our model has five key assumptions, which we support qualitatively in this section. Our first assumption is that multiple cartels do not always peacefully coexist. Unlike traditional firms, cartels lack formal dispute resolution mechanisms like the courts. This is because the possession, sale, and/or distribution of narcotics is illegal under Mexican law. When disputes arise, or rival cartels attempt to enter a new market, the existing cartel can only use violence to defend its market (Miron 1999). Despite the lack of property rights, cooperation might still be possible given the right incentives. Indeed, cartel leaders sometimes form temporary alliances and cooperate with one another.¹⁰ The need to monopolize smuggling routes into the United States makes any such cooperation epiphenomenal. In sum, cartels routinely use violence to compete for territory.

Second, we assume that cartels do not know the corruptibility of local political elites. In other words, a politician's corruptibility is an innate quality that is difficult to suss out. Politicians, moreover, have incentives to misrepresent their willingness to take bribes to maximize a cartel's offer and improve their perception among the public. As an example of such misrepresentation, Andrés Granier was governor of Tabasco until 2012. During his time in office, Granier was not generally seen as corrupt. This changed in 2013, when a local radio station leaked recording of a conversation where he claimed to own enormous quantities of designer clothing (Zabludovsky 2013a). Later arraigned on tax evasion, Granier is alleged to have diverted \$156 million in federal funds from the state budget (Castillo 2013). This example suggests that corruptibility is a latent personality trait not apparent to voters or cartels.

Third, we assume that police enforcement increases the costs of territorial competition.

¹⁰Many of these, however, are relatively short lived. The story of Juárez Cartel leader Vincente Carrillo Fuentes is emblematic. Carrillo formed an alliance with the Sinaloa cartel early in the 2000s. When the head of the Sinaloa cartel killed Carrillo's brother in 2004, the alliance ended (Associated Press 2014; Beittel 2011, 10).

Consider when police confiscate large portions of a cartel's profits in raids. Without access to this cash, a cartel is in a worse position to bribe officials, purchase weapons, and pay its workers. Alternatively, more enforcement means more arrests, forcing a cartel to train new recruits and increase hazard pay to meet that demand. Either way, a local cartel would expect to pay more to maintain its control.

Fourth, we assume that political elites can influence the deployment and enforcement priorities of police and security forces. There are three principle police forces in Mexico: the Policía Federal (PF), state, and local police forces. Political elites can influence policing decisions at all levels of government through encouraging corruption at the Attorney General's office, among police chiefs, and even by directly ordering police officers to ignore drug trafficking (GAO 1996, 9; Sullivan and Elkus 2008). For example, the former governor of Quintana Roo state, Mario Villanueva Madrid, was sentenced to almost eleven years in American prison for conspiracy to launder millions of dollars in bribes (Zabludovsky 2013b). According to prosecutors, "Mr. Villanueva had agreed to let the Juárez cartel...transport cocaine from Colombia through Quintana Roo and on to the United States in exchange for up to \$500,000 per shipment. Traffickers were free to unload drug shipments at a state government hangar of a local airport" (Zabludovsky 2013b). As a clandestine activity, we cannot directly prove collusion between politicians and cartels. However, the number of arrests of high-ranking politicians suggests that these are not isolated incidents.

Finally, to obtain any variation empirically, parties must be willing to reject low bribes. One potential issue here is that cartels can threaten violence against politicians and force them to accept even minimal amounts or risk death. Although cartels have assassinated numerous politicians over the course of the drug war, such a strategy appears to be ineffective at reducing local enforcement. For example, after the Knights Templar (allegedly) assassinated mayor of Santa Ana Maya Ygnacio Lopez Mendoza, President Felipe Calderon deployed federal troops to combat cartel activity in the area. So while assassinations may remove troublesome party officials from power, they may ultimately create a worse problem. Bribery thus appears to be a cheaper option.

2.2 Complete Information Equilibria

Since this is an extensive form game with complete information, we solve for its subgame perfect equilibria. SPE require that all strategy choices are sequentially rational, ensuring that players can only carry out threats that they have incentive to follow through on.

Proposition 1. *If the party's level of corruption is sufficiently high, Cartel 1 and the party reach an agreement. In the unique SPE for these parameters, violence levels are high. If the*

party's level of corruption is sufficiently low, no mutually acceptable bribe exists. In all SPE for these parameters, violence levels are low.

See the appendix for a complete proof. There are two phases to analyze: bribery and violence. First, consider the violence subgame with varying levels of enforcement. Standard with contest success functions, each party produces non-zero violence in equilibrium. Moreover, because Cartel 1 has a lower marginal cost for violence on its territory (which α reflects), Cartel 1 produces more violence than Cartel 2, ensuring that it expects to win more of the prize at the end. Based on these predicted levels of violence, the party chooses a level of enforcement that optimizes its tradeoff between reducing the effectiveness of violence and exerting effort, which we call α^* .

That optimal level of enforcement lingers throughout the game. Critically, enforcement erodes Cartel 1's status quo advantage over Cartel 2, giving it incentive to bribe the party and secure a greater share of the good through the contest. This issue impacts the other phase: bargaining between Cartel 1 and the party. Anticipating how various levels of enforcement affect its ability to capture rents, Cartel 1 can calculate its marginal gain for buying the party's compliance. Meanwhile, knowing the party's level of corruption and desire to reduce violence, Cartel 1 can calculate the party's minimally acceptable bribe and convert it to a monetary value. If the value to Cartel 1 is greater than the party's minimally acceptable bribe—because the party's level of corruption is sufficiently high—then a bargaining range exists. Because Cartel 1 has all the proposal power, it chooses a bribe exactly equal to the minimally acceptable amount, and negotiations succeed. The party subsequently shirks on enforcement. If the value to Cartel 1 is less than the party's minimally acceptable bribe—because the party's level of corruption is sufficiently low—then the bargaining range disappears.

Although enforcement is higher when the bribe succeeds, it remains unclear how agreement affects observed violence. Despite the higher costs of violence, Cartel 1 might overcompensate for the disadvantage. Alternatively, Cartel 2 might endogenously increase its violence to exploit Cartel 1's weakness. The following remark addresses that:

Remark 1. *Levels of violence are higher when Cartel 1's bribe succeeds than when it fails.*

The appendix provides a detailed explanation. Regardless, for any given α , the optimal levels of violence for the respective states are $v_1^* = \frac{1}{(1+\alpha)^2}$ and $v_2^* = \frac{\alpha}{(1+\alpha)^2}$. Recall that, in equilibrium, the party's optimal level of enforcement is α^* , which is greater than $\underline{\alpha}$. As a result, Cartel 1's violence *decreases* with enforcement but Cartel 2's *increases*. However, the decreasing effect on Cartel 1 dominates the increasing effect on Cartel 2, meaning that overall violence diminishes when with enforcement.

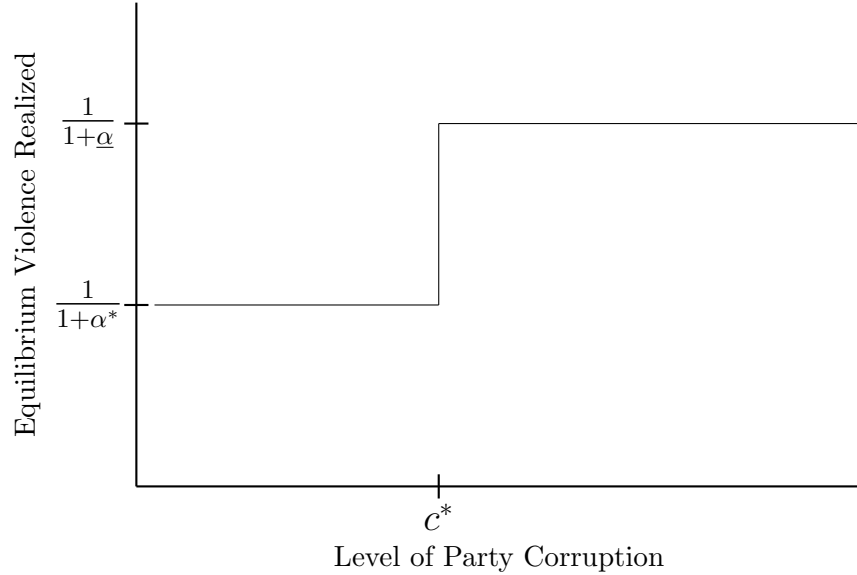


Figure 1: Equilibrium levels of realized violence by the level of party corruption. When corruption is below a critical threshold c^* , the cartel finds bribery too expensive. Violence subsequently diminishes. When corruption is high, the bribe succeeds, resulting in higher levels of violence.

While this complete information game generates baseline results, it makes a strong assumption about the bargaining phase of the game: Cartel 1 knows the party's exact level of corruption. It can then select the appropriate offer to the party and reap the entire surplus. In practice, though, it would be difficult for a cartel to know the exact amount it needs to offer a party to buy its compliance. After all, although levels of corruption correlate with many observable factors like platform and reputation, the precise level is an internal attribute of party officials. Thus, a more plausible setup would make Cartel 1 uncertain about party's minimally acceptable bribe. We investigate this scenario below.

