

Enclaves of Violence: Organized Crime and Strategic Territories in Mexico*

Enclaves de violencia: el crimen organizado y los territorios estratégicos en México

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Abstract

Understanding the underlying hidden patterns of criminal activity can play a crucial role in their elimination and ensuring public safety. We develop a statistical model for the behavior of organized criminal groups in Mexico from 2007 to 2011, which shows the territorial reconfiguration of illegal activity in enclaves of violence. The model provides empirical evidence of the strategic rationality of criminal groups in occupying specific regions in the country. To capture these patterns of organized criminal behavior, we employ indicators of spatial correlation of the first and first adjusted orders, and centrality measures for the regions – nodes of spatial networks. The network variables improve the fit and explanatory power of the model by accounting for intricate spatial patterns. The modeling approach contributes to characterizing the violence from a geographical approach, transcending the boundary between the origin and consequences of violence on a particular territory.

Keywords

Drug War
Contagion
Geographic Network
Random Network
Network Centrality

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Resumen

Comprender los patrones subyacentes de la actividad delictiva puede desempeñar un papel crucial en limitar la actividad delictiva y con ello garantizar la seguridad pública. El presente trabajo desarrolla un modelo estadístico del comportamiento de los grupos delictivos organizados en México de 2007 a 2011, que muestra la reconfiguración territorial de la actividad ilícita en enclaves de violencia. El modelo proporciona evidencia empírica de la racionalidad estratégica de los grupos criminales en la ocupación de regiones específicas del país. Para capturar estos patrones de comportamiento del crimen organizado empleamos indicadores de correlación espacial de primer y primer orden ajustado, así como medidas de centralidad mediante nodos de redes espaciales. Las variables de red mejoran el ajuste y el poder explicativo del modelo al tener en cuenta patrones espaciales intrincados. El enfoque usado contribuye a caracterizar la violencia desde una perspectiva geográfica y trasciende la frontera entre el origen y las consecuencias de la violencia en un territorio determinado.

Palabras Clave

Guerra de drogas
Contagio
Red geográfica
Red aleatoria
Centralidad de la red

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Introduction

This article analyzes the violence stemming from organized crime that was reflected in high homicide rates in Mexico from 2007 to 2011. This kind of violence includes all criminal acts that use extreme physical force, resulting in homicides. Violence as a social phenomenon contains the characteristics of people involved in violent acts, whether as victims or perpetrators (Gamlin, 2015). Violence has time- and space-related dimensions, meaning specific periods and places where violent acts occur (Calderon et al., 2015), leading to particular enclaves.

This article analyzes the link between these enclaves of violence and space where agents who developed the enclaves (organized crime gangs), the population at risk (municipalities), and violence-generating factors (geographic and social traits of the municipalities) – all exhibiting violence-spreading behaviors – can be identified.

Analyzing data on violence and the locations of homicides aids in developing effective policies for prevention and intervention. This article's research question is: How is violence triggered by organized crime distributed throughout the Mexican territory? Our hypothesis suggests that during the study period, the primary causes of high homicide rates

linked to organized crime are greater social inequality within municipalities, increased fragmentation and reduced territorial control by cartels, and the presence of organized crime in those regions, all contributing to the formation of violent enclaves. These factors account for disputes over key geographic positions in the production, control, and distribution of narcotics, as well as the proliferation of weapons within the country.

To test this hypothesis, we carry out a spatial analysis of violent acts in Mexico using the database developed by the Center for Research and Teaching in Economics (CIDE) Drug Policy Program (Programa de Política de Drogas [PPD]), (Atuesta & Pérez-Dávila, 2018; Atuesta & Ponce, 2017; Atuesta, Siordia & Madrazo, 2019); the geographic, economic, and demographic characteristics of the municipalities (National Institute of Statistics and Geography [INEGI]; National Council for the Evaluation of Public Policies of Social Development [CONEVAL], and National Population Council, [CONAPO]), and the spatial links between organized crime groups.

The dataset provided by the PPD includes information on events related to organized crime, such as date, municipality, state, and groups involved. The PPD at CIDE has meticulously validated and described the dataset, as documented by Atuesta, Siordia, and Madrazo (2019). Analyzing this dataset is pertinent as it constitutes a detailed record of violent deaths related to organized crime during a period marked by the reconfiguration of criminal activity, making it a relevant subject of study to comprehend the current state of violence in Mexico.

