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# The Beheading of Criminal Organizations and the Dynamics of Violence in Mexico's Drug War*

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## Abstract

In 2006 the Mexican government launched an aggressive campaign to weaken drug-trafficking organizations (DTOs). The security policies differed significantly from those of previous administrations in the use of a leadership strategy (the targeting for arrest of the highest levels or core leadership of criminal networks). While these strategies can play an important role in disrupting the targeted criminal organization, they can also have unintended consequences, increasing inter-cartel and intra-cartel fighting and fragmenting criminal organizations. What impact do captures of senior drug cartel members have on the dynamics of drug-related violence? Does it matter if governments target drug kingpins vs. lower ranked lieutenants? We analyze whether the captures or killings of kingpins and lieutenants have increased drug-related violence and whether the violence spills over spatially. To estimate effects that are credibly causal, we use different empirical strategies that combine difference-in-differences and synthetic control group methods. We find evidence that captures or killings of drug cartel leaders have exacerbating effects not only on DTO-related violence, but also on homicides that affect the

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general population. Captures or killings of lieutenants, for their part, only seem to exacerbate violence in "strategic places" or municipalities located in the transportation network. While most of the effects on DTO-related violence are found in the first six months after a leader's removal, effects on homicides affecting the rest of the population are more enduring, suggesting different mechanisms through which leadership neutralizations breed violence.

## 1. Introduction

Since 2006, more than 60,000 drug-related murders have taken place in Mexico. The vast majority of these deaths have been caused by confrontations between drug cartels competing for control of drug trafficking routes to the world's largest market: the United States. While Mexican drug trafficking organizations (DTOs) are primarily about the trafficking of narcotics, they have diversified into extortion, kidnapping for ransom, oil theft, and human trafficking, among other criminal activities. DTOs extend their tentacles to many realms of society, and they have built a huge capacity for violence.

The sharp increase in homicide rates coincides approximately with the start of President Felipe Calderón's administration and his militarized campaign to debilitate DTOs. A critical question is to understand what happened in that period to cause such a dramatic increase in violence. There is controversy about whether the "war against drug cartels" caused some or all of the escalation of violence. In December of 2006, president Calderón deployed 6,500 federal troops to his native state of Michoacán; thereafter operations against drug trafficking increased, with approximately 45,000 troops involved by 2011. President Calderón's policies differed significantly from that of previous administrations in using a leadership strategy – the targeting for arrest of the highest levels or core leadership of criminal networks -- as a key element of his counter-narcotics policy. In fact, during Calderón's administration, crop eradication (marihuana and poppy seed) and cocaine seizures were considerably lower than during president Fox's

administration (2000-2006). Even marihuana seizures showed a slight decrease during this period (Primer Informe de Gobierno, 2013)[1]. But what really differentiated these administrations was the unprecedented number of arrests and the magnitude of military deployment[2]. In March 2009 the government released a list of Mexico's 37 most wanted drug lords and by January 2011 the army, navy, and federal police had captured or killed 20 out of the 37, twice the number of kingpins captured during the two previous administrations (Guerrero 2011).

Leadership strategies often play a significant role in counter-narcotics policies, but did they work in Mexico? Does it matter if governments target the kingpins vs. lower ranked lieutenants? These questions are critical and should be able to inform government policy beyond the normative judgments about the desirability of these arrests. Targeting insurgent and terrorist leaders is also central to many states' counterinsurgency policies (Pape 1996, 2003; David 2003; Jordan 2009; Johnston 2012). Hence, beyond Mexico's drug war, this paper is relevant for the broader question of counterinsurgency strategies and the effectiveness of leadership elimination.

Critics of President Calderón's policies claimed not only that he was unsuccessful in disarticulating criminal organizations but also that his actions in arresting or killing the leaders of many drug cartels were a direct cause of the sharp increase in violence during his administration (Guerrero 2011). Others have joined a lively debate about whether Calderón's policies caused the violence or rather were a response to intensified inter-cartel fighting (Escalante 2011; Merino 2011; Poiré and Martínez 2011; Rosas 2011; Jones 2013; Trejo and Ley 2013)

In this paper we seek to evaluate the consequences of the kingpin capture strategy for the escalation of violence. While these strategies can play an important role in disrupting the targeted criminal organization, they can also have unintended consequences, increasing inter-cartel and intra-cartel fighting and fragmenting criminal organizations (Guerrero 2010, 2011; Jones and Cooper 2011; Jones 2013).

A limitation of previous studies that attribute the escalation of violence to government policies is that they do not adequately address the challenges of identifying causal effects. Kingpin killings and captures are not randomly assigned. It is conceivable that successful captures or killings take place in areas where there are pre-existing internal splits within DTOs or where rival criminal gangs violently dispute territory. These pre-existing conflicts might facilitate the work of government intelligence agencies and make captures more likely. A host of threats to inference, including selection bias and reverse causality, arise from the non-random assignment of captures or killings.

Our empirical strategy combines a difference-in-differences methodology with the use of credible counterfactuals of policy interventions by using synthetic control methods (Abadie and Gardeazabal 2003; Abadie, Diamond, and Hainmueller 2010) to construct "control" municipalities that have trends in homicides that are similar to "treated" municipalities, namely those where kingpins or lieutenants are killed or captured. This empirical strategy requires a time series that is long enough to estimate pre-intervention or "natural" trends in violence. We use data from the National System of Health Information (SINAIS) to construct crime statistics at the municipal level for over a decade prior to Calderón's presidency.

Our results can broadly be summarized as follows. Neutralizations of drug cartel leaders have positive (i.e., exacerbating) short-term effects not only on DTO-related violence, but also on homicides that affect the general population. Moreover, after the capture of either a leader or a lieutenant violence spills over to neighboring municipalities in the form of both increased DTO-related deaths and homicides among the general population, particularly to places that are connected to the transportation network and are thus "strategic" for the drug trafficking business. While most of the spillover effects on DTO-related violence occur in the first six months after a leader or lieutenant's neutralization, all spatial effects on homicides against the rest of the population are observed in the medium term.

The rest of the paper is organized as follows. Section 2 discusses the existing literature. Section 3 discusses our theoretical expectations about when and why we should expect captures or killings of kingpins and lieutenants to increase violence. Section 4 describes the data we use. In Section 5 we explain our empirical strategy; while section 6 describes the results. We present our conclusions in Section 7.

## 2. Related Literature

Do government crackdowns on drug cartels increase violence? Using a case study of the Arellano Felix Organization, Jones (2013) documents an apparent increase in kidnappings and extortion as a result of kingpin arrests in Tijuana. In a series of articles, Guerrero (2010 and 2011) has argued that a key cause of the escalation of violence in Mexico is the war on drugs and the leadership strategy followed during the Calderón administration. Poiré and Martínez [3] (2011) responded, arguing that government interventions tend to happen in places where

violence is escalating, normally as a result of pre-existing turf wars among criminal organizations. In their view, pre-existing conflicts between criminal organizations, rather than government action, are the main factor that explains spikes in violent trends in specific regions in Mexico.

In a related debate on the impact of "joint operations" – interventions involving the participation of military forces in coordination with the federal and local police – on violence, Escalante (2011) argues that the deployment of the army has played a significant role in the escalation of violence in Mexico.

Lessing's (2012) comparative study of Brazil, Mexico and Colombia emphasizes that state crackdowns on traffickers are more likely to succeed when the state follows a "conditional approach," where repression is conditional on cartels' use of violence, as in Rio de Janeiro's recent pacification of some of the city's favelas, and not when the state hits cartels "without distinction," as in Mexico's recent drug war. His approach draws from Kleiman's (2009) insightful analysis arguing that "brute force strategies" to fight crime often backfire and that strategies that focus on "crime-control" are more effective. In his approach, governments should develop a "consequence-focused approach" to crime control that aims to limit the damage crimes does rather than focusing exclusively on punishing criminals.

Almost all of the aforementioned analyses on the effects of Calderón's government policies on drug-related violence fail to use current methods that seek to address classic endogeneity and identification problems. In an innovative study, Dell (2011) uses a regression discontinuity design to compare municipalities in which a mayor from the PAN, Calderón's party, won or lost an election by a narrow

margin, assuming that this is akin to a random assignment. The intuition behind this identification strategy is that the federal government is likely to intervene more effectively in municipalities that are controlled by the PAN. She provides evidence suggesting that post-election violence is higher for municipalities where the PAN wins by a small margin, and argues that violence increases due to state crackdowns on drug cartels. Nevertheless, her analysis lacks a direct measure of government action.