2.3 Uncertainty about Corruption

Consider the following modification to the game. Nature now begins by drawing a level of corruption of the party as one of two types.¹¹ Specifically, the party is more corrupt with probability p while the party is less corrupt with probability $1 - p$. These varying levels of corruptibility influence the intrinsic value of the bribe to the party. Thus, holding a bribe level fixed at b , a more corrupt type values that bribe at bc' whereas a less corrupt type

¹¹Similar results would follow in an interaction where the party's level of corruption from a continuum of types.

values it at bc , with $c' > c$. In words, less corrupt types find bribes to be less valuable peso for peso. Because corruptibility is an internal attribute, it is private information to the party. The cartels therefore only know the prior at the start of the game. This prior may be strong or weak based on observable factors that correlate with corruptibility, and we will eventually investigate how the game's equilibria change as a function of the extent of Cartel 1's uncertainty.

Since the interaction is now a sequential game with incomplete information, we search for its perfect Bayesian equilibria (PBE). A PBE is a set of strategies and beliefs such that the strategies are sequentially rational and players update their beliefs via Bayes' rule wherever possible. Although this type of incomplete information game often yields multiple equilibria depending on off-the-path beliefs that cannot be derived from Bayes' rule, the outcomes we present here are unique. This is because the cartels' uncertainty about the party's level of corruption only has payoff-relevant ramifications during the accept/reject phase of the game. However, the actor facing uncertainty (Cartel 1) makes an offer before the informed actor (the party) decides how to respond. Consequently, the cartels need not analyze signals before moving.

We begin with the case in which uncertainty proves irrelevant:

Proposition 2. *For c' sufficiently small, bargaining between Cartel 1 and the party fails with certainty. Equilibrium levels of violence are low.*

The logic follows straight from the complete information analysis; thus, we omit a full proof. If the most corrupt type is not particularly corrupt, then no bargaining range exists. In turn, Cartel 1 offers an amount insufficient to reach an agreement. But if Cartel 1 is unwilling to buy off the more corrupt type, it certainly is unwilling to buy off a less corrupt type too.

As such, information only matters in cases where corruption is generally high. We therefore focus the remainder of our analysis on situations in which both types would be willing to accept the largest bribe Cartel 1 would be willing to offer.¹² This is also the most interesting case substantively. Based on our above qualitative discussion above, local officials and cartels seem willing to negotiate agreements with one another. Stories and criminal proceedings of corruption and collusion between cartels and officials are not limited to any particular geographic region, political party, or socioeconomic background. With bribery so prevalent, we focus on that particular parameter condition.

¹²Another case exists in which a bargaining range exists only for the more corrupt type. Here, Cartel 1 can simply focus on settling with the more corrupt type. However, uncertainty is not relevant here. Under such conditions, the different types could credibly separate in a cheap talk extension to the game. This is because the less corrupt type, even with complete separation, receives the same offer as it would with all information revealed.

Note that knowing the party will accept *some* bribe does not imply that they will reach an agreement. Indeed, the cartel might wish to offer small bribes, hoping to purchase the party's compliance at a low price. As the following proposition explains, this can lead to bargaining breakdown:

Proposition 3. *If the party is sufficiently likely to be more corrupt, Cartel 1 offers a small bribe. The more corrupt type accepts with certainty while the less corrupt type rejects with certainty. Violence levels are high against the more corrupt type but lower against the less corrupt type.*

The appendix contains a full proof. For intuition, note that high values of p mean that Cartel 1 believes it is very likely facing the more corrupt type. Consequently, it prefers tailoring its bribe to that type even though it knows that this smaller offer induces the less corrupt type to reject; it is not worth paying more to cover the rare event that the party is hard to corrupt. Because the less corrupt type proceeds to enforce the laws, violence diminishes. In contrast, when the bribe succeeds versus the high type, enforcement levels drop and violence rises. Because both outcomes occur with positive probability in this case, we expect to see a middling level of violence here.¹³

Violence is more prominent in the next case, however:

Proposition 4. *If the party is sufficiently likely to be less corrupt, Cartel 1 offers a large bribe. Both types accept with certainty. Without enforcement, violence levels are high.*

Again, the appendix contains a full proof. The intuition here is that Cartel 1 ought to tailor its bribe to the less corrupt type because that type is more prominent in this case. Unfortunately for Cartel 1, this requires offering a large amount. Because the more corrupt type is receptive to small bribes, it is also willing to accept larger bribes. As a result, both types accept and do not enforce the laws. In turn, violence increases for the reasons described above. As such, the expected level of violence for these parameters is greater under these parameters.

2.4 Comparative Statics

Below, we empirically investigate the sources of violence in Mexican municipalities. To do this effectively, we first need to draw a comparative static from the model that we can then use to construct a testable hypothesis. Our qualitative overview at the beginning of this paper

¹³One may wonder if cheap talk signaling can resolve the bargaining breakdown here. It cannot. The key is that the more corrupt type always has incentive to mimic the less corrupt type; if believed, the more corrupt type receives a larger bribe than it would if Cartel 1 knew it was a more corrupt type. This incentive to misrepresent therefore prohibits meaningful communication under these circumstances.

pointed to the ease of successful bribery as a critical driver of drug violence in Mexico. With incomplete information, such ease is a function of the informational environment. We thus focus on the “bandwidth” of potential types Cartel 1 might be facing:

Proposition 5. *If mutually acceptable bribes exist for both types, violence weakly increases as uncertainty about the party (i.e., $c' - c$) decreases.*

Once more, the appendix contains the full proof. The basic intuition is as follows. Without uncertainty, per Proposition 1, Cartel 1 can appropriately tailor the bribe and reach a mutually preferable settlement with the party. In the incomplete information case, the bandwidth of types ($c' - c$, or how different the types are compared to one another) is one measurement of uncertainty. As that bandwidth diminishes, the potential types the cartel could be facing become increasingly similar. This helps Cartel 1 find an offer that both would prefer to bargaining breakdown.

Essentially, Cartel 1 faces a risk-return tradeoff. Broadly, it has two options. First, it can offer small amount, hope that it is actually facing the more corrupt type, and suffer through full enforcement against the less corrupt type. Second, it can offer a large amount and induce both types to accept. This second case is expensive because it requires paying the large bribe to both types, effectively costing Cartel 1 some fixed amount whenever the party is the more corrupt type. However, as $c' - c$ goes to 0, the risk premium Cartel 1 pays becomes vanishingly small. As such, the amount “wasted” on the bribe to the corrupt type becomes increasingly insignificant. In turn, Cartel 1 prefers offering the amount necessary to induce both types to accept.¹⁴

Although reducing uncertainty leads to an increase in the likelihood of settlement, note that it leads to an *increase* in the level of violence. This should be striking to researchers familiar with bargaining and conflict. Normally such models indicate that reducing uncertainty reduces conflict. On a technical level, this remains true here: the level of observed conflict (i.e., bargaining breakdown) between Cartel 1 and the party decreases as uncertainty decreases. However, the purpose of an agreement between the two is to increase the effectiveness of violence for Cartel 1. As such, decreasing uncertainty has a negative externality on outsiders (i.e., private citizens) who want a decrease in the level of violence.

Before moving on, it is worth highlighting that this is a comparative static on how bargaining patterns change when information exogenously improves. This is useful because dominant cartels can shift over time. Nevertheless, one may reasonably wonder whether the same effect

¹⁴Note that Proposition 5 is a conditional statement. If the bargaining range is empty for one type but not the other, decreasing uncertainty could push the bribable type across c^* threshold, which in turn decreases violence. Due to the prevalence of corruption, we choose to focus on the case where both levels of corruption are greater than c^* .

would hold if information endogenously improved through a repeated offers bargaining setup. Indeed, through a process similar to “convergence” (Slantchev 2003), it does. Since such a model is substantially more complicated and yields comparable results, we choose to focus on the one above.

3 Empirics

This section introduces our dataset on violent events and political tenure in Mexico. We discuss our model of the effect of tenure on violence and conclude by presenting our results.

3.1 Hypothesis

Before delving into the data, we must first derive a testable implication from the model. The formal analysis demonstrates that high-quality information is critical for the parties to reach an agreement. This presents a major problem for empirical inquiry, however. Perfectly predicting bargaining failure would require the analyst to know more than the parties in the interaction. After all, if breakdown were perfectly predictable for the actors involved, the cartel would simply increase its offer to an acceptable level and eliminate any inefficiency. Thus, inevitably, bargaining breakdown (and thus variation in violence) is in the error term (Gartzke 1999).

Fortunately, despite this hurdle, fruitful inquiry is still possible. Rather than assume that researchers can better understand the information asymmetry than the players involved, we can instead investigate environments that correlate with uncertainty in general. Recall that Proposition 5 measures such uncertainty using the “bandwidth” of possible types. Relating this to observable factors, Wolford (2007) argues that new leadership creates a shock to informational structures. Opposing actors must throw out their estimates of the old leader’s resolve and begin the intelligence process anew. However, as a leader’s tenure increases, those estimates become progressively better and therefore the bandwidth of possible types decreases. Bargaining is more likely to succeed under these circumstances.