The initial section provides an overview of the current context of violence in Mexico. The second section defines the concept of “enclaves of violence” and illustrates how it aids in identifying variables and geographical characteristics related to violence by revisiting the processes involved in the emergence and strengthening of criminal groups in the country. The third section outlines the methodological framework for data analysis using CIDE’s PPD dataset and the econometric and statistical models employed to understand violence in Mexico. Finally, the article presents the results and a discussion of findings, including variables closely linked to the presence of organized crime in the territory.

The article makes three specific contributions. First, it characterizes areas of violence resulting from the war on drug trafficking, opening the door to a discussion on violence in terms of numbers and local zoning with strategic implications. Second, it examines the territorial configuration

of violence as an expression of a shift in how organized crime operates. Third, it provides a behavioral model of organized crime in Mexico from 2007-2011, illustrating the territorial reconfiguration of criminal activity into enclaves of violence.

The context: When everything went wrong, the beginning of the “War on drugs”

The analysis of the territorial configuration of violence centers on two pivotal elements: the instability of the drug market and the decision of the government of Felipe Calderon to pursue a militarized strategy termed the “war on drugs,” initiated in 2006 (Astorga, 2015; Oyarbide, 2011; Zepe-da Gil, 2018). President Calderon assumed the responsibility of ensuring the safety of Mexicans and launched a strategy to combat organized crime and drug trafficking. Calderon’s main argument for legitimizing this strategy was the nearly 300 percent increase in the crime rate during his predecessor Vicente Fox Quesada’s term (Ríos, 2013, p. 2). This surge in violence led to various consequences, including the fragmentation of drug trafficking groups, their migration to different geographical areas, and the emergence of new connections and networks to propagate violence, ensuring control across several municipalities (Atuesta & Pérez-Dávila, 2018; Bergman, 2018).

In this context, aggressions perpetrated by criminal groups unfolded in response to the state’s military strategy (Piñeyro, 2010) and the struggle to control illegal markets, resulting in the formation of a new map of violence. Organized crime successfully consolidated its presence in 20 out of 59 Metropolitan Areas of Mexico, including Leon, Celaya, Tijuana, Juarez Chihuahua, La Laguna, Saltillo, Monterrey, Guadalajara, Morelia, and Tampico (Fuerte-Celis, 2016). The strategy of territorial control, reliant on the use of violence, profoundly affected how these places were occupied, leading to the continuous geographical expansion of violent actors, transforming vast areas into battlegrounds (Dulin & Patiño, 2020; Fuerte-Celis, 2016).

Criminal agents started competing for territorial control (Fuerte-Celis, 2016). In response to instability and the increasingly stringent measures of the state, each violent group utilized violence as its primary tool to seize control of transportation routes for illegal drugs to the US market (Atuesta & Pérez-Dávila, 2018). They also aimed to dominate local consumer markets (Dulin & Patiño, 2020) and ensure control of areas rich in natural

resources such as timber, mining, and water. As clashes and operations intensified, these groups diversified their criminal activities, including kidnapping and extortion (Dulin & Patiño, 2020; Querales-Mendoza, 2020).

Amidst this instability, territorial conflicts, and processes of territorialization (the organized crime groups establish links with specific areas using violence), these places turned into actual battlefields characterized by a growing number of homicides. Anthropological and ethnographic studies, such as those conducted by Lomnitz (2022) in the case of Zacatecas, found that some rationale explains the apparent insecurity, chaos, and violent confrontations.

In light of the rationale explaining the struggles and conflicts of agents generating violence, resulting in a new configuration of criminal organizations, we aim to review the empirical evidence available from this period and uncover the geographical patterns present in the dispute for territory. Due to their location, we assume that the most valuable places provide greater economic freedom, allow evasive movements, and represent alternative income sources to the priority task of drug distribution.

For this purpose, we develop a model examining the association between homicide rates due to organized crime and its main determinants, understanding the latter as motivators explaining the occurrence of violence in a place. We propose the concept of “enclaves of violence” as a conceptual tool to identify geographical areas or territories where homicides, as an expression of violence, are intense and frequent, given the unique characteristics motivating crime groups to seek control. As a contribution to developing other proposals highlighting the territoriality of violence, this paper offers a statistical model based on empirical evidence provided by the CIDE-PPD database, identifying the territorial variables associated with the violent activity of organized crime.