Most of the scholarly literature has focused on the extent to which state polices against drug cartels impact the dynamics of drug trafficking violence. Nevertheless, international factors have also played a role in Mexico's recent escalation of violence. Castillo et al (2013) argue that Colombia's successful interdiction policies implemented since 2006 should also be credited for Mexico's intensification of violence. The authors empirically demonstrate that drug seizures in Colombia translated into increases in cocaine prices, which in turn increased incentives for drug cartels in Mexico to expand their control over valuable drug trafficking routes and to fight each other for control of such routes, predominantly located near the US-Mexico border.

Going beyond drug wars, comparative research has explored the effectiveness of leadership captures or killings in counterinsurgency strategies. Most scholarly work contends that leadership neutralizations are ineffective. In his study of suicide terrorism, Pape (2003) argues that leadership arrests have meager success. Jordan (2009) found that instead of causing organizational collapse, leadership removals often extend the survival of groups that would have otherwise dissolved. David

(2002) argues, for the case of Israel's targeted killing policy, that it has had a negative net effect, "increasing the number of Israelis killed, by provoking retaliation" (p. 2002: 22).

However, Johnston (2012) challenges these findings drawing on newly collected data on counterinsurgency campaigns. The author looks at cases when governments attempted, successfully or unsuccessfully, to remove top insurgent leaders. This variation is exploited to construct plausible counterfactual scenarios that enable him to study differences in political and military outcomes that follow successful and failed attempts. He shows that after a successful intervention, insurgencies are more likely to end and insurgent attacks to decrease.

Price (2012) argues that effective leadership arrests require that: i) leadership survival must be essential for the overall success of the organization; and ii) leadership should be hard to replace. Price claims that both of these conditions apply to terrorist groups. The empirical analysis focuses on the "mortality rate" (in a hazard model) of terrorist groups over a longer period of time. He finds that "decapitated" groups have a significantly higher mortality rate than non-decapitated ones.

## 3. Theory: linking drug kingpin captures and violence

We can identify four mechanisms through which captures or killings of DTO leaders might breed violence. Captures or killings of DTO leaders might cause violent succession struggles within cartels. Although DTO leaders are critical for coordinating the operations of the criminal organization, these leaders can be replaced. There are likely large numbers of potential leaders given that cartels seem

to predominantly attract members through the promise of profits--although there is evidence that some cartels in Mexico, such as La Familia Michoacana, have also relied on indoctrination[4].

The internal organization of DTOs might further affect their vulnerability to leadership replacement. Hierarchical, coherent, and centralized organizations might be more vulnerable to leadership killings or captures than horizontal, amorphous, and decentralized groups. Although the word "cartel" is used colloquially, Mexican criminal organizations do not collude to set the price of drugs. Grillo (2011) describes them as highly decentralized organizations, in which *plaza* heads run cells that are semiautonomous.[5] Each cell makes money in its own territory and delivers it to lieutenants, who deal with the kingpins or *capos*. A cartel's kingpin typically has near absolute control over his lieutenant subordinates, who respond directly to him. Lieutenants are responsible of overseeing the operation of the various criminal cells in their area of influence. The lieutenants also oversee the selection of *plaza* heads, who appoint cartel *sicarios,* or killers, and *halcones*, or hawks, who are "the eyes and ears" of DTOs in charge of identifying those who seek to traffic without permission.[6] These kinds of decentralized and amorphous criminal organization are likely to be less vulnerable to leadership captures.

A second reason why leadership captures or killings might breed violence is by creating inter-cartel fighting. Drawing on Fearon (1995) and Powell (2006), we can hypothesize that DTOs fight among themselves to control mutually prized territories when they can't reach stable bargained solutions due to commitment problems stemming from imperfect contracting in a black market, where

institutional enforcement mechanisms are lacking, or to asymmetric or imperfect information about the value of the trafficking route that prevents them from reaching a mutually agreed price. Territorial control allows the armed group to operate a protection and taxation racket, and to control the retail trade of drugs (or other illicit goods) by criminal organizations in towns and neighborhoods.

The nature of turf wars implies that state interventions vs. DTOs often produce the paradoxical result of lowering the cost of fighting. When the government targets a DTO's leader, it weakens the leader's organization, creating incentives for other cartels to challenge its control over trafficking routes and territories, and for lower rank members to fight among themselves for the vacant leadership position.

Drug cartels are especially motivated to fight for what in this paper we call "strategic points," transportation hubs and territories that are valuable for the trafficking of drugs: logistics points that are well connected to the flows of international trade because they have a port, an airstrip, an airport, freight hubs or high-speed highways to the US border and major cities in Mexico. The control of a strategic point gives a cartel not only capacity to smuggle drugs into the US, but—perhaps of equal importance-- the power to tax the long-distance drug trade of other criminal organizations.[7]

A third way in which leadership captures or killings might breed violence is by breaking chains of command within cartels that seem to play a role in disciplining local criminal cells. Local criminal cells work for the drug-trafficking network by providing a variety of services, including moving drugs across their territory, negotiating with the local police, enforcing deals, and silencing and deterring rivals.

When a DTO leader or lieutenant is neutralized, this chain of command is broken. Local criminal cells might find it too costly to continue to engage in long-distance drug trade –which requires coordinating a large criminal network – and might switch to other delinquent behaviors to extract resources, including extortion and kidnappings (Guerrero, 2011). Hence, an additional unintended consequence of kingpin and lieutenant captures might be to increase crime and violence against the general population. This last mechanism presupposes that senior cartel members possess an interest in limiting criminal predation by their cells against civilians. [8]

A final way through which leadership captures might translate into more violence is when DTOs decide to attack the state, perhaps as a warning signal to the government about their capacity for resistance or in the hope that their attacks will be attributed to a rival organization, thereby increasing the likelihood that the government will target the latter. Nevertheless, our data on DTO-state violence is scarce and does not allow us to estimate how much captures increase this type of violence.

Our analysis will seek to uncover differential impacts for captures of kingpins and lieutenants. Lieutenants are DTOs' territorial agents who have the knowledge and connections to run the illegal business in a particular territory. *Capos* are not in charge of the DTO operations for a specific municipality or territory. Rather, they manage the larger organization and coordinate DTO activities across territories and municipalities.

The empirical section of our paper leverages the timing and location of a killing or capture to estimate how they affect violence in the region where they take place.

Because lieutenants are DTOs' territorial agents who run the illegal business and command the local criminal cells in a particular territory, the effects of these captures should be more localized than leaders' captures. Kingpin captures presumably impact the structure of the illegal market in all of the territories where the cartel operates.

## 4. Data and variables of interest

In the next sections we estimate the temporal and spatial effects of capturing DTOs leaders and lieutenants on violence, measured by the number of homicides in a given municipality. Two sources of information are available to measure our dependent variable: the number of homicides related to DTOs as reported by the federal government (herein government data) and the information from death certificates collected by the Mexican National Institute of Statistics and published by the National System of Health Information (SINAIS data).

The government data was built in a coordinated effort by the federal security agencies: Ministry of National Defense, Ministry of the Interior, Attorney General's Office, Federal Police, and Mexican army. The database reports the number of homicides presumed to be related to drug-trafficking per municipality from December 2006 to September 2011. Deaths are classified in three groups: (i) deaths observed during a government intervention ("confrontations"), (ii) deaths related to DTO attacks against military and police forces ("aggressions"), and (iii) homicides related to DTO rivalry ("executions").

According to government data, most of the sharp increase in homicides is accounted by "executions" or DTO-DTO violence escalating after 2007. DTO-state violence accounts for less that 10% of the deaths reported in the database.

A main disadvantage of the government dataset is that information on homicides before December 2006 is not available, making comparisons to violence trends before Calderón's administration difficult. In addition, there might be biases due to government under- or over-classification of "drug related" homicides and the incentives of local police and prosecutors to misreport, making necessary the use of additional sources of information.

In our analysis we use both the government data and the SINAIS data. The latter has the advantage of having information on the trends of violence before 2007; death certificates are coded by doctors and issued by local offices of the Attorney General's Office and contain information on the age and gender of the deceased.

The SINAIS data is available for a longer period of time, but it does not separate those homicides related to DTO-DTO confrontations from homicides within the general population. In order to estimate the historic trends of drug-related violence in each municipality, we analyzed the variation of homicides across different groups of age and gender in SINAIS data and chose the group that best resembled the variation of drug-related deaths ("executions") reported by the government.

In particular, we estimated the number of homicides for each gender in five-year age cohorts between 15 and 64 years old -- from 15 to 19 years old, from 20 to 24 years old, and so on up to 60 to 64 years old. Then we constructed all possible combinations of any size from 1 to 20 of the 20 groups[9] – 10 for each gender – and

used each combination to predict (the government dataset) of drug-related murders from December 2006 to December 2010 on a quarterly basis.