That said, Proposition 2 indicates that information—and thus tenure—only matters in areas where corruption is high in general.¹⁵ When a political machine first takes local control, cartels will be unfamiliar with the key political elite. As time progresses, though, observable information about these leaders accumulates. Thus, although a level of corruption is an innate trait, cartels can update and narrow their expectations by seeing how these leaders

¹⁵In places where corruption is normally low—highly function Western democracies, for example—we would expect tenure to matter little in this regard. In contrast, we would expect the mechanism to apply to local Mexican political machines and drug cartels.

behave over time. Per Proposition 5, this accumulation of knowledge decreases the probability of bargaining breakdown, which in turn decreases levels of law enforcement and increases violence. We can thus summarize our hypothesis as follows:

Hypothesis 1. *Violence levels are increasing in leader tenure.*

Note how our hypothesis differs from previous claims about the interaction between elites and violent organizations. In general, elites and violent groups’ relationship is cast as one of principals and agents, where violent groups serve politicians’ interests (Collier and Vicente 2012; Hafner-Burton, et al. 2014).¹⁶ Our model shows that this is an inappropriate way to understand this relationship in the case independently wealthy drug cartels. By harnessing their financial resources, cartels attempt to bribe politicians into serving as their agents. Another common argument is that beyond passing laws or creating opportunities for criminal organizations, governments are hapless before violent organizations (Varese 2011; Miron 1999; Rios 2012). Violence occurs because cartels do not have property rights and use it to settle disputes. In contrast, we show that local institutions play an important role in determining levels of violence.

3.2 Data and Model

There have been several attempts to measure the ongoing violence in Mexico released within the past few years. In this paper, we use the official dataset released by the Office of the President in 2011. It contains the reported number of homicides, by municipality, from 1990 to 2011.¹⁷ For reasons discussed above, we drop observations before 2000 because electoral results were not free and fair (Magaloni 2008). Violence in the pre-2000 period unambiguously originated from a separate data generating process, with a government vertically integrated and often willing to actively police inter-cartel agreements (Rios 2015).¹⁸ Further, even if dissatisfied, voters faced enormous difficulties removing the PRI from power.¹⁹ The clear solution

¹⁶Common examples include studies of electoral violence, where politicians hire thugs to harass and intimidate opposition voters and candidates.

¹⁷The Office of the President stopped updating this dataset in 2012 without explanation.

¹⁸Given this, we identify several reasons to be suspicious as to whether our model captures the dynamics of bargaining between political elites and cartels during prior elections. First, as local political parties were unlikely to face defeat, it is possible that local elites only nominated corrupt types, simplifying the bargaining procedure. Second, given different political parties’ strict geospatial control of various regions, cartels likely negotiated with national elites rather than regional ones. Finally, earlier PRI administrations agreed to tolerate cartels so long as they followed certain rules (Resa Nestares 2003; Guerrero 2009). In sum, bargaining dynamics before 2000 were likely quite different than after.

¹⁹This leaves us with a question of how to code tenure at the beginning of the time period. We choose to reset all party tenures to 0 for two reasons. First, from a theoretical standpoint, the lack of party competition and electoral responsiveness made the bargaining environment substantially different between these time periods. And second, resetting the data acts as a “hardest case” test—because we believe that long periods of tenure

is to focus on the years of competitive democracy. After dropping the other observations, the resulting dataset has 28,368 municipality-year observations.

From among several potential measures of violence in Mexico, we use the dataset generated by the Office of the President for several reasons. First, its data acquisition process is the least likely to be geographically or temporally biased. While newspapers such as *Reforma* and *Milenio* also attempt to record all killings, they have particular regional focuses that might cause upwards bias in estimates from their home region.²⁰ Second, although the Department of Justice released some datasets with more detailed information the nature of the crime, they all have extremely short time series. For example, the time series in a dataset exclusively of “organized-crime style homicides” lasts only from January to September 2011. As these datasets do not have data before and after an election, they are inappropriate to test our argument. Finally, Department of Justice-compiled figures are generally reported at the state level. While all states maintain their own police force, the Policía Federal (PF) and municipal police forces are the most important law enforcement branches of the Mexican state (Bailey and Dammert 2006). It is more likely that corrupt political elites can influence the PF as well as their local police forces than state police, which are commanded by the state’s governor (Bailey and Taylor 2009).

Although the measure is an official count of the number of killings in Mexico, there are certain caveats that are necessary to keep in mind when using this data to study the behavior of cartels. First, this dataset only contains killings that were reported to police agencies. It is still possible that its totals underestimate all cartel-related homicides.²¹ This is because cartels frequently punish rivals by disposing of their bodies in such a way that they cannot be located. For example, a cartel head based in Tijuana frequently “[boiled] rivals in barrels of lye” to dispose of their bodies (Lacey 2010). Given the dissolution of the human remains, it is unlikely that authorities received reports of the killing of someone disposed of this way. Second, although it does not state so explicitly, it is possible that the dataset records deaths in the year they were discovered, not necessarily the year they occurred. While this might be a concern, it is unlikely that the late discovery of criminal incidents should be correlated with Congressional party incumbency.

assist in the learning process and leads to more violence, this coding rule only makes it more difficult to obtain statistically and substantively significant results.

²⁰The newspapers generate statistics by compiling police reports, social media accounts, and other sources for information about the style of execution. This is incredibly detailed work, but requires reporters to have local contacts throughout the entire country. To cross validate our measure, we check the correlation between our figures and those released by *Reforma* and *Milenio*. Our measure is highly correlated with both but has better temporal and geographic coverage.

²¹Indeed, it is easier to imagine a situation wherein police departments overestimate the number of homicides to receive additional funds and matériel.



Figure 2: Homicide rate by municipality, 2000 - 2005. During this period, this map shows that violence was primarily concentrated in the Altiplano around Oaxaca and along the Sierra Madre Occidental.

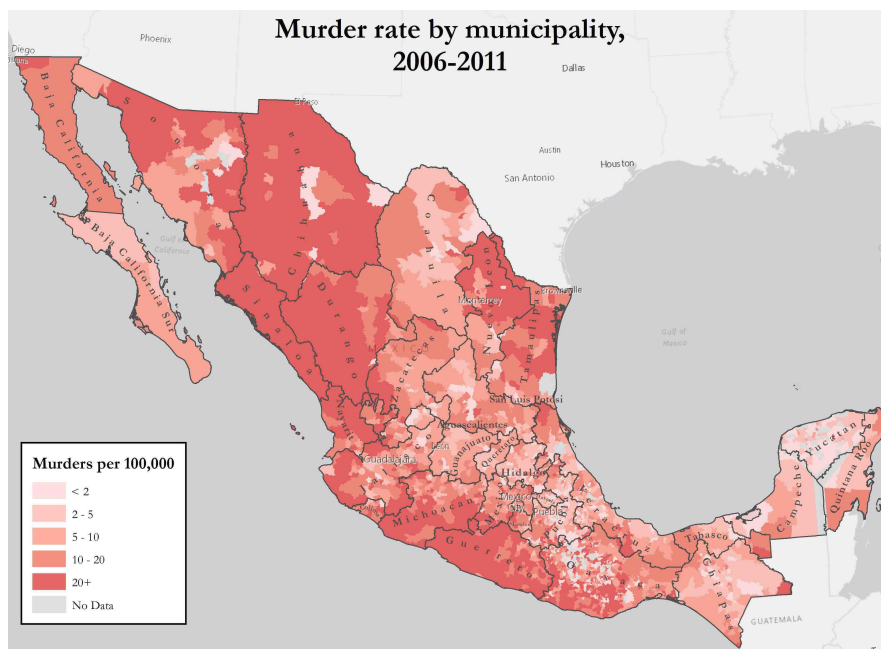


Figure 3: Homicide rate by municipality, 2006 - 2011. During this period, this map shows that violence spread across Chihuahua, Sinaloa, Sonora, and Tamaulipas. The level of violence remains high along the Sierra Madre del Sur.

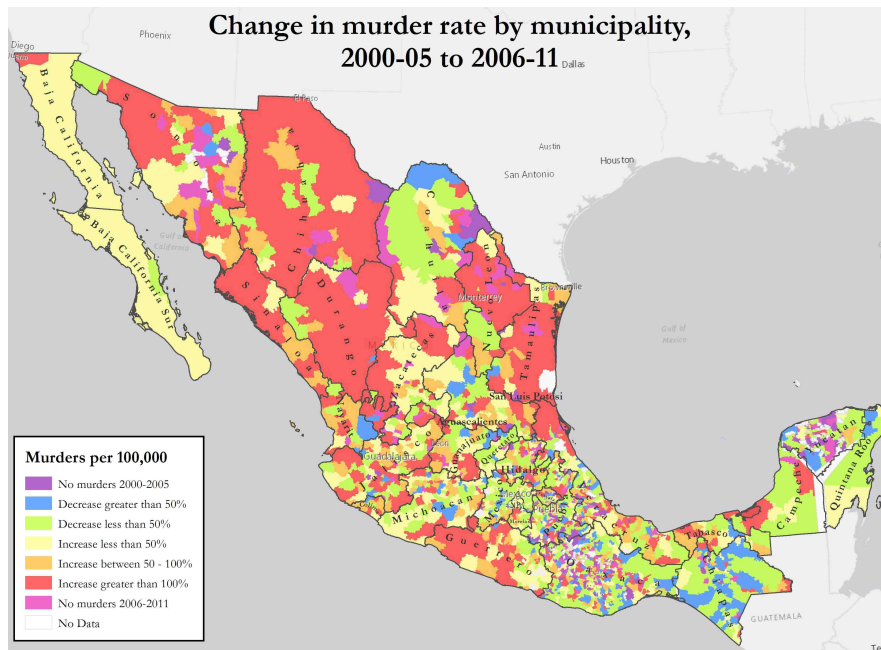


Figure 4: Change in homicide rate by municipality, 2000-05 to 2006-11. This map shows that homicide rates increased dramatically in the North and East of the country, but declined in the Altiplano and South. It also shows tremendous variation in the rate and location of these changes, which suggests that our results do not come from uniform increases throughout the country.