What do we mean by enclaves of violence?

Enclaves of violence can be conceptualized as specific territories or areas characterized by a shared feature, be it physical or social, setting them apart from other spaces. Traditionally, enclaves have been regarded as the smallest category of territory marked by spatial homogeneity and continuity (Johnston, Gregory & Smith, 1987). In contemporary contexts, formal enclaves are demarcated by political jurisdictions defined by local, regional, and national cultural and economic characteristics. Essentially,

an enclave exists within a space delimited by borders that have shaped the characteristics of the social groups inhabiting it while sharing a particular feature.

Several multinational enclaves, such as the European Union, MERCOSUR, and North America, have been integrated under joint national projects throughout the twentieth century (Coe et al., 2004; Swyngedouw, 2004). However, some enclaves are defined by criteria beyond national borders, such as business, ethnic, social, and cultural enclaves. Enclaves have a different meaning when approached in ecological or environmental terms, such as watersheds and protected natural areas or parks. They can also be based on the movement of species and people, cultural characteristics, or productive activities. However, enclaves of violence are territories or areas defined by violence as their common feature.

As mentioned earlier, the concept of enclaves refers to small, culturally distinct but politically united territories, such as the “grain belt” of the central United States, Champagne in France, or Tequila in Mexico. This concept extends to non-material enclaves, such as virtual communities (Johnston, Gregory & Smith, 1987). Enclaves are characterized by a minimal territorial unit containing borders and an essential feature. Enclaves of violence, in turn, are distinguished by the presence of a very specific feature: the occurrence of intense and frequent violence. Additionally, we introduce an additional condition derived from the term “contagion,” which denotes drastic changes in the number of homicides and their spread over time and space, giving rise to new acts of violence that may or may not be related to the original event (Cohen & Tita, 1999).

This research proposes four main components regarding the determinants of violence in Mexico. The first determinant pertains to agents that generate violence, such as organized crime and gangs (Papachristos, 2009; Auyero & Berti, 2013; Zeoli et al., 2014). The second refers to the means through which violence is transmitted, encompassing mechanisms of social control, revenge, carrying firearms, and a willingness to use violence (Fagan & Wilkinson, 1998; Zeoli et al., 2014; Zeoli et al., 2015). The third factor is the susceptible population, consisting of individuals most likely to be affected by contagion, such as young people, minorities, and those living in marginalized areas or municipalities (Braga, Papachristos & Hureau, 2010; Cook & Laub, 2002; Zeoli et al., 2014), with men between 20 and 39 years old identified as particularly susceptible in the case of Mexico (Gamlin, 2015). Finally, local determinants such as

geographical and strategic position, the presence of illicit crops, and economic characteristics also play a role (Camara & Salama, 2004; Olivera & Fuerte-Celis, 2020). These features act as triggering events or the initial sources of violence. Other examples of these factors include economic inequality or political corruption (Camara & Salama, 2004; Muggah, 2017).

To advance our understanding of the territorial distribution of violence in Mexico, the subsequent sections provide a more detailed explanation of the determinants of violence, as defined here.

Determinants of enclaves of violence

Understanding the presence of violence in a society and its evolution begins by establishing a measure to analyze this phenomenon across its various dimensions. Violence serves as an expression of more profound social phenomena, and its comprehension involves selecting a unit of measurement based on the type of violence under scrutiny. Measures of violence often rely on estimates derived from public statistics, encompassing different levels of aggregation of violent events, thereby complicating their analysis and understanding.

In the context of analyzing violence and organized crime, the common practice is to utilize the number of homicides as a primary indicator, given its widespread acceptance as a unit of measurement for assessing societal violence. This approach primarily focuses on quantifying the extreme manifestation of violence: homicide (Hamby, 2017; Merino, 2011; Sánchez-Munguía, 2009). While this measure is valuable for characterizing the phenomenon, our objective surpasses mere characterization. We aim to pave the way for understanding Mexico's territorial distribution of violence. We propose four key determinants: 1) violent agents; 2) means of transmission; 3) susceptible population, and 4) local factors contributing to the generation of violence.