After comparing the minimum mean squared error over more than one million regressions, the homicides of males between 15 and 39 years old in the SINAIS dataset best resembled the variation across time and space of drug-related homicides reported by the government (see Figure 1 below). In the sections to follow we use this group of homicides as a proxy of homicides related to DTO-DTO confrontations.

**[Figure 1 about here]**

According to the government data, between December of 2006 and 2010 drug-related homicides were observed in 1,132 municipalities. The 20 most violent municipalities account for 50% of total deaths during this period. The most violent municipality was Ciudad Juárez, Chihuahua, where 6,437 drug-related homicides -- 20% of the observations – occurred during the period of study. In order to estimate more accurately the average effect of capturing or killing a lieutenant on violence, we excluded Ciudad Juárez from the analysis since it is an outlier with considerably higher variance than the rest of the sample. Including it in the analysis does not alter the direction of our results.[10]

In 2007 violence was initially concentrated in a few municipalities, mainly on the border with the U.S. and in drug producing states such as Sinaloa and Michoacán. By 2010, violence was widely spread in the north of the country but also in major cities like Guadalajara and Monterrey. The most violent states were Chihuahua, Sinaloa, Tamaulipas, and Guerrero, all of them in the main routes of drug trafficking.

Closer inspection of the data suggests that turf wars among DTOs are predominantly fought in prized municipalities connected to the transportation network. Figure 2 maps DTO-related homicides using the government data, zooming in on the northwest of the country, which is the most violent region. The map displays the location of strategic points --ports, border crossings, freight train hubs, airports, landing sites, railroads, and highways. Municipalities at or along these points are particularly valuable for the trafficking of drugs because they are connected to the flows of commerce and international trade. For the same reason, they are also more likely to witness drug-related violence. There is also a spatial correlation in the levels of violence. Municipalities closer to more violent municipalities seem to also experience higher levels of violence.

**[Figure 2 about here]**

In order to estimate the effects of capturing or killing a leader or a lieutenant we analyzed the trends of violence across three different groups of municipalities: *Treated municipalities* are defined as those municipalities where a leader or a lieutenant was captured between December 2006 and December 2010. *Neighboring municipalities* are defined as those municipalities with a geographic border with a treated municipality. Finally, *Strategic neighboring municipalities* are those municipalities with a geographic border with a treated municipality that are also strategic points in the transportation network, as will be described in Section 6.2.[11]

Table 1 shows summary statistics of drug-related deaths and homicides during the period of study. The average monthly number of homicides for males between 15 and 39 years old for treated municipalities is 4.48 while the monthly mean of

drug-related murders in the government data for the same municipalities is 2.74. The difference in the datasets suggests two possible overlapping scenarios: i) treated municipalities experienced a high number of homicides for this group of age and gender that were not related to DTOs; ii) there were homicides related to DTOs that were not classified as such by the government authorities. If the second scenario is more prevalent, then estimates based on the SINAIS data should provide more accurate estimates of violence than those based on the government data.

Municipalities where government interventions occurred were far more violent than other municipalities during the period of study. Neighboring municipalities were also more violent on average than municipalities where the government did not intervene. Finally, it can be observed in Table 1 that homicides of males 15-39 years old are more prevalent than homicides in the rest of the population, especially in treated municipalities and neighboring municipalities.

**[Table 1 about here]**

The information on neutralization of leaders comes from President Calderon's last annual government report (Sexto Informe de Gobierno, 2012). The report contains an extensive list of government interventions between 2007 and 2012 including drug and gun seizures, eradications of marihuana and poppy seed plots, and captures of DTO's main leaders and lieutenants.

While the list on leadership captures is exhaustive, the report underlines the neutralization of more than 150 lieutenants but fails to describe them. Our data on lieutenants comes from an extensive online search on the main national and local newspapers in Mexico. For each capture, we looked for two different sources of

information to confirm the identity, date, place, rank, and criminal organization of the regional leader[12.]

According to our sample, between December of 2006 and December of 2010 the government captured or killed 18 leaders and 119 lieutenants of seven main cartels in 73 municipalities. About one third of the lieutenants and leaders who were captured or killed were related to the Gulf Cartel or the Zetas. The rest of the neutralized leaders came mostly from the Beltrán Leyva and Sinaloa cartels.

## 5. Empirical Strategy

### 5.1. Captures and Killings of Leaders and Lieutenants

In assessing the possible effects of the leadership neutralizations, comparisons should be made across time and space. First, within each municipality, we must compare violence before and after an intervention. Second, we must compare municipalities where the government captured a leader or a lieutenant to other municipalities.

Locations where leadership eliminations occur are not random. As discussed above, the government might intervene when rival criminal gangs are fighting turf wars and a municipality is observing increasing violence. These municipalities might have unobservable characteristics that make them different than the rest of the municipalities. For these reasons, not all untreated municipalities are good counterfactuals.

On the other hand, leadership neutralizations do not occur at the same time. When planning an intervention, the government not only considers a municipality's levels of violence, but also logistics (coordination of federal police, army, and navy)

and whether it has the criminal intelligence to locate a leader. We exploit the variation in the timing of captures by restricting the sample to only those municipalities where a leadership removal occurred. The identifying assumption in our strategy is that there is no omitted variable that changes at the same time and space as captures or killings and that directly affects the occurrence of homicides.

More specifically, by using time fixed effects and municipality fixed effects this strategy will control for: i) observed and unobserved characteristics common to all treated municipalities in a specific period of time; and ii) observed and unobserved characteristics for every treated municipality that are constant over time.

However, the empirical strategy will not control for unobservable characteristics that are changing over time and affect the trends of homicides. We refer in particular to interventions by the military or federal police or fights between competing DTOs that take place before a leader is captured or killed and that might also affect violence. A way to control for the non-random assignment of leadership captures or killings is to use as a comparison group places that have experienced similar circumstances. By exploiting the different timing of the captures, and restricting the sample to the treatment group, we will make sure that those places have been, on average, under similar circumstances before a leader or lieutenant was caught. In addition, credible counterfactuals for the treated municipalities are built through the use of the synthetic control method explained below.

It is reasonable to argue that places where leaders were captured are intrinsically different from those where lieutenants were caught. Therefore, in the first part of the analysis we estimate different regressions restricting the sample to

either municipalities where leaders were captured or those where lieutenants were captured.

Nonetheless, there are not many municipalities where the government captured either leaders or lieutenants, which causes a reduction of statistical power to estimate the effects of captures or killings of DTO leaders. But there are likely to be multiple municipalities with similar characteristics to the treated municipalities that remain untreated. For instance, when the government plans to capture a leader or a lieutenant, it is likely to perform various failed attempts in different locations across municipalities until it is finally able to apprehend or eliminate him. Ideally, we should look at cases of successful and unsuccessful attempts to remove top leaders, as in Johnston (2012), to construct plausible counterfactual scenarios. Although we do not have such data, we can still find some untreated municipalities that serve as accurate counterfactuals, increasing the statistical power of our analysis.

Using the synthetic control method developed by Abadie and Gardeazabal (2003) and Abadie, Diamond, and Hainmueller (2010), we construct counterfactuals that will allow us to estimate what would have happened in a given treated municipality had government captures or killings not taken place. This method constructs a "synthetic" control municipality for each treated unit by assigning greater weight to control (untreated) municipalities that experienced similar pre-treatment homicide trends to those of the treated municipality, and smaller weights (or no weight) to control units that observed different trends. The pre-treatment period is defined as the time span before a leader or lieutenant was captured. The

optimal weighting ensures then that the synthetic control municipality has pre-treatment trends that are maximally similar to that of the treated municipality.

The synthetic control method follows the same principle as the traditional matching methods. However, by constructing each match as a weighted average of the full set of control units, the synthetic control method is able to reproduce the pre-treatment trends of the outcome variable of interest better than other methods of matching. Let $X_1$ be a $(K \times 1)$ vector of pre-treatment values of $K$ homicide predictors for a treated municipality. Let $X_0$ be a $(K \times J)$ matrix of the same predictor variables for $J$ potential control units. Let $V$ be a $(K \times K)$ diagonal matrix of non-negative weights for the predictor variables. The vector of synthetic weights $W^*$ minimizes the function $(X_1 - X_0 W)' V (X_1 - X_0 W)$ subject to $w_j \geq 0$ $(j=1,2,...J)$, with the sum of these weights equal to one. The vector $W^*$ depends on the matrix $V$, and as Abadie and Gardeazabal (2003) mention, $V$ is chosen such that the convex combination produced by the synthetic control group best reproduces the pre-treatment trends of the treated municipality.