Finally, and perhaps most importantly, our dataset contains all homicides and non-negligent manslaughters reported to the Office of the President. While this includes both cartel and non-cartel related deaths, our argument does not explain killings unconnected to the drug trade. Although occasionally it might be possible to use the particulars of a slaying to code whether it is cartel-related, systematic attempts cover limited time periods or have regional focuses. Even so, drawing on Kalyvas (2006), we argue that this does not impose a serious constraint in our data analysis for three reasons. First, the measurement error in our dependent variable should make it more difficult for us to find a statistically significant relationship with our explanatory variable. Second, as non-cartel related violence is unrelated to politics, the frequency and geographic distribution of such crime should be relatively randomly distributed. Finally, we use several statistical techniques to control for the unobserved mixture of cartel- and non-cartel related violence.

We code our key independent variable, Tenure, with data from the Instituto Nacional Electoral (INE). The INE reports results at the municipal level for both legislative and general elections.²² As voters elect new legislators every three years, we have electoral results from the elections in 2000, 2003, 2006, and 2009. We correspondingly assigned Tenure a value of 0 in the year a district elected a political party to Congress.²³ It then increases by one every year a political party remains in office within a particular district. Should the party lose an election, Tenure resets to 0 in the year of the election.²⁴

Tenure is at the party, rather than individual, level due to Mexican law. Until electoral reforms passed in 2013, the Constitution strictly prohibited reelection in all political offices.²⁵ As a result, no Congressperson was reelected in the period of our study. Because politicians cannot build personal clientelist networks and support bases, Mexican political parties exert substantial influence over their actions. Without independent bases of support, politicians who go against their local party officials' wishes encounter substantial difficulty in pursuing higher office or using their final year in office to seek alternate employment (Magaloni 2008; Mainwaring and Scully 1995; Morgenstern and Nacif 2002). As we contend that cartels

²²We use data from Federal elections because they are complete, unlike local and state elections. To assess whether our results hold when focusing on local elections, we reestimate our main models with data gathered by Dell (Forthcoming) on electoral returns in some states. Those results, presented in the online appendix, suggest that the direction and significance of our measure of tenure does not change when looking at different levels of government.

²³As is common for studies using leader tenure as a key independent variable, one concern is how to assign transition years since there is split responsibility during that period. The appendix shows that the results are robust (and, indeed, slightly stronger) to dropping all transition years from the analysis.

²⁴One concern might be that some parties are more professional and therefore less likely to lose an election. However, the correlation between political party and Tenure (0.33) is not significant.

²⁵Coming into effect in 2018, mayors may now serve two consecutive terms, while legislators may serve for up to 12 years. Once elected, they are forbidden from switching political parties.

need time to learn whether it is possible to bribe political leaders, they likely work much more closely with local political party organizations and elites than individual legislators. Substantively, moreover, there is no variation in tenure at the individual level until 2018. For these reasons, we code tenure based on the number of years a party — and not a politician — remains in office.²⁶

To test the empirical implications of our formal model, we run a linear ordinary least squares (OLS) model with municipal fixed effects and cubic restricted time splines (Green, Kim, and Yoon 2001).²⁷ We use municipal fixed effects to control for unit-specific factors to reduce unobserved heterogeneity. For example, some municipalities might be more politically competitive, have their own media market, or be located more closely to international borders. While these are unit-specific, many such features are unobservable. We therefore include $\sum_{j=1}^n \theta_j$, where θ_j represents a set of unobserved fixed parameters for each of the n units in our sample. The short duration of our time series imposes certain restrictions on the number of additional factors for which we can control. Although scholars continue to debate the minimum number of observations per parameter necessary to avoid bias, simulations show that the bare minimum of observations in each group per parameter is around five (Harrell 2002; Vittinghoff and McCulloch 2007). While we cannot completely eliminate the risk of omitted variable bias and autoregressive disturbance, our results are robust to a variety of model specifications.²⁸

With this restriction in mind, we estimate the predicted homicide level in municipality i in year t with Equation 1:

$$Homicide_{it} = \beta_0 + \beta_1 Tenure_{it} + \beta_2 Homicide_{(it-1)} + f(\gamma) + \sum_{j=1}^n \theta_j + \epsilon_{it} \quad (1)$$

To account for the possibility of temporal dependence in our dependent variable and autoregressive disturbances, we control for temporal effects in two ways. First, we include a lagged dependent variable (Kiviet and Phillips 1993; Achen 2000). Second, we follow Beck,

²⁶In a few instances, political parties campaign in coalition with a junior party. For example, the *Alianza por el Cambio* was an alliance in the 2000 elections between the PAN and Green Ecological Party of Mexico. In the following election, the alliance ended and the PAN competed separately. In such cases, we do not code these party renamings as a break in incumbency.

²⁷The Nickell effect—an artificial reduction in the model’s mean square error—is a potential concern when including fixed effects with lagged dependent variables (Nickell 1981). To explore whether this effect biases the results presented below, we include a series of alternate specifications in our online appendix. Our results are robust to a lagged DV without fixed effects as well as municipal- and year-fixed effects.

²⁸As additional robustness checks, we present several alternate model specifications in the appendix. Across all models, including first differencing and standard OLS, Tenure remains significant and positive. It also remains significant and positive after controlling for whether the PRI controls a given municipality and election years.

Katz, and Tucker (1998) and include restricted cubic time splines with knots at each quartile. A spline function is a “smoothly joined piecewise polynomial of degree n ” (Durrleman and Simon 1989, 552). Splines control for nonlinear time effects, such as the death of cartel leaders or new smuggling routes, which affect all municipalities in the panel differently (Dickenson 2014).²⁹ Our dependent variable Homicide, is a count of the number of extralegal deaths recorded by the Office of the President.

3.3 Results

We report the results of our statistical model in Table 3. In line with our theoretical predictions, it shows that additional years of political tenure are associated with greater violence. This result, moreover, is robust to municipality fixed effects, cubic restricted time splines, and a lagged dependent variable.³⁰ While our model might appear sparse, it is worthwhile to note that including a lagged dependent variable controls for autocorrelation and the dynamics of the data generating process in $t - 1$ (Keele and Kelly 2006). Statistical research, moreover, suggests that lagged dependent variables can suppress the coefficients of the remaining independent variables; as such, the inclusion of a lagged dependent variable is a highly conservative model (Achen 2000; Durbin 1970). Together, this suggests the effect is quite robust to alternate model specifications and is not the result of autocorrelation.

To uncover the substantive effect of an additional year of tenure on homicide rates, Figure 5 plots the marginal effects of each additional year of tenure on homicide rates. After setting all other explanatory variables to their median values in Equation 1, the predicted homicide rate across all Mexican municipalities increases from 2.93 ($\sigma = 0.87$) when leaders have been in power for only one year to 12.20 ($\sigma = 1.80$) after 11 years of tenure. This suggests that each additional year of tenure is associated with an additional homicide within a given municipality.³¹

While one additional homicide per year might not sound substantively meaningful, it is

²⁹Geospatial clustering is another concern. Clustering could bias our inferences by making coefficients inconsistent and inflating our model’s R^2 . To check for the presence of such clustering, we estimate a geographically weighted regression and present the results in the appendix. We then check for clustering in our residuals by estimating Moran’s I (Moran 1950). Results from this analysis show that our data is randomly distributed geospatially.

³⁰In our online appendix, we also assess whether cartels use violence strategically to influence electoral returns. We find that the level of violence in the year of an election or the year proceeding an election has no impact on the probability a party is returned to office, suggesting that our results are not driven by cartels’ electoral manipulation.

³¹Reverse causality — where politicians strategically deploy violence to either depress incumbents’ probability of reelection or frighten opposition voters away — is a potential concern with interpreting these results. We explore this possibility with a variety of methods in the online appendix. To summarize our findings, we find no evidence that violence affects political outcomes.

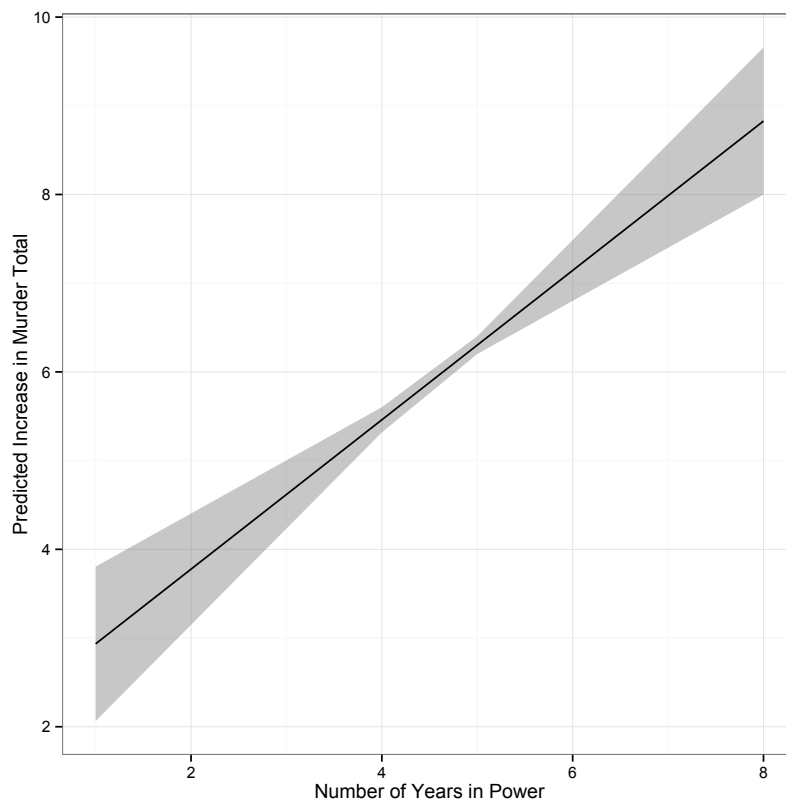


Figure 5: Estimated marginal effect for *Tenure* on the number of homicides in a municipality. This figure shows that a one year increase in *Tenure* leads to an additional homicide.