- a) Violent agents: This category encompasses individuals, groups, or actors who intentionally or deliberately engage in acts of violence (Checkel, 2017; Shirk & Wallman, 2015).
- b) Means of transmission of violence: This term refers to the channels, mechanisms, or means through which violence spreads in a society or community. These means can vary and significantly impact how violence is perceived, experienced, and manifested in a given society (Kort-Butler & Habecker, 2018).

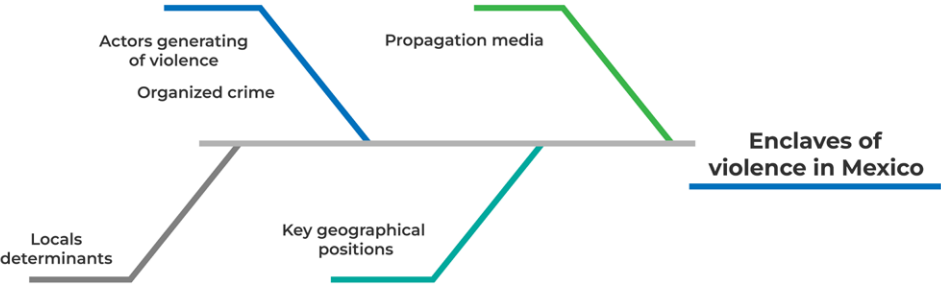
- c) Local factors: These factors pertain to characteristics specific to a geographic area or community that may influence the motivation for violence or the occurrence of violent behavior in that particular location. Local factors are crucial for understanding violence, as they help explain why certain areas or communities may have higher rates of violence than others (Fuerte-Celis & Sánchez-Castañeda, 2021).

This article delves into the analysis of these four determinants of violence, considering a series of variables that would enable us to elucidate how violence triggered by organized crime is distributed across the entire Mexican territory.

Determinants of enclaves of violence in Mexico

According to the determinants of violence mentioned above, we identify the following determinants in Mexico: 1) The perpetrator agents that are identified as well-organized crime groups; 2) The means of transmission are the deaths perpetrated as a control mechanism based on fear and a way to communicate territorial control; 3) The population susceptible to violence is the population living in the municipalities that have a presence of organized crime, which corresponds to 1,893 municipalities detected in the CIDE-PPD database, where it was detected to have at least one death related to organized crime, and 4) Finally, the local determinants in Mexico are the geographic location, and local economic characteristics, which are crucial elements that encourage the expansion of enclaves of violence by organized crime (Figure 1).

Figure 1. Determinants of violence in Mexico.



Source: Own elaboration.

- a) Violence-generating agents in Mexico: These are organized agents that respond to a strategic rationality focused not only on profit and the continuity of the organization (Bagley, 2011), but also on the strengthening of its structures (Asal, Forest & Nussbaum, 2015), its reputation (Arteaga-Botello, 2009), and a sense of identity (Dishman, 2005). In Mexico, crime organizations focus on activities related to the distribution of illegal goods into the United States, growing poppy crops, and controlling spaces on the border with the United States for surveillance of goods, people, and resources (Serrano, 2007; Guerrero, 2013; Valdés, 2013; Osorio, 2015). The variable in the model corresponding to this determinant is the number of cartels operating in the municipality.
- b) Means of transmission of violence: Organizations use networks of fear to establish communication between other cartels. These warnings or forms of communication usually follow the occurrence of a homicide. Hence, each cartel communicates its presence and the fight it will face to control the territory through the homicide of a member of a rival cartel (Phillips & Ríos, 2020). In the empirical model, we use the category of networks that will allow us to analyze the location of the homicide, the organization to which the victim belongs, and the levels of contagion of violence.
- c) Local determinants are identified as the geographical position and local economic characteristics, key aspects promoting violence expansion, and illicit activities among organized crime (Dulin & Patiño, 2020). Regarding the geographical position, some areas of the country are strategically located, making them particularly attractive for organized crime. The model considers the distance to the coastline and the border with the United States. As for economic characteristics, we considered social inequality.