### 5.2. Construction of Synthetic Weights

For each treated municipality we estimated a vector of synthetic control weights by assigning optimal non-negative weights to the more than two thousand untreated municipalities. Untreated units are defined as those municipalities where neither a leader or a lieutenant was captured during the period of study, and that were not geographic neighbors to treated municipalities.

Eleven predictors were chosen to reflect the short and long term trends in violence in each treated municipality before a capture. The predictors were the

monthly number of homicides in the six previous months before the intervention and the total number of homicides in each of the 5 years before this 6-month period.

Given computational constraints, for each of the eleven pre-treatment periods we identified the thirty municipalities in the set of potential control municipalities with the closest levels of violence in absolute value to the ones of the treated municipality. The control group for each treated municipality was then formed by the union of the eleven sets with thirty municipalities each. A single synthetic control unit for each treated municipality was estimated as an optimal weighted average of the corresponding control group.[13] Finally, after estimating a vector of optimal weights for each treated municipality, we added the weights for each control municipality across vectors and conducted our analysis using the resulting vector of sums.

We estimated a vector of optimal weights for each treatment (capture of a leader *vs* capture of lieutenant) for each outcome variable (drug-related homicides *vs* homicides in the general population), for both treated and neighboring municipalities, giving a total of eight different sets of weights.

As mentioned above, because the synthetic control municipality is meant to reproduce the trends of homicides that would have been observed in the absence of the treatment, we excluded from the potential control group those municipalities that could have been affected by regional spillover effects, such as municipalities that share a geographic boundary with the treated ones.

We can now compare the estimates from the synthetic control method to those obtained through our first strategy with a restricted sample. Similar estimates using

the two methods will suggest that treated municipalities are a good comparison group among themselves. The second strategy will provide additional information in case we do not observe a significant effect using the first method because of the lack of statistical power.

Figure 3 shows the weighted residuals of homicide trends for the synthetic controls and the residuals for treated municipalities (separating those where a leader was captured from those where a lieutenant was caught). We use as outcome variable the monthly number of homicides of males between 15 and 39 years old from December 2006 to December 2010 as reported by SINAIS.[14] The residuals are constructed after running a regression with municipality and time fixed effects and a linear time trend for each municipality. The linear time trend is the prediction of the linear representation of homicides using the pre-treatment period, which is from January 2001 to one month before a leader or a lieutenant is captured or killed. Time is normalized such that zero represents the month when the intervention occurs. For the control municipalities, zero represents December 2006.

The variation of the residuals must be accounted for by the treatment--the capture or the killing of a senior cartel member. Municipality-specific characteristics that are likely to affect violence (geographic location, poverty, urban or rural status, etc.) or municipality pretreatment trends of violence do not shape the residuals. The exercise presented here is then a useful way to evaluate the validity of our synthetic control group.

**[Figure 3 about here]**

It can be seen that the pre-capture homicide trends for municipalities where a leadership capture occurred closely match the homicide trends of the synthetic control groups. The results of the exercise give us confidence that there is no observed upward trend before a leader is captured, which would render our control group problematic. We conclude that the optimal weighting of untreated municipalities using the synthetic weights estimated above provides good counterfactuals to municipalities where government interventions occurred.

Figure 3 shows an increase in violence during the first six months after the capture of a leader. The increase persists for another six months. Our analysis does not uncover longer-term effects since the number of municipalities that we can observe one year after the treatment is small.

### 5.3. Econometric Specification

Table 1 provides summary statistics on the monthly number of homicides for different series of data from December 2006 to December 2010. Given that the variance of homicides is greater than the mean for any group and period, a negative binomial distribution is preferred to a Poisson distribution in the econometric specification. In order to identify the effects of capturing a leader or a lieutenant we define the following equation:

$$(1)\quad E[y_{mt}|x] = \exp\,(\alpha + \gamma PopSize_{mt} + \delta_t + c_m + \beta_1 after(1-6\ months) * leader_{mt} + \beta_2 after(7-12\ months) * leader_{mt} + \beta_3 after(remaining\ months) * leader_{mt} + \beta_4 after(1-6\ months) * lieut_{mt} + \beta_5 after(7-12\ months) * lieut_{mt} + \beta_6 after(remaining\ months) * lieut_{mt}$$

where $y$ is the monthly number of homicides in municipality $m$ in time $t$; $\delta_t$ represents time fixed effects and $c_m$ are the municipality fixed effects. The variable $PopSize_{mt}$ represents the population size of interest. The variables *after(1-6*

*months)*leader* and *after(7-12 months)*leader* are indicator variables that take the value of 1 during the first 6 months and between the 7th and 12th months, respectively, after a leader's capture. The same logic is followed for the case of a lieutenant. Finally, the variable *after(remaining months)* takes the value of 1 for all remaining periods in the dataset after one year beyond the government intervention. Because of the timing of the captures and the length of our time series, we only have information beyond a year from the treatment for 8 out of 18 captures of leaders, and for 53 out of 119 captures of lieutenants. Given the insufficiency of data for longer post-treatment periods, the analyses in the following sections will focus on the effects of government interventions on violence during the first two six-month periods after the treatment.[15]

Neighboring municipalities are analyzed as well. In this case, treated units are defined as neighboring municipalities to the ones where government interventions occurred. To estimate the effects of leadership captures or killings on violence for this set of "indirectly" treated municipalities, we will use the following econometric specification:

$$(2)\quad E[y_{mt}|x] = \exp\,(\alpha + \gamma PopSize_{mt} + \delta_t + c_m + \beta_1 after(1-6\,m) * (leader\ neigh)_{mt} + \beta_2 after(7-12\,m) * (leader\ neigh)_{mt} + \beta_3 after(remaining\ m) * (leader\ neigh)_{mt} + \beta_4 after(1-6\,m) * (lieut\ neigh)_{mt} + \beta_5 after(7-12\,m) * (lieut\ neigh)_{mt} + \beta_6 after(remaining\ m) * (lieut\ neigh)_{mt}$$

As in Equation 1, the interaction of each variable indicates the time span after a DTO member is captured in a neighboring municipality. For example, the variable *after(1-6m)*(leader neigh)* takes the value of 1 when a municipality shares a geographic border with one where a leader is captured and only during the first 6 months after the intervention. Corresponding sets of weights and synthetic control

units were estimated for neighboring municipalities to replicate their pre-treatment trends of homicides.

## 6. Results

### 6.1. Effects of government interventions on violence in treated municipalities.

Table 2 below shows the estimated coefficients of the negative binomial model described in Equation 1, taking as the dependent variable the number of homicides of males between 15 and 39 years old, our proxy for drug-related homicides, and the number of homicides in the rest of the population between December of 2006 and December 2010.[16]

The results are estimated for different samples of the data. The sample in the first two models is restricted to those municipalities where at least one leader (Model 1) or one lieutenant (Model 2) was captured. Models 3 and 4 weight the full sample using the corresponding vector of synthetic weights.

**[Table 2 about here]**

Models 1 and 3 compare, respectively, homicide levels after a leader's capture to pre-treatment levels in treated municipalities, and to post-treatment levels in their synthetic counterfactual scenarios. Since the treatment in these models is defined as the capture of a leader, the variables of interest (in bold) are *after(1-6 months)*leader* and *after(7-12 months)*leader*. Conversely, the relevant comparison scenarios in Models 2 and 4 are, respectively, the pre-treatment violence levels in municipalities where a lieutenant was captured, and the post-treatment levels in the synthetic counterfactuals estimated around such interventions. Therefore, the

variables of interest in these two models are *after(1-6 months)*lieutenant* and *after(7-12 months)*lieutenant*.

The rest of the covariates in the models shown in Table 2 are included as control variables. All specifications include time and municipality fixed effects and control for the size of the population of males in the same group of age. Robust standard errors are clustered at the municipality level.

The results show a significant and positive increase in both DTO-related homicides and homicides in the rest of the population in the first 6 months after the neutralization of a leader. The predicted percentage change in the number of homicides after a government intervention is reported in the second column of each model.[17]

According to Model 1, the average number of monthly homicides in treated municipalities during the six months after a leader is captured or killed is about 31.2% higher than in the pretreatment period, with respect to DTO-related violence, and 33.9% higher with respect to homicides in the general population.

The estimated effects for leadership captures or killings in the difference-in-difference specification using the full weighted sample (Model 3) are of similar magnitude and significance. With respect to its synthetic counterfactual, the capture of a leader is related to average increases of 36.5%, in drug-related homicides and 34.0% in homicides against the rest of the population, during the first six months after the capture. After this period, we found no evidence that the levels of violence are significantly greater than those in the pre-treatment period or in the counterfactual scenario.