Table 2: Fixed Effects OLS of Incumbency's Effect on Violence with Lagged DV

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
Tenure	0.39*** (0.06)	0.16** (0.07)
Homicide ₋₁	0.84*** (0.01)	0.84*** (0.01)
Municipal FE	Yes	Yes
Time Splines	No	Yes
Observations	25,538	25,538

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

important to remember that this effect accrues across all 2,371 municipalities in our study. As such, we predict that an additional 4,742 people die during the period between elections that would not otherwise. Across the eleven years in our study, this finding suggests that approximately 26,000 people have died in Mexico as a result of collusion between politicians and cartels.

Since many political scientists are not familiar with crime statistics, it might not be clear how to interpret an additional 2,371 deaths per year in a comparative context. As mentioned above, according to United Nations Office of Drugs and Crime estimates, 2,371 additional deaths per year is equivalent to the combined 2011 homicide totals of France, Germany, the United Kingdom, the Netherlands, and Belgium (UNODC 2014). While our estimate might seem unrealistically high, Mexico is one of the world's most violent countries. With 27,213 violent deaths reported in 2011, our estimated treatment effect only represents approximately eight percent of all homicides reported to Mexican authorities. This suggests that we can, with relative confidence, eliminate the possibility that the effects our model has captured may be due to modeling error.

4 Conclusion

This paper investigated a novel mechanism to explain subnational variation in violence: political corruption. Bribery occurs because effective law enforcement hinders cartels from maintaining territorial control and reduces their profits. Although bribes are costly, cartels want to buy off politicians to secure their monopoly on the use of violence in their territory. Despite cartels' incentives to offer bribes, they are only certain to be successful when they have sufficient information about officials' corruptibility. Ultimately, increased information about politicians' indifference points drives conflict. To test this argument, we use data from Mexico on political tenure as a proxy for information and show that uncertainty (as measured by time in office) is statistically and substantively associated with lower levels of violence.

As a mechanism, political corruption has a substantively large effect on violence. In the year following an election, we estimate that the increased information available to cartels increases the number of homicides in Mexico by more than 2,300. This finding highlights the clear link between politicians' incentives and local violence. It also shows that political institutions are important explanatory variables for both traditional civil wars as well as violence among criminal organizations.

Beyond improving our understanding of the mechanisms that drive political violence, we focus on the interaction between cartels and political parties because it is not trivial for Mexican voters. Although recent reforms ended Mexico's traditional prohibition against reelection, this issue remains highly contentious. The threat remains that political parties might return to their PRI-era behavior and wield significant and pernicious control over their home regions. As our model suggests, this would lead to increased violence throughout Mexico. To encourage further reform in Mexican politics, activists in Baja California launched a new political party in 2014 aimed at ending the leadership of the two main parties and increasing political turnover in the state. This strongly suggests that our proposed mechanism is not far-fetched to Mexican voters.

Our results have important implications for future study of the relationship between political institutions and conflict. First, scholars commonly assume that ideology determines a violent group's choice to fight the state or attempt to co-opt it (McAdam, et al. 2003). Instead, our results suggest that this decision might instead be conditional upon the group's access to rents. Rich groups should find it easier to bribe and co-opt officials. In contrast, poor groups might not have access to sufficient resources to make bribery a viable option. Second, electoral laws that favor status quo parties—such as minimum vote thresholds and public financial support for parties—might have the unintended consequence of improving violent groups' odds at bribing officials. Practically, this implies that lobbying against such laws

might help activist groups improve domestic security.³² Finally, and perhaps most troublingly, our results show that there is no easy fix to the cartel problems in Mexico.

Our paper’s implications also raise questions about when strengthening democratic institutions reduces violence. The civil war literature suggests that making politicians accountable to voters through competitive elections should decrease rent-seeking behavior and their tolerance for violence. This strategy was successful in decreasing cartel violence during Prohibition in the United States and among Mafia in Italy yet has largely failed in Latin America (Varese 2011). We help explain this variation by demonstrating that elections are only one mechanism that explains a state’s monopoly on violence. Future research might investigate the effect of specific institutions, such as independent anti-corruption investigators. By investigating politicians who accept bribes, such institutions plausibly make it too risky to cooperate with violent agents. These institutions, rather than elections, might be key to reducing cartel violence.

Finally, the scope of our project is limited to understanding how cartels and local officials conspire with each other for mutual benefit at the expense of rival cartels and the municipality’s citizens. However, this is only one interesting strategic aspect of the Mexican drug wars. Future research ought to consider how cartels negotiate with each other and how national intervention in local affairs complicates the larger bargaining and enforcement process.

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³²Of course, implementing such reforms might require herculean effort—those in power have strong incentives to maintain and strengthen the systems that put them in office. Moreover, artificially reducing party tenure could have unintended negative consequences, as experience and professionalization are desirable in other policy areas.

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5 Appendix: Formal Proofs

5.1 Proof of Proposition 1

We proceed with backward induction. Fix a level of enforcement α . Cartel 1’s objective function is $\frac{v_1}{v_1+v_2} - \alpha v_1$, with its choice a value for v_1 . Its first order condition is therefore:

$$\frac{v_2}{(v_1 + v_2)^2} - \alpha = 0 \quad (2)$$

Meanwhile, Cartel 2’s objective function is $1 - \frac{v_1}{v_1+v_2} - v_2$, with its choice a value for v_2 . Its first order condition is therefore:

$$\frac{v_1}{(v_1 + v_2)^2} - 1 = 0 \quad (3)$$

Using Equations 2 and 3 as a system of equations, the unique solution pair is $v_1^* = \frac{1}{(1+\alpha)^2}$, $v_2^* = \frac{\alpha}{(1+\alpha)^2}$. Note that when the politician accepts the bribe, $\alpha = \underline{\alpha}$ and therefore the solution pair is $v_1^* = \frac{1}{(1+\underline{\alpha})^2}$, $v_2^* = \frac{\underline{\alpha}}{(1+\underline{\alpha})^2}$.³³

³³Note that the objective functions are undefined for $v_1 = v_2 = 0$. Regardless of the rule we use to define each objective function’s value in that instance, $v_1 = v_2 = 0$ cannot be part of any equilibrium—as is standard for contest success functions, the marginal value for investing a slight amount overwhelms the cost to do so and is therefore a profitable deviation for at least one player.

Now consider the party's enforcement level, conditional on its rejection of the bribe. The party's objective function is $-(v_1 + v_2) - k(\alpha)$, with its choice a value for α . Because $v_1^* = \frac{1}{(1+\alpha)^2}$ and $v_2^* = \frac{\alpha}{(1+\alpha)^2}$, we can rewrite this as $-\frac{1}{1+\alpha} - k(\alpha)$. The first portion is strictly concave, while the second is weakly concave. Therefore, the addition of the two is strictly concave. This implies that the objective function has a unique solution. Call that solution α^* .

The remaining task is to solve for the bargaining game. We first look at the politician's accept or reject decision. Accepting yields $-(v_1^* + v_2^*) + bc$. Substituting for the equilibrium levels of violence, we have:

$$-\frac{1}{(1+\underline{\alpha})} + bc \quad (4)$$

Meanwhile, the politician receives $-(v_1^* + v_2^*) - k(\alpha^*)$ if it rejects. Again substituting for the equilibrium levels of violence, we have:

$$-\frac{1}{(1+\alpha^*)} - k(\alpha^*) \quad (5)$$

Using Equations 4 and 5, the politician is willing to accept any a bribe if:

$$\begin{aligned} -\frac{1}{(1+\underline{\alpha})} + bc &\geq -\frac{1}{(1+\alpha^*)} - k(\alpha^*) \\ b \geq \underline{b} &\equiv \frac{\frac{1}{1+\underline{\alpha}} - \frac{1}{1+\alpha^*} - k(\alpha^*)}{c} \end{aligned} \quad (6)$$

That leaves Cartel 1's bribe decision. To analyze this, we first need to find 1's payoffs in the violence decision subgames with and without enforcement. Without enforcement, recall that the equilibrium levels of violence are $v_1^* = \frac{1}{(1+\underline{\alpha})^2}$, $v_2^* = \frac{\underline{\alpha}}{(1+\underline{\alpha})^2}$. Plugging these into Cartel 1's utility function gives:

$$\frac{1}{(1+\underline{\alpha})^2} \quad (7)$$

In contrast, with enforcement, the equilibrium levels of violence are $v_1^* = \frac{1}{(1+\alpha^*)^2}$, $v_2^* = \frac{\alpha^*}{(1+\alpha^*)^2}$. Thus, Cartel 1's utility function for an unsuccessful bribe is:

$$\frac{1}{(1+\alpha^*)^2} \quad (8)$$

Combining Equations 7 and 8, Cartel 1's utility differential between successful and unsuccessful negotiations equals:

$$\bar{b} \equiv \frac{1}{(1+\underline{\alpha})^2} - \frac{1}{(1+\alpha^*)^2} \quad (9)$$