We consider other variables, such as the fragmentation of the agents generating violence (which leads to a dispute over geographic locations that are key for producing and distributing narcotics). Also, we included the creation of organized crime networks in the geographical space characterized by the proliferation of gun violence. Precise definitions of all variables collected to study this phenomenon from 2006 to 2012 and the data sources are provided in the Appendix.

Spatial autocorrelation

One way to assess the presence of spatial patterns is with an index of spatial autocorrelation, e.g., Moran's I index. Such an index quantifies the degree to which similar observations tend to occur near each other (Waller & Gotway, 2004, Chapter 7). Moran's I index takes the form related to Pearson's correlation coefficient:

$$I = \frac{1}{s^2} \frac{\sum_{i=1}^N \sum_{j=1}^N w_{ij} (Y_i - \bar{Y})(Y_j - \bar{Y})}{\sum_{i=1}^N \sum_{j=1}^N w_{ij}}, \quad (1)$$

where Y_i and Y_j are data values at location level weighted with the equation j ($i, j = 1, \dots, N$); $\bar{Y} = N^{-1} \sum_{i=1}^N Y_i$, $s^2 = N^{-1} \sum_{i=1}^N (Y_i - \bar{Y})^2$ and w_{ij} are weights describing the proximity between locations i and j . In the case of the absence of correlation between neighboring values, the expected values of I are

$$E(I) = -\frac{1}{N-1}. \quad (2)$$

The statistical significance of the I statistic can be judged based on its distribution for randomized values among locations or by comparing the z-score $z = [I - E(I)]/\sqrt{\text{Var}(I)}$ to a standard normal distribution, where

$$\text{Var}(I) = \frac{N^2 S_1 - N S_2 + 3 S_0^2}{(N-1)(N+1) S_0^2} - \left(\frac{1}{N-1}\right)^2, \quad (3)$$

with $S_0 = \sum_{i=1}^N \sum_{j=1}^N w_{ij}$, $S_1 = 1/2 \sum_{i=1}^N \sum_{j=1}^N (w_{ij} + w_{ji})^2$, and $S_2 = \sum_{i=1}^N (w_{i+} + w_{+i})^2$, with $w_{i+} = \sum_{j=1}^N w_{ij}$ and $w_{+i} = \sum_{j=1}^N w_{ji}$ (Cliff & Ord, 1981; Waller & Gotway, 2004). The test may suggest that there are groups in the data, but it does not indicate where they are (Getis & Ord, 1992).

Network analysis

Consider a network as a set of N nodes connected by edges. Municipalities represent nodes in our geographic networks; boundaries are drawn between municipalities within the same and neighboring states. The methodology of random networks allows us to serve data in a way that is different from indexing the observations by time and space. It changes the definitions of proximity and centrality (Dey et al., 2021; Lyubchich et al., 2019).

Distance between two network nodes, $dist(v, u)$, is the length of the shortest path, or the smallest number of edges, one needs to use to move from node v to node u . One of the most straightforward measures of node centrality is node degree, $d(v)$, which is the number of edges incident to that node. Other measures of node centrality in a network include (Granovetter, 1985; Kolaczyk & Csárdi, 2014):

- Closeness centrality = $1/\sum_{i \in N} dist(v, i)$ shows close a particular node v to all other nodes in the network.
- Betweenness centrality = $\sum_{s \neq t \neq v \in N} \frac{\sigma(s, t|v)}{\sigma(s, t)}$, where $\sigma(s, t|v)$ is the total number of shortest paths between nodes s and t that go through node v , and $\sigma(s, t)$ is the total number of shortest paths.
- Embeddedness = $d(v)^{-1} \sum_{i \in \Gamma(v)} |\Gamma(v) \cap \Gamma(i)| / |\Gamma(v) \cup \Gamma(i)|$ measures how much the neighborhood of node v , $\Gamma(v)$, overlaps with the areas of its neighbors. The embeddedness of an isolated node (i.e., with node degree being zero) is zero.

For each year of our analysis, we selected municipalities/states where the activity of cartels was reported and reconstructed a geographic network based on these municipalities to update the values of node degree, closeness and betweenness centrality, and embeddedness. Thus, these network-originated values also change over the years, reflecting the changing geographic importance of municipalities in the geographic networks of organized crime.