There is no evidence that the capture of a lieutenant is related to increases of violence in the short or medium term in treated municipalities. Nevertheless, the neutralization of a leader in municipalities where a lieutenant was also captured is related to substantial increases in both general and drug-related violence during the first six months after the capture (Models 2 and 4).

A conclusion from these models is that captures of kingpins are associated with increases in both DTO-related violence and homicides among the rest of the population during the first six months after the intervention takes place. By contrast, lieutenant captures or killings do not seem to cause increases of DTO-related violence nor spread homicides among the general population in the treated municipality.

### 6.2. Spillover effects in neighboring municipalities

The spillover effects are presented in the following sections. The estimates for the coefficients of the negative binomial model described in Equation (2) measure the change -- after a government intervention-- in the monthly number of homicides in neighboring municipalities.

For each type of capture (leader *vs.* lieutenant), two different sets of synthetic weights were estimated in order to resemble the pre-intervention trends of homicides in neighboring municipalities. One set was constructed to approximate the monthly number of homicides of males between 15 and 39 years old and another one to match the homicides for the rest of the population. Municipalities where the interventions occurred were excluded in the estimation of the weights.

In general, our estimates do not show significant spillover effects in neighboring municipalities on DTO-related violence, as measured by homicides of males between 15 and 39 years old when either a leader or a lieutenant is captured.[18] But we do find evidence of spillover effects in neighboring municipalities with respect to homicides within *the rest* of the population when a leader is captured. The estimates in Table 3 show that the capture of a leader is associated with a medium-term increase of 33.6% (Model 1) in the number of homicides in the general population in neighboring municipalities, and 29.9% increase with respect to their counterfactual synthetic scenarios (Model 3). In comparison, we found no evidence that the capture of a lieutenant has short- or medium-term spillover effects on violence within the general population (Models 2 and 4).

Hence, there is strong evidence for the spread of violence within the general population after a leader is captured, both in the treated municipality and in neighboring municipalities. These results demonstrate that drug cartel leadership captures not only increase DTO-DTO violence in the short term but have medium-term consequences by increasing violence in other groups of the society. By contrast, there is no evidence that violence increases when lieutenants are captured. Does this mean that lieutenants' removals are inconsequential? Below we further explore spillover effects by focusing on strategic municipalities. We believe that lieutenant captures might be more consequential in places that DTOs aspire to control and hence are worth fighting for.

**[Table 3 about here]**

### 6.3. Spatially heterogeneous effects: the role of strategic points

The increase in the number of homicides in Mexico has strong connection to turf wars between DTOs that fight for the control of valuable plazas and traffic routes. We have argued that municipalities located in strategic points or near the transportation network are particularly valuable and hence vulnerable to turf wars.

In this section, we estimate spatially heterogeneous effects of government captures of DTO members on the monthly number of homicides. In particular, we are interested in differentiating the regional effects of leadership captures or killings in those municipalities more central, or strategic, in the trafficking network compared to less connected municipalities.

The analysis of a transportation network is a challenging task and requires a model complexity that falls outside of the scope of this study. Instead, we propose a simple measure of connectivity to roughly distinguish the most valuable municipalities in the drug trafficking routes. As defined earlier, a municipality is a strategic point in the transportation network if at least one of the following facilities is located within it: an airport, an aerial landing field, a seaport, a freight train crossing, or a Northern border crossing.[19]

We added to the specification in Equation (2) interaction terms of our dummy variable for strategic points and each of the variables measuring the temporal effects of government interventions. Given the limited number of treated municipalities with respect to the number of covariates in the new model, we only estimate heterogeneous effects of government interventions for neighboring municipalities. Spillover effects were estimated separately for leaders' and

lieutenants' captures using three different monthly series: homicides of males between 15 and 39 years old (SINAIS data), deaths presumably related to DTO rivalry (government data), and homicides in the rest of the population (SINAIS data). Treated units are defined as neighboring municipalities to those where a leadership capture or killing occurred. The latter municipalities were excluded from the analysis.

The estimated coefficients for each model are shown in Table 4. The econometric specifications in each column use the full weighted sample, include municipality and time fixed effects, and control for the size of the population of males between 15 and 39 years old in Models (1) and (2), and for the size of the rest of the population in Model (3). The synthetic weights used in each model are similar to those estimated for the specifications without the interaction terms with the strategic points dummy. The synthetic weights in the model using the government data are the same as those constructed to approximate the pretreatment trends of homicides of males between 15 and 39 years old in neighboring municipalities.[20] Robust standard errors are clustered at the municipality level.

**[Table 4 about here]**

The specifications in the upper part of the table compare homicide levels in neighboring municipalities after a leader's neutralization to the post-intervention levels in their synthetic counterfactuals. Conversely, the synthetic controls in the lower part of the table are estimated using lieutenant captures as treatment. Therefore, the variables of interest (in bold) are all the interactions with the treatment *leader* in the first set of models, and all interactions with the treatment

*lieutenant* in the models in the lower part of the table. The rest of the covariates are included as control variables (not in bold).

The estimated coefficients in the first part of Table 4 show that the capture of a leader increases drug-related violence in the short and medium term in valuable neighboring territories and that the effects are substantial – a 165% increase in the first six months and 126% in the following six months. Nevertheless, the predicted spillover effects are only significant in the specification using the government data.

With respect to lieutenants' neutralizations, we find that both types of violence (drug-related and against the rest of the population) increase in these strategic municipalities. Using SINAIS data, we found increases of 25.4% in homicides of males between 15 and 39 years old and 51.8% in deaths presumably related to DTO rivalry, in the first six months after the capture of a lieutenant. Moreover, we found an increase of 32.6% in the second six-month period in homicides against the rest of the population. Hence, in comparison to leader removals, captures of lieutenants appear to have broader spillover effects on violence in neighboring municipalities that are central in the transportation network.

## 7. Conclusions

Between 2006 and 2012 the Mexican government deployed a massive military operation with the explicit aim to debilitate drug cartels. The strategy seemed to have paid off by eliminating a large number of drug cartel leaders: more than 25 capos and 160 lieutenants were captured or killed in just six years. At the same time, however, drug-related violence escalated by almost 300%.

Existing scholarly literature has focused on whether government crackdowns on drug cartels have partially caused the escalation of violence in Mexico. A limitation of prior studies focusing on the effects of government crackdowns on the spread of violence is that they do not adequately address the challenges of identifying causal effects. Government crackdowns are not randomly assigned but likely take place where violence is escalating or where there are pre-existing turf wars among cartels. Our analysis approaches causal identification following a dual strategy: 1) an econometric specification restricting the sample to treated municipalities; and 2) the construction of credible counterfactuals to government interventions using the synthetic control methodology.

We also move beyond the existing literature in that we estimate differential impacts between captures of kingpins and of lieutenants; examine how captures or killings differently affect DTO-related violence relative to homicides in the general population; measure temporal effects of the interventions; and estimate treatment effects of captures or killings on violence in three different groups of municipalities, including what we call "strategic" municipalities due to their connectivity to the transportation network.

In the treated municipalities, we find evidence that there are substantial six-month increases in all types of violence, DTO-related deaths and homicides among the rest of the population, following the neutralization of a leader. There is hence strong evidence indicating that captures of capos have strong "hydra" effects in the locality where these take place, presumably increasing both intra- and inter-cartel

fighting as well as violence within the population not directly involved in drug trafficking.

Our results also provide evidence of spillover effects in neighboring municipalities. In particular, we find substantial spillover effects in the medium term (6 to 12 months after the intervention) after the capture of a leader in homicides within the general population. As discussed above, these increases in general violence might be explained by leadership removals damaging the chain of command that keeps local criminal cells more or less under control.

Neutralization of lieutenants, for their part, do not seem to increase DTO-related violence or violence in the general population in the treated municipalities. These captures or killings have spillover effects, nonetheless, when they take place near strategic neighboring municipalities, as we find significant increases in both DTO-related violence and general violence. We should note that spillover to strategic neighboring municipalities appears to be stronger for neutralization of lieutenants relative to kingpin captures. It is in these strategic points where turf wars among rival DTOs are more likely to erupt as a result of the neutralization of the local leader in charge of administering the *plaza*.

Finally, while most of the spatial effects on DTO-related violence were found in the first six months after a leader or lieutenant's neutralization, all spillover effects on violence within the rest of the population were found to be more permanent. This should be a troubling finding for policy-makers because it suggests that state crackdown on DTOs has powerful externalities, increasing homicides and possibly other types of crimes, such as kidnappings and extortion, among the general

population.