This is also the maximum bribe Cartel 1 is willing to pay. Using Equations 6 and 9 as the constraints, a mutually acceptable bargain exists if:

$$\underline{b} < \bar{b}$$

$$c > c^* \equiv \frac{\frac{1}{(1+\underline{\alpha})^2} - \frac{1}{(1+\alpha^*)^2} - k(\alpha^*)}{\frac{1}{(1+\underline{\alpha})^2} - \frac{1}{(1+\alpha^*)^2}}$$

So if $c > c^*$, Cartel 1 offers the politician's minimally acceptable amount (\underline{b}), and the politician accepts. If $c < c^*$, no bribe is mutually acceptable. Cartel 1 is then free to offer any bribe less than \underline{b} , guaranteeing the politician's rejection. Note that Proposition 2 therefore applies to all cases where $c' < c^*$. \square

5.2 Proof of Proposition 3 and 4

To begin, let $b' = \frac{\frac{1}{1+\underline{\alpha}} - \frac{1}{1+\alpha^*} - k(\alpha^*)}{c'}$ and $b'' = \frac{\frac{1}{1+\underline{\alpha}} - \frac{1}{1+\alpha^*} - k(\alpha^*)}{c}$. These values represent the minimally acceptable bribe to the more corrupt and the less corrupt types. Note that $b'' > b'$, so it costs more to bribe the less corrupt type.

No equilibria exist in which Cartel 1 offers a value not equal to b'' or b' . To see why, consider proof by cases. If Cartel 1 offers $b > b''$, both types accept. Cartel 1 receives $\frac{1}{(1+\underline{\alpha})^2}$ for the remainder of the game. However, Cartel 1 could alternatively offer the midpoint between that offered bribe and b'' . Because that value is still strictly greater than b'' , both types still accept. Cartel 1 in turn receives $\frac{1}{(1+\underline{\alpha})^2}$. But note that it receives this same payoff but pays a strictly smaller bribe. This is a profitable deviation. Therefore, offering $b > b''$ is never optimal.

Next, offering $b < b'$ is not optimal either. Such an offer induces both types to reject. Cartel 1's payoff therefore equals $\frac{1}{(1+\alpha^*)^2}$. In contrast, consider an offer $b \in (b', b'')$ instead. That amount induces the more corrupt type to accept and the less corrupt type to reject. In turn, Cartel 1's payoff is equivalent if it is facing the less corrupt type. However, with positive probability, it is facing the more corrupt type. Because that offer is in the bargaining range for the more corrupt type, Cartel 1 earns strictly more than in this case than if bargaining fails. This is a profitable deviation. Therefore, offering $b < b'$ is not optimal.

Finally, consider $b \in (b', b'')$. As discussed above, such an offer induces the more corrupt type to accept and the less corrupt type to reject. Now consider a deviation to the midpoint between that offer and b' . This amount is still strictly greater than b' and strictly less than

b'' . Consequently, the more corrupt type still accepts and the less corrupt type still rejects. Cartel 1's payoff for the contest portion of the game remains the same. However, it pays a strictly smaller bribe to the more corrupt type. This is a profitable deviation. Therefore, offering $b \in (b', b'')$ is not optimal.

That information means that strategies can only satisfy equilibrium conditions if Cartel 1 offers b' or b'' . In the first case, note that the weak type is indifferent between accepting and rejecting; in the second case, the strong type is indifferent. For reasons standard to ultimatum games like this one, no equilibria exist when one of those types rejects with positive probability when indifferent. This leaves two possibilities: Cartel 1 offers b'' and both types accept with certainty and Cartel 1 offers b' , the more corrupt type accepts with certainty, and the less corrupt type rejects.

To see which offer prevails under equilibrium conditions, note that offering b'' yields Cartel 1 a flat payoff of $\frac{1}{(1+\underline{\alpha})^2} - b''$. Offering b' leads to a probabilistic outcome: Cartel 1 receives $\frac{1}{(1+\underline{\alpha})^2} - b'$ with probability p and $\frac{1}{(1+\alpha^*)^2}$ with probability $1 - p$. As such, making the safe offer is optimal if:

$$\begin{aligned} \frac{1}{(1+\underline{\alpha})^2} - b'' &> p \left(\frac{1}{(1+\underline{\alpha})^2} - b' \right) + (1-p) \left(\frac{1}{(1+\alpha^*)^2} \right) \\ p < p^* &\equiv \frac{\frac{1}{(1+\underline{\alpha})^2} - \frac{1}{(1+\alpha^*)^2} - b''}{\frac{1}{(1+\underline{\alpha})^2} - \frac{1}{(1+\alpha^*)^2} - b'} \end{aligned} \quad (10)$$

By analogous argument, Cartel 1 offers b' if $p > p^*$. □

5.3 Proof of Proposition 5

Rewriting b' and b'' explicitly from Equation 10 yields:

$$p < \frac{\frac{1}{(1+\underline{\alpha})^2} - \frac{1}{(1+\alpha^*)^2} - \frac{\frac{1}{1+\underline{\alpha}} - \frac{1}{1+\alpha^*} - k(\alpha^*)}{c}}{\frac{1}{(1+\underline{\alpha})^2} - \frac{1}{(1+\alpha^*)^2} - \frac{\frac{1}{1+\underline{\alpha}} - \frac{1}{1+\alpha^*} - k(\alpha^*)}{c'}} \quad (11)$$

Because we care about how this function behaves as $c' - c$ decreases, we implicitly need to know how the cutpoint behaves as c' decreases and as c increases. This is easy to show since both the numerator and denominator must be positive for the parameter space. As c' decreases, the size of the optimal bribe against the more corrupt type increases. That in turn decreases the value of the denominator, increasing the size of the fraction overall. Meanwhile, as c increases, the size of the optimal bribe against the less corrupt type decreases. That in turn increases the value of the numerator, again increasing the size of the fraction overall.

Both of these effects make it easier to fulfill the inequality overall.

In relating this to the equilibrium level of violence, decreasing the bandwidth of possible types $(c' - c)$ either has no effect because it does not change whether p^* is greater or less than p or it changes p from being greater than p^* to less than. Therefore, the level of violence is weakly decreasing in the bandwidth. \square

6 Appendix: Robustness Checks

When presenting quantitative models, it is important to test the robustness of the conclusions to alternate model specifications. Here, we present a variety of different model specifications. We also reestimate the main model from our paper using data on turnover at the municipal level. The results in all cases are highly similar to those presented in the paper, suggesting that our results are quite robust to alternate specifications.

6.1 Municipal Data

In this section, we reestimate the model using data on electoral turnover at the municipal level. One potential concern with our focus on Federal politicians is that they might lack sufficient ability to influence in the policing decisions made by municipal police. As employees of the city government, municipal police presumably take their orders from the mayor and not local Congresspeople. To address this possibility, we use data on electoral turnover in municipal governments gathered by Dell (Forthcoming). As municipal elections are conducted by state and municipal organizations, and not the Instituto Nacional Electoral (INE), some of the turnover data is both missing and not at random (MAR). As such, these results should be treated with some caution as we are missing data for approximately 700 municipalities. Despite these caveats, our main variable of interest, *Tenure*, remains positive and significant. This suggests that increased tenure affects both Federal and local politicians.

Table 3: Lagged Fixed Effects OLS of Incumbency's Effect with Municipal Data

	(1)	(2)
Years	0.225** (0.0949)	
L.Homicide rate	1.014*** (0.225)	1.014*** (0.225)
L.Years		0.253** (0.0982)

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

6.2 Reverse Causality

One potential concern with interpreting the above results is reverse causality. Cartels might strategically use violence ahead of elections to scare the public away from polls; politicians could target incumbents by increasing violence to make them appear weaker; or politicians could use violence against opposition voters. This might bias our results by inflating the relationship between political tenure and homicide, yet provide no support for the mechanism we model in this paper because the violence results from political competition rather than cartels. To explore whether a municipality's homicide rate affects the probability the incumbent political party is reelected, we include a variable *Reelection* that takes a value of 1 in years when a political party is elected to office (and zero otherwise). If the above concern about reverse causality were correct, we should observe that violence should be correlated with reelection (either positively or negatively). Using a panel model probit with time splines, we find no relationship between homicide and the probability of reelection. This strongly suggests that pre-electoral violence does not drive our results.

Table 4: Probit of Homicide's Effect on Probability of Reelection

	<i>Dependent variable:</i>		
	Reelection		
	(1)	(2)	(3)
Homicide Rate	-0.00 (0.00)	-0.00 (0.000)	
L.Homicide Rate			-0.00 (0.00)
Time Splines	No	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

Standard errors reported in parentheses.