These differential impacts shed light on the different mechanisms through which captures or killings of DTO leaders might breed violence. Inter- and intra-cartel turf wars tend to occur immediately after the removal of a leader in the municipality of intervention and after the neutralization of a leader or a lieutenant in strategic neighboring municipalities. Such disruptions of the previous order are followed by a subsequent (and relatively slow) deterioration of the chains of command within cartels that discipline local criminal cells, which might then opt for increasing criminal behavior against the general population in order to extract additional resources.

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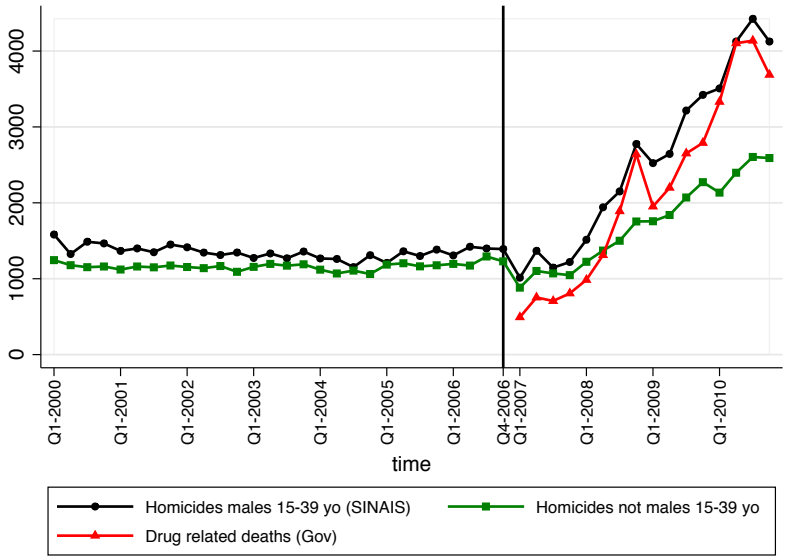
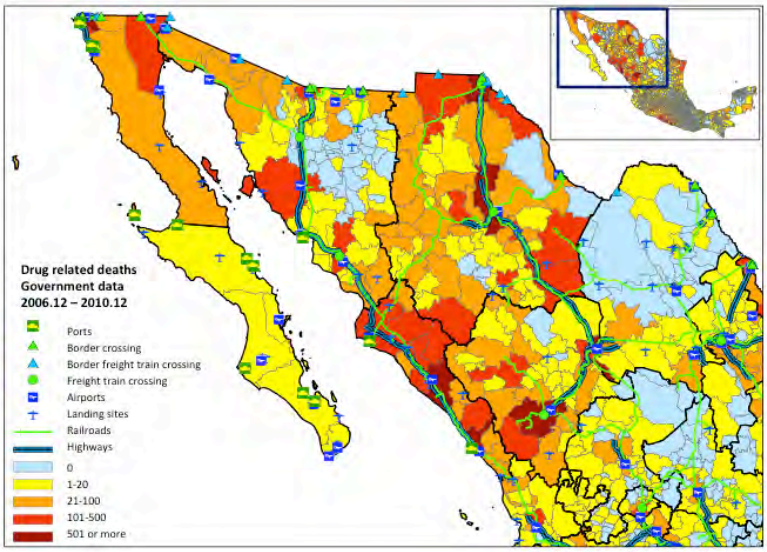
**Figure 1: Trends of Homicides Using SINAIS and Government Data**



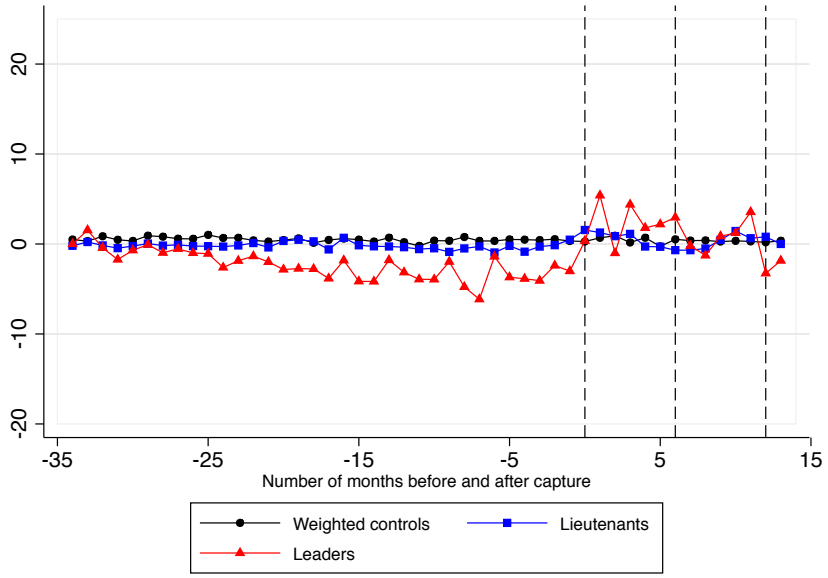

SINAIS data are quarterly homicides of males between 15 and 39 years old and homicides for the rest of the population. Government data are all homicides presumably related to rivalry between DTOs.

**Figure 2. Transportation Network and Drug-related Violence**




The transportation network in Mexico and the accumulated number of deaths presumably related to DTO rivalry from December 2006 to December 2010.

**Figure 3: Weighted Residuals of Homicides of Males between 15 and 39 Years Old**




Source: SINAIS. The figure shows the weighted residuals of control and treated municipalities using synthetic weights. The residuals are constructed after running a regression with municipality and time fixed effects and a linear time trend for each municipality. The linear time trend is the prediction of a linear model of homicides during the pre-treatment period, which is from January 2001 to one month before a leader or a lieutenant is captured or killed. Time is normalized such that zero represents the month when the intervention occurs. For control municipalities, zero is equal to December 2006. Ciudad Juárez was excluded from the sample.

## Table 1: Summary Statistics of Monthly Homicides (2006.12 – 2010.12)

| | Number of municipalities | Homicides of males 15-39 yo (SINAIS Data) | | Homicides w/o males 15-39 yo (SINAIS Data) | | Deaths related to DTOs (Gov. Data) | |
|---|---|---|---|---|---|---|---|
| | | Mean | Total | Mean | Total | Mean | Total |
| Control municipalities | 2049 | 0.133 | 13393 | 0.109 | 10909 | 0.103 | 10382 |
| | | (0.825) | | (0.499) | | (0.948) | |
| Treated municipalities | 73 | 4.475 | 16007 | 2.743 | 9810 | 3.347 | 11971 |
| | | (11.06) | | (6.166) | | (9.635) | |
| Neighboring municipalities | 358 | 0.949 | 16639 | 0.66 | 11575 | 0.683 | 11988 |
| | | (4.486) | | (2.793) | | (3.432) | |
| Total | 2440 | 0.3 | 35918 | 0.215 | 25730 | 0.235 | 28060 |
| | | (2.227) | | (1.284) | | (2.025) | |

Source: Government and SINAIS data. Ciudad Juárez is excluded from the sample. Homicides w/o males 15-39 yo is the number of homicides for the population outside this range of age and gender. Standard deviations in parentheses.

## Table 2: Effects of Leadership Captures on Homicides
## Negative Binomial Model, 2006.12 - 2010.12

| **Effects of leadership captures on homicides presumably related to DTOs** | **(1) Subsample treatment leader** | | **(2) Subsample treatment lieutenant** | | **(3) Weighted sample treatment leader** | | **(4) Weighted sample treatment lieutenant** | |
|---|---|---|---|---|---|---|---|---|
| | Coef | % | Coef | % | Coef | % | Coef | % |
| *after(1-6 months)*(leader)* | **0.272**** | **31.2%** | 0.408*** | 50.3% | **0.311**** | **36.5%** | 0.398*** | 48.9% |
| | **(0.12)** | | (0.149) | | **(0.126)** | | (0.155) | |
| *after(6-12 months)*(leader)* | **0.103** | **10.8%** | 0.182 | 20.0% | **0.178** | **19.4%** | 0.186 | 20.4% |
| | **(0.163)** | | (0.194) | | **(0.197)** | | (0.219) | |
| *after(1-6 months)*(lieutenant)* | -0.128 | -12.0% | **0.098** | **10.2%** | -0.178 | -16.3% | **0.088** | **9.2%** |
| | (0.14) | | **(0.077)** | | (0.114) | | **(0.085)** | |
| *after(6-12 months)*(lieutenant)* | 0.268* | 30.7% | **-0.107** | **-10.1%** | 0.329** | 38.9% | **-0.086** | **-8.3%** |
| | (0.156) | | **(0.108)** | | (0.129) | | **(0.104)** | |
| Log pseudolikelihood | -1424.36 | | -5964.89 | | -2449.35 | | -10842.37 | |
| Number of observations | 637 | | 3381 | | 2989 | | 19036 | |
| Number of municipalities | 13 | | 69 | | 61 | | 394 | |

| **Effects of leadership captures on homicides among the general population** | **(1) Subsample treatment leader** | | **(2) Subsample treatment lieutenant** | | **(3) Weighted sample treatment leader** | | **(4) Weighted sample treatment lieutenant** | |
|---|---|---|---|---|---|---|---|---|
| | Coef | % | Coef | % | Coef | % | Coef | % |
| *after(1-6 months)*(leader)* | **0.292***** | **33.9%** | 0.373*** | 45.3% | **0.293**** | **34.0%** | 0.367*** | 44.3% |
| | **(0.111)** | | (0.139) | | **(0.121)** | | (0.141) | |
| *after(6-12 months)*(leader)* | **0.206** | **22.9%** | 0.225 | 25.2% | **0.29** | **33.6%** | 0.237 | 26.8% |
| | **(0.195)** | | (0.142) | | **(0.185)** | | (0.156) | |
| *after(1-6 months)*(lieutenant)* | 0.02 | 2.0% | **0.048** | **4.9%** | -0.065 | -6.3% | **0.024** | **2.4%** |
| | (0.12) | | **(0.092)** | | (0.127) | | **(0.091)** | |
| *after(6-12 months)*(lieutenant)* | 0.115 | 12.2% | **-0.034** | **-3.4%** | 0.207 | 22.9% | **-0.04** | **-3.9%** |
| | (0.116) | | **(0.111)** | | (0.142) | | **(0.108)** | |
| Log pseudolikelihood | -1249.06 | | -5141.75 | | -2152.69 | | -9250.73 | |
| Number of observations | 637 | | 3381 | | 5586 | | 19110 | |
| Number of municipalities | 13 | | 69 | | 114 | | 390 | |

The dependent variables in each table are, respectively, the number of homicides of males between 15 and 39 years old and the number of homicides in the rest of the population 2006.12 to 2010.12, using SINAIS data. All specifications include time fixed effects and municipality fixed effects and control for the size of the corresponding population. The variables *after(1-6 months)*(leader)* and *after(7-12 months)*(leader)* indicate the time-span after a leader is captured or killed in a municipality in the first and the second half year, respectively. The same logic is followed for the case f a lieutenant. The observations used in specifications (3) and (4) are weighted by synthetic weights that were estimated using SINAIS data. The treated units for the synthetic weights are defined as those municipalities in which a leader or a lieutenant was captured, respectively. The estimated effect of a government intervention is presented as the percentage increase in homicides of males between 15 and 39 years old. All specifications assume a negative binomial distribution. Robust standard errors are in parentheses and are clustered at the municipality level. *** : $p < 0.01$, ** : $p < 0.05$, * : $p < 0.1$.

## Table 3: Neighboring Effects of Leadership Captures on Homicides
## Negative Binomial Model, 2006.12 - 2010.12

| **Neighboring effects of leadership captures on homicides presumably related to DTOs** | **(1) Subsample treatment leader** | | **(2) Subsample treatment lieutenant** | | **(3) Weighted sample treatment leader** | | **(4) Weighted sample treatment lieutenant** | |
|---|---|---|---|---|---|---|---|---|
| | Coef | % | Coef | % | Coef | % | Coef | % |
| *after(1-6 months)*(leader neigh)* | **-0.019** | **-1.90%** | 0.11 | 11.6% | **-0.019** | **-1.9%** | 0.109 | 11.5% |
| | **(0.13)** | | (0.138) | | **(0.133)** | | (0.138) | |
| *after(6-12 months)*(leader neigh)* | **0.008** | **0.8%** | 0.03 | 3% | **-0.041** | **-4.0%** | 0.002 | 0.2% |
| | **(0.159)** | | (0.131) | | **(0.144)** | | (0.13) | |
| *after(1-6 months)*(lieu neigh)* | -0.048 | -4.7% | **0.095** | **10.0%** | -0.072 | -6.9% | **0.057** | **5.9%** |
| | (0.127) | | **(0.065)** | | (0.111) | | **(0.065)** | |
| *after(6-12 months)*(lieu neigh)* | 0.33*** | 39.1% | **0.04** | **4.1%** | 0.279*** | 32.2% | **0.043** | **4.4%** |
| | (0.107) | | **(0.066)** | | (0.099) | | **(0.065)** | |
| Log pseudolikelihood | -2951.41 | | -9192.07 | | -6449.35 | | -20183.85 | |
| Number of observations | 3185 | | 14700 | | 23128 | | 42777 | |
| Number of municipalities | 65 | | 300 | | 472 | | 873 | |

| **Neighboring effects of leadership captures on homicides among the general population** | **(1) Subsample treatment leader** | | **(2) Subsample treatment lieutenant** | | **(3) Weighted sample treatment leader** | | **(4) Weighted sample treatment lieutenant** | |
|---|---|---|---|---|---|---|---|---|
| | Coef | % | Coef | % | Coef | % | Coef | % |
| *after(1-6 months)*(leader neigh)* | **0.146** | **15.7%** | 0.174* | 19.1% | **0.116** | **12.3%** | 0.16* | 17.3% |
| | **(0.122)** | | (0.097) | | **(0.112)** | | (0.094) | |
| *after(6-12 months)*(leader neigh)* | **0.289**** | **33.6%** | 0.268*** | 30.8% | **0.262**** | **29.9%** | 0.274*** | 31.6% |
| | **(0.135)** | | (0.093) | | **(0.133)** | | (0.097) | |
| *after(1-6 months)*(lieu neigh)* | -0.026 | -2.6% | **0.084** | **8.7%** | -0.078 | -7.5% | **0.068** | **7.0%** |
| | (0.097) | | **(0.061)** | | (0.088) | | **(0.059)** | |
| *after(6-12 months)*(lieu neigh)* | 0.139 | 14.9% | **0.098** | **10.2%** | 0.141 | 15.1% | **0.109** | **11.6%** |
| | (0.102) | | **(0.07)** | | (0.107) | | **(0.071)** | |
| Log pseudolikelihood | -2584.35 | | -8022.05 | | -5391.19 | | -17404.28 | |
| Number of observations | 3185 | | 14700 | | 22785 | | 45374 | |
| Number of municipalities | 65 | | 300 | | 465 | | 926 | |

The dependent variables in each table are, respectively, the number of homicides of males between 15 and 39 years old and the number of homicides in the rest of the population 2006.12 to 2010.12, using SINAIS data. All specifications include time fixed effects and municipality fixed effects and control for the size of the corresponding population. The variables *after(1-6 months)*(leader _neigh)* and *after(7-12 months)*(leader _neigh)* indicate the time-span after a leader is captured or killed in a neighboring municipality in the first and the second half year, respectively. The same logic is followed for the case of a lieutenant. The observations used in specifications (3) and (4) are weighted by synthetic weights that were estimated using SINAIS data. The treated units for the synthetic weights are defined as those municipalities that were neighbors of municipalities where leaders or lieutenants were captured, respectively. The estimated effect of a government intervention is presented as the percentage increase in total homicides excluding males between 15 and 39 years old. Robust standard errors are in parentheses and are clustered at the municipality level. *** : $p < 0.01$, ** : $p < 0.05$, * : $p < 0.1$.