6.3 Lagged Independent Variable

One concern with our results is that they might be driven by reverse causality, i.e. a party's electoral fate is decided by the current level of violence. This would introduce simultaneity bias wherein an unobserved variable that explains both levels of violence and electoral success biases the error term in our results. One common way to address this issue is through an instrumental variable, where an exogenous variable is used to perform a two-stage OLS. Unfortunately, we are unable to identify a good instrument that predicts which parties are reelected and is also satisfies the exclusion restriction that it is uncorrelated with violence. To address this potential problem, we follow Clemens, et al. (2012, 1) and "avoid poor quality instrumental variables and instead address potential biases from reverse and simultaneous causation by the more transparent methods of lagging and differencing." This is a relatively common econometric technique to overcome simultaneity bias. We then estimate the predicted homicide level in municipality i in year t with Equation 12:

$$\Delta Homicide_{it} = \Delta\beta_0 + \beta_1\Delta Tenure_{it-1} + \beta_2\Delta Homicide_{it-1} + \Delta f(\gamma) + \Delta\epsilon_{it} \quad (12)$$

The results from this model are presented in Table 5:

Table 5: Lagged Fixed Effects OLS of Incumbency's Effect on Violence with First Differences

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
LD.Congress Tenure	0.27*** (0.05)	0.29*** (0.05)
LD.Homicide Rate	1.48*** (0.14)	1.48*** (0.14)
District FE	Yes	Yes
Time Splines	No	Yes
Observations	25,517	25,517

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

As these results show, the finding presented in the body of the paper likely does not result from simultaneity bias and is robust to a lagged IV.

6.4 Lagged DV with Fixed Effects

The Nickell effect is a concern when including fixed effects in a lagged dependent variable model. By including fixed effects, one might bias results by artificially deflating the model's mean square error (MSE). This is particularly problematic with a small number of time periods in the data. Beck and Katz (2009) show that the bias produced by the Nickell effect is less than some of the proposed solutions, such as the Kiviet method. As such, this suggests that the results presented in the body of the paper are one modeling choice with TCSC data. It is still possible, however, that our results remain biased by the Nickell effect. To explore this possibility, we first reestimate our model with a lagged dependent variable without fixed effects. Second, we reestimate our results with year- and municipal-fixed effects. The results from these models are presented in Table 6:

Table 6: Lagged DV Without FE and Year FE

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
Congress Tenure	0.22*** (0.05)	0.47** (0.23)
L.Homicide Rate	0.99*** (0.05)	- -
Municipal FE	No	Yes
Year FE	No	Yes

*p<0.1; **p<0.05; ***p<0.01

Bootstrapped errors reported in parentheses.

Estimates for year fixed effects not reported.

As Table 6 shows, our results remain broadly consistent (and in fact the coefficient on Congress Tenure becomes larger) without municipal FE. This suggests that the results reported in the main body of the paper are not strongly biased by the Nickell effect. Second, we show that our choice to model time with splines is not necessary to obtain our results. After using year fixed effects, our variable of interest continues to have a positive and statistically significant effect on violence.

6.5 First Differences

Our first robustness check is a first differences time series pooled ordinary least squares (OLS) regression. Unlike standard OLS, a first difference model subtracts the observed values of the dependent and independent variables in $t = 1$ from $t = 2$. In the process of subtracting, taking the first difference removes all invariant, unit-specific factors, denoted by θ .³⁴ This is because all of the factors contained within θ do not change between time periods, meaning they reduce to zero.

We estimate the predicted homicide level in municipality i in year t with Equation 13:

$$\Delta Homicide_{it} = \Delta\beta_0 + \beta_1\Delta Tenure_{it} + \Delta f(\gamma) + \Delta\epsilon_{it} \quad (13)$$

The results from this model are presented in Table 7:

Table 7: Fixed Effects OLS of Incumbency’s Effect on Violence with First Differences

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
D.Congress Tenure	0.05** (0.03)	0.05** (0.03)
District FE	Yes	Yes
Time Splines	No	Yes
Observations	25,517	25,517

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

³⁴First differences are not the only estimation technique to control for unobserved heterogeneity. Many scholars use fixed effects to do so. Although we present results using district fixed effects in the online appendix, we believe fixed effects’ assumption that the error term is serially independent to be harder to justify. Homicide rates in $t = 0$ likely are likely highly predictive of violence in $t = 1$. As serial correlation incorrectly decreases the coefficients’ standard errors, this is a serious specification issue. First differences, in contrast, are more robust to violations of this assumption (Liker, et al. 1985).

6.6 Fixed Effects OLS

In this section, we estimate use the following equation to estimate a fixed effects OLS regression:

$$Homicide_{it} = \beta_0 + \beta_1 Tenure_{it} + f(\gamma) + \sum_{j=1}^n \theta_j + \epsilon_{it} \quad (14)$$

The results, presented in the table below, are also statistically significant and in the right direction.

Table 8: Fixed Effects OLS of Incumbency's Effect on Violence

	<i>Dependent variable:</i>		
	Homicide		
	(1)	(2)	(3)
Tenure	0.84*** (0.07)	0.47*** (0.11)	0.26** (0.11)
PRI			4.21*** (0.68)
ElectionYear			0.93** (0.41)
Observations	27,861	27,861	27,861
Municipal FE	Yes	Yes	Yes
Time Splines	No	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

6.7 Coding of Independent Variable

In the main body of the paper, we code our main independent variable — *Tenure* — as linearly increasing year-on-year. One concern with this might be that each additional year a political party remains in office might not in fact provide substantial additional information to cartels. Instead, cartels might update only after each election and then adopt similar bargaining strategies with politicians during their time in office. To address this possibility, we recode *Tenure* so that it increases only when a political party secures reelection. This reduces the scale of our new *Tenure** variable from 11 to 4 ($\sigma = 0.95$, $\mu = 1.83$). We then estimate the effect of an increase in this *Tenure* variable with a cross sectional Poisson regression. As before, increases in *Tenure* are positively and significantly associated with an increased number of homicides in a given municipality.

Table 9: Recoding Key Independent Variable

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
<i>Tenure*</i>	0.06*** (0.01)	0.06*** (0.01)
L.Homicide	0.00*** (0.00)	0.00*** (0.00)
Observations	25,943	24,629
Municipal FE	No	Yes
Time Splines	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

6.8 Count Data

Our dependent variable, the number of homicides a municipality experiences in a year, cannot take negative values. As such, it is an example of count data. While OLS estimators are BLUE for count data, they could potentially be inefficient. Correcting for this inefficiency might affect estimated coefficient direction, significance, or show that the model does not appropriately fit the data. To address this possibility, we present the results here from a class of models specifically designed for count data — a cross sectional Poisson regression. These results, presented in Table ??, show that our main coefficient of interest is not affected by accounting for count data.

Table 10: Poisson Regression

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
Tenure	0.03*** (0.002)	0.03*** (0.002)
L.Homicide	0.00*** (0.00)	0.00*** (0.00)
Observations	25,538	24,224
Municipal FE	No	Yes
Time Splines	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

6.9 Power Transition Years

Empirical models that use tenure as a key independent variable inevitably face problems coding transition periods. With elections midway through the election year, it is difficult for the researcher to know exactly whom to assign the homicides to. In the interest of completeness, the main model included the transition years. However, there are two relevant alternative coding schemes. The first assigns all the homicides to the party in power at the beginning of the year. Some may find this coding scheme preferable because fresh leaders may not have held office long enough to sway policy in a meaningful way. Running the main model specification with the alternative coding scheme generates the following results:

Table 11: Fixed Effects OLS with Lagged DV Subsetting Transition Years

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
Tenure	0.17** (0.07)	0.17** (0.07)
Homicide ₋₁	0.84*** (0.01)	0.84*** (0.01)
Observations	25,517	25,517

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

As Table 11 shows, our Tenure variable remains positive and significant with this alternate specification.

The second alternative scheme is the most conservative option available. It removes all transition years from the data. In other words, if a party does not hold office for the entire year, we subset it out of the analysis. Note that this is not the same as removing all election years—for elections where the incumbent party wins, we know who is responsible for the homicides in that year.

As Table 12 illustrates, the model is robust to this specification. Moreover, the effect is stronger here. While it is important not to overanalyze these differences, we would expect this to be true given our mechanism. After all, if transition years mix the “correct” assignment of homicides, the model would systematically underreport the actual effect due to newer leaders

Table 12: Fixed Effects OLS of Incumbency's Effect on Violence with Lagged DV

	<i>Dependent variable:</i>	
	Homicide	
	(1)	(2)
Tenure	0.41*** (0.06)	0.20** (0.08)
Homicide ₋₁	0.84*** (0.005)	0.83*** (0.005)
Observations	23,985	23,985
Municipal FE	Yes	Yes
Time Splines	No	Yes

*p<0.1; **p<0.05; ***p<0.01

Standard errors (clustered on municipality) reported in parentheses.

Estimates for cubic restricted time splines not reported.

being unfairly assigned homicides from their predecessor.