## Table 4: Neighboring Effects of Leadership Captures: Neighboring Municipalities and Strategic Points Negative Binomial Model, 2006.12 - 2010.12

| **Neighboring effects of captures of leaders: neighboring municipalities and strategic points** | **(1) Homicides of males 15-39 y/o (SINAIS Data)** | | **(2) Deaths presumably related to DTOs (Gov. Data)** | | **(3) Homicides excluding males 15-39 y/o (SINAIS Data)** | |
|---|---|---|---|---|---|---|
| | Coef | % | Coef | % | Coef | % |
| *after(1-6 months)*(leader neigh)*SP* | **0.417** | **51.80%** | **0.975***** | **165.0%** | **0.389** | **47.6%** |
| | **(0.317)** | | **(0.357)** | | **(0.285)** | |
| *after(6-12 months)*(leader neigh)*SP* | **0.392** | **48.0%** | **0.814*** | **125.7%** | **0.415** | **51%** |
| | **(0.34)** | | **(0.459)** | | **(0.299)** | |
| *after(1-6 months)*(lieu neigh)*SP* | 0.336 | 39.9% | 0.403 | 49.7% | 0.165 | 17.9% |
| | (0.213) | | (0.331) | | (0.146) | |
| *after(6-12 months)*(lieu neigh)*SP* | 0.281 | 32.5% | 0.062 | 6.4% | 0.306 | 35.8% |
| | (0.184) | | (0.231) | | (0.208) | |
| *after(1-6 months)*(leader neigh)* | **-0.156** | **-14.40%** | **-0.354** | **-29.8%** | **-0.013** | **-1.3%** |
| | **(0.148)** | | **(0.223)** | | **(0.103)** | |
| *after(6-12 months)*(leader neigh)* | **-0.124** | **-11.7%** | **-0.298** | **-25.8%** | **0.177** | **19%** |
| | **(0.156)** | | **(0.273)** | | **(0.13)** | |
| *after(1-6 months)*(lieu neigh)* | -0.187 | -17.0% | -0.088 | -8.4% | -0.133 | -12.5% |
| | (0.14) | | (0.193) | | (0.125) | |
| *after(6-12 months)*(lieu neigh)* | 0.146 | 15.8% | 0.394** | 48.2% | 0.014 | 1.5% |
| | (0.145) | | (0.191) | | (0.145) | |
| Log pseudolikelihood | -6440.21 | | -5209.73 | | -5380.76 | |
| Number of observations | 23128 | | 23128 | | 22785 | |
| Number of municipalities | 472 | | 472 | | 465 | |
| **Neighboring effects of captures of lieutenants: neighboring municipalities and strategic points** | **(1) Homicides of males 15-39 y/o (SINAIS Data)** | | **(2) Deaths presumably related to DTOs (Gov. Data)** | | **(3) Homicides excluding males 15-39 y/o (SINAIS Data)** | |
| | Coef | % | Coef | % | Coef | % |
| *after(1-6 months)*(leader neigh)*SP* | 0.435 | 54.5% | 0.692** | 99.8% | 0.262 | 29.9% |
| | (0.294) | | (0.334) | | (0.233) | |
| *after(6-12 months)*(leader neigh)*SP* | 0.265 | 30.4% | 0.209 | 23.2% | 0.082 | 8.5% |
| | (0.366) | | (0.492) | | (0.269) | |
| *after(1-6 months)*(lieu neigh)*SP* | **0.226*** | **25.4%** | **0.417**** | **51.8%** | **0.101** | **10.7%** |
| | **(0.133)** | | **(0.213)** | | **(0.117)** | |
| *after(6-12 months)*(lieu neigh)*SP* | **0.19** | **20.9%** | **0.294** | **34.2%** | **0.282**** | **32.6%** |
| | **(0.139)** | | **(0.219)** | | **(0.128)** | |
| *after(1-6 months)*(leader neigh)* | -0.018 | -1.7% | -0.138 | -12.9% | 0.079 | 8.2% |
| | (0.158) | | (0.215) | | (0.1) | |
| *after(6-12 months)*(leader neigh)* | -0.06 | -5.8% | -0.041 | -4.0% | 0.264** | 30.2% |
| | (0.135) | | (0.249) | | (0.11) | |
| *after(1-6 months)*(lieu neigh)* | **0.005** | **0.5%** | **0.052** | **5.4%** | **0.048** | **5.0%** |
| | **(0.075)** | | **(0.091)** | | **(0.07)** | |
| *after(6-12 months)*(lieu neigh)* | **-0.01** | **-1.0%** | **0.129** | **13.8%** | **0.029** | **2.9%** |
| | **(0.073)** | | **(0.105)** | | **(0.087)** | |
| Log pseudolikelihood | -20176.70 | | -16578.66 | | -17397.81 | |
| Number of observations | 42777 | | 42777 | | 45374 | |
| Number of municipalities | 873 | | 873 | | 926 | |

All specifications include time fixed effects and municipality fixed effects. Models (1) and (2) include a control for the size of the population of males between 15 and 39 years old. Model (3) includes a control for total population excluding males between 15 and 39 years. The variables *after(1-6 months)*(leader_neigh)* and *after(7-12 months)*(leader_neigh)* indicate the time-span after a leader is captured or killed in a neighboring municipality in the first and the second half year, respectively. The same logic is followed for the case of a lieutenant. The variable *SP* is a dummy variable and indicates whether a municipality is a *strategic point* in the country's transportation network. The variable is equal to one if an airport, a landing site, a port, a freight train crossing, or a border crossing is located on the municipality. The observations are weighted by synthetic weights that were estimated using SINAIS data. The treated units for the synthetic weights are defined as those municipalities that were neighbors of municipalities where leaders or lieutenants were captured. The estimated effect of a government intervention is presented as the percentage increase in homicides, according to each case. All specifications assume a negative binomial distribution. Robust standard errors are in parentheses and are clustered at the municipality level. *** : $p < 0.01$, ** : $p < 0.05$, * : $p < 0.1$.

[1] Cocaine seizures and eradication of marihuana and poppy seed crops between 2007-2012 were 20% and 38% lower, respectively, than during the 2001-2006 period.

[2] Although president Fox also used the army to fight drug cartels, the magnitude of the troops involved in both administrations is by no means comparable. Unfortunately, data on military deployment is not available at the municipality levels during these periods.

[3] Poiré is a political scientist who served as the president's spokesman for security and later as interior minister for Calderón's administration.

[4] In fact, research suggests that there is not such a sharp distinction between profit motivated violent groups and insurgents and terrorist groups. In their research on the second intifada, Brym and Araj (2006) document an array of motives for participating in a terrorist act and presumably for joining a terrorist group, including economic returns. However see Berman et al. (2011) for evidence that unemployment and terrorist/rebel activity are not strongly correlated in some contexts and Berman et al. (2013) about the role of predation and rebel activity. We thank an anonymous reviewer for pointing out to us that the importance of "profits" as a motive for joining DTOs versus other groups likely varies in degree, not kind.

[5] In Mexico a *plaza* refers quite generally to a place where drugs are sold, produced, or smuggled.

[6] It is believed that the Zetas initially modeled this chain of command on the Mexican army and that other cartels learned from them.

[7] We thank Kristof Gosztonyi for the insight about the importance of the revenue from taxation of the illegal long-distance drug trade.

[8] There is anecdotal evidence that this is the case: el Cartel de Tijuana had an internal split between two factions, one led by Teodoro García Simental (aka *El Teo*), which apparently favored kidnappings in Tijuana, and the other faction, led by Luis Fernando Sánchez Arellano (aka *El Ingeniero*—the Engineer), with strong political and economic connections in the city, which wanted to focus primarily on drug trafficking (Jones, 2013). After a wave of violence between the two factions and the arrest of El Teo in January 2010, the faction led by Sánchez Arellano regained control of the cartel and the kingpin was able to restrain his subalterns from engaging in kidnappings.

[9] ${}_{20}C_1 + {}_{20}C_2 + \ldots + {}_{20}C_{20}$.

[10] When Ciudad Juárez is included in the analysis, the results end up being driven completely by this case and the magnitude of the coefficients become very large. Additionally, there is no synthetic control that could resemble the level of homicides in the municipality before the first government intervention.

[11] The geographic location of the different types of municipalities is available upon request.

[12] Earlier versions of this paper used an official government list of captures and killings of leaders and lieutenants, finding similar results. Nevertheless, this information is confidential and protected by Mexican law and cannot be shared by the authors. To comply with the replication policy of JCR, we built an alternative dataset from public sources.

[13] There were 2049 control units and 11 predictors which implied a maximization problem of 22,539 variables for each municipality. With this pre-selection rule, the average number of municipalities in the control group was higher than 100 while the average number of units with positive weights was close to 10.

[14] The sample of the synthetic control group excludes those municipalities where the synthetic weights are 0.

[15] The coefficient estimates for the months beyond the year after an intervention are not conclusive given the imbalance of the panel data for these periods. Control variables for these periods were included in every specification and the estimated coefficients are available upon request.

[16] All the models were also run using the government data. The results, available upon request, are consistent with the results using the data from SINAIS. Hence here we report only results using data from SINAIS.

[17] The estimated percentage change is the exponential function of the estimated parameter minus 1, i.e., $\exp(\beta)-1$.

[18] Analogous estimates available upon request were performed for drug-related deaths using the government data with similar results.

[19] The data on the transportation network comes from the National Institute of Statistics and Geography (INEGI), the Mexican ministry of transportation, and the US Bureau of Transportation Statistics (BTS).

[20] The synthetic weights in Model 3 are the ones estimated to resemble pretreatment trends of homicides in the rest of the population in neighboring municipalities.