6.10 Geospatial Dependence

In the previously discussed models, our estimation strategies depend upon two assumptions that may be violated in our data. First, we assume that the effect of congressional tenure is consistent across units. Second, we assume that each municipality is statistically independent, i.e. that there is no spatial autocorrelation. Examples of such spatial autocorrelation include community and spillover effects. With spatially dependent data, estimated coefficients can be unstable and estimated measures of model fit can be inflated. The independence assumption, moreover, might be especially hard to justify in the case of political violence. Due to the quality of their security institutions, their terrain, or social structures, certain regions might be more prone to experience violence than others (Fearon and Laitin 2003). Regions with these characteristics might be more susceptible to diffusion from neighboring units. As the inclusion of such units would violate ordinary least squares' (OLS) independence assumption, we perform spatial statistics and visually plot residuals to check for evidence of such spatial autocorrelation. As a first cut, Figure 6 plots the residuals from a spatial bivariate OLS regression with data from 2008:

Although Figure 6 does not show unambiguous evidence of spatial dependence, it does appear that the effect of tenure on violence is greater in border regions and in the north of the country. It also shows that the center of the country is less influenced by tenure. For the reasons stated above, it is possible that our estimated coefficients are unstable due to our inclusion of data from border municipalities. To systematically test whether our results are robust to controlling for spatial autocorrelation, we take two steps. First, we estimate a geographically weighted regression (GWR). Second, we test for spatial dependence in the residuals with Moran's I , which is a measure of spatial autocorrelation. Following Fotheringham, et al. (1998), we estimate our GWR using the following equation:

$$Homicide_{it} = a_0(u_i, v_i) + \sum_k a_k(u_i, v_i) Tenure_{ik} + \epsilon_{it} \quad (15)$$

where " (u_i, v_i) denotes the coordinates of the i th point in space and $a_k(u_i, v_i)$ is a realization of the continuous function $a_k(u, v)$ at point i " (Fotheringham, et al. 1998, 1907). The estimated coefficients from this regression are displayed in Figure 7:

Unlike the potentially problematic clustering in the OLS model's residuals, evidence of clustering in the estimated coefficients from our GWR is far less obvious. As shown in Figure 7, municipalities with positive coefficients — such as Tijuana and Ciudad Juárez — appear to be surrounded by a randomly distributed mixture of positive and negative units. Beyond visual inspection, we can test whether these observed coefficients are geospatially clustered with Moran's I statistic. Moran's I is a means of detecting the presence of multidimensional

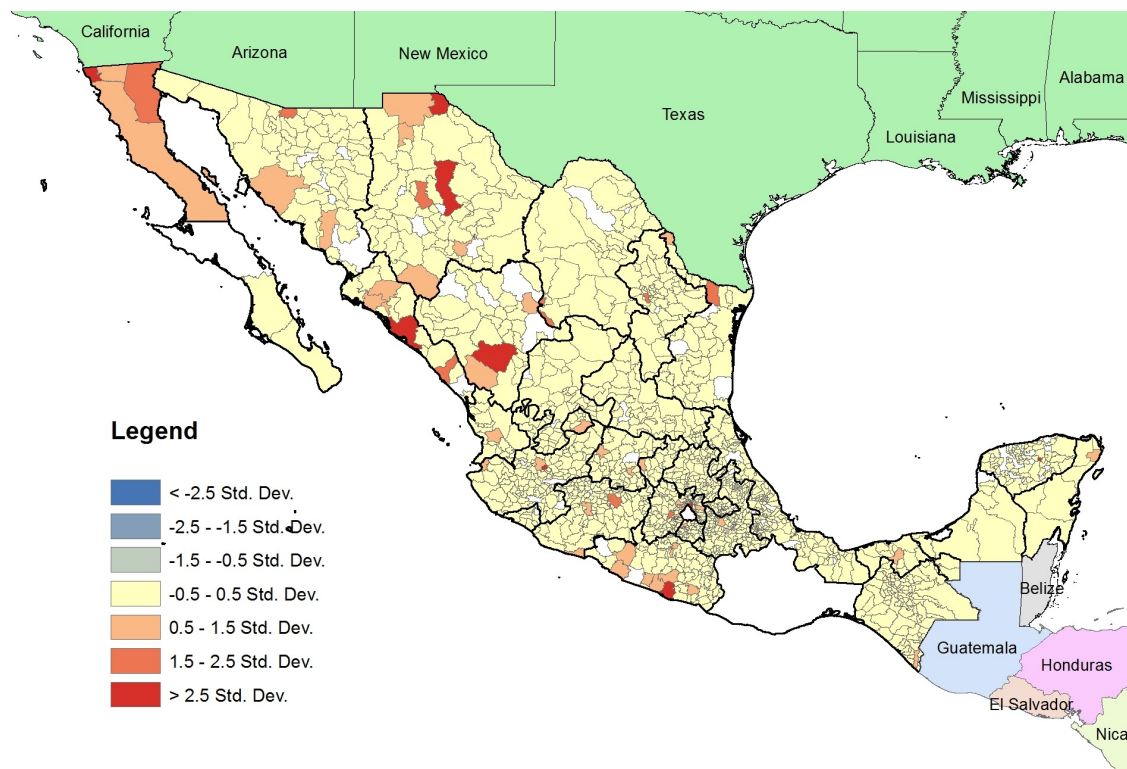


Figure 6: OLS residuals by municipality for 2008. Note that Oaxacan municipalities do not follow a consistent naming pattern and are excluded from this analysis.

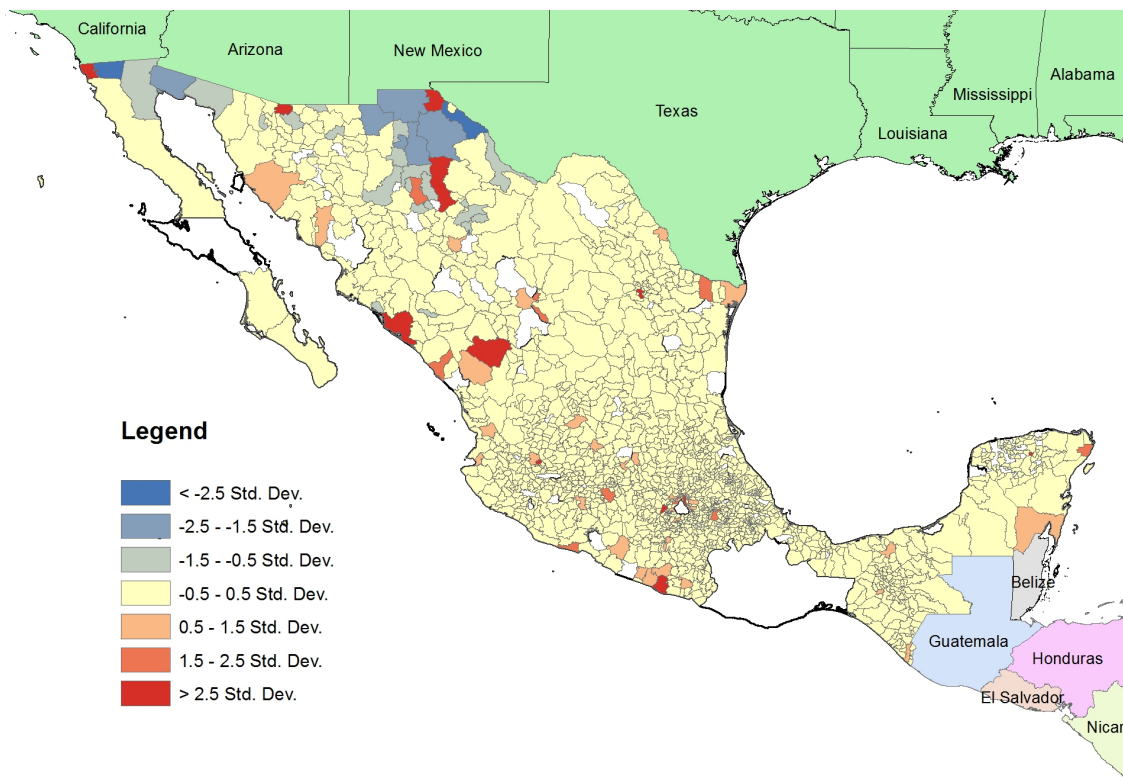


Figure 7: Coefficient estimated by GWR for all municipalities in 2008. Note that Oaxacan municipalities do not follow a consistent naming pattern and are excluded from this analysis.

correlation in geospatial data (Paradis 2014). Moran’s I , as defined by Moran (1950) is:

$$I = \frac{N}{\sum_{i=1} \sum_{j=1} w_{ij}} \frac{\sum_{i=1} \sum_{j=1} w_{ij} (X_i - \bar{X})(X_j - \bar{X})}{\sum_{i=1} (X_i - \bar{X})^2} \quad (16)$$

where N is the number of units in the sample; X is our variable of interest (in this case, Tenure), \bar{X} is the mean of X ; and w_{ij} is an index of spatial weights. As the null hypothesis is no spatial autocorrelation, the expected value of I_0 is defined as $I_0 = -1/(n - 1)$. The expected value of I_0 is known, we can test for a statistically significant difference between the observed I (\hat{I}) and I_0 . When $I_0 > \hat{I}$, it suggests evidence of positive spatial correlation. In contrast, when $I_0 < \hat{I}$, it is evidence of negative spatial correlation. Finally, when I_0 is not statistically distinguishable from \hat{I} , we cannot reject the null hypothesis that the data is randomly distributed spatially (Paradis 2014).

In this case, we use Equation 16 to estimate the Moran’s I for our model. Our estimated I — i.e. \hat{I} — is 0.002. We then test whether this estimated value is statistically distinguishable from the expected value of I under the null hypothesis, which is -0.0005. The p -value of the difference between these two values is 0.20, which means we cannot reject the null hypothesis. Although this does not definitely prove that there is no spatial dependence, it strongly suggests that there is no statistical evidence for it that is discernible in our data.