Econometric model

We fit a regression model that links the homicide rate H with the municipal social, economic, and geographic characteristics X_k ($k = 1, \dots, K$):

$$H_{it} = \sum_{k=1}^K \beta_k X_{kit} + \varepsilon_{it}, \quad (4)$$

where H_{it} is the homicide rate in i th municipality at time t , X_{kit} are corresponding characteristics (see definition of all K variables in Table 2 Appendix), ε_{it} is a random error term.

In the first step, we estimate the model (4) using the econometric approach of panel-corrected standard errors (PCSE). The method allows us to calculate the multivariate model and determine significant factors associated with the homicide rate at the municipal level. The advantage

of this method is that it accounts for autocorrelation, spatial correlation, and heteroscedasticity (Aparicio & Marquez, 2005; Beck & Katz, 1995). As an alternative to PCSE, we provide ordinary least squares (OLS) estimates of the same model. In the second step, we analyze the marginal effects of each variable on the explanatory power of the model, by decomposing the goodness-of-fit (expressed here with the model's R^2) according to the Shapley and Owen values (Huettnner & Sunder, 2012). With this methodology, the marginal contribution of each variable can be interpreted as part of the model's general explanation (R^2), regardless of the units in which each explanatory variable X_k is measured.

Results

The homicides related to organized crime show a sustained increase during 2006-2011, a trend consistent with the perception that violence in Mexico has intensified. An increase in total homicides was observed each year from those reported, with the most significant growth in 2010 compared to the previous year (see Figure 4 Appendix). However, the worst year was 2011, registering 16,968 homicides that occurred in violent events only up to November, the date on which the recording of this information was interrupted.

The analysis of global spatial correlation using Moran's I index did not unveil significant spatial clustering during any of the years (see Table 3 Appendix), implying that spatial patterns are much more local and cannot be comprehensively characterized by geodesic distances.

Table 1 reports the PCSE and OLS estimates for the final econometric model linking the homicide rates in 2007-2011 with the defined above variables and their functions. The whole model is statistically significant (p -value < 0.05), and each coefficient in the model is individually statistically significant. The factors have the expected signs (regarding the desired form of relationships between homicide rates and each of the variables), and the model explains about 50 % of the total variation of homicide rates (based on the adjusted R^2). Below, we discuss each variable or group of variables in more detail:

Table 1. Estimates of the models linking homicide rates to organized crime.

Variable	Model		Percentage of the total R ²	
	PCSE	OLS	Individual	Group
X_1 : Income inequality	-5.5710 ^{-2***} (8.6010 ⁻³)	-5.5610 ^{-2***} (8.5710 ⁻³)	12.78	22.75
X_2 : (Income inequality) ²	2.8010 ^{-4***} (7.6410 ⁻⁵)	2.7610 ^{-4***} (7.6310 ⁻⁵)	9.96	
X_3 : Number of cartels in the municipality	3.2210 ^{-1***} (4.2810 ⁻²)	3.3910 ^{-1***} (4.1410 ⁻²)	15.44	15.44
X_4 : Year as a categorical variable [†]	^***	^***	—	15.37
X_5 : Logarithm of the municipality area	2.3110 ^{-1***} (2.7810 ⁻²)	2.3510 ^{-1***} (2.8010 ⁻²)	10.20	10.20
X_6 : Presence of illegal crops	5.5910 ^{-1***} (7.7210 ⁻²)	5.9410 ^{-1***} (7.5310 ⁻²)	6.66	9.40
X_7 : Intensity of eradication of illegal crops	8.0810 ^{-4***} (1.6510 ⁻⁴)	7.4010 ^{-4***} (1.5710 ⁻⁴)	2.73	
X_8 : Urban area	5.8910 ^{-1***} (8.5110 ⁻²)	6.0610 ^{-1***} (8.6110 ⁻²)	8.80	8.80
X_9 : Network node degree	5.3210 ^{-3***} (1.1810 ⁻³)	5.4710 ^{-3***} (1.1610 ⁻³)	1.64	8.77
X_{10} : Closeness centrality	-1.29 ^{***} (3.4810 ⁻¹)	-1.27 ^{***} (3.2710 ⁻¹)	0.34	
X_{11} : Betweenness centrality	-8.2910 ^{-4***} (1.8710 ⁻⁴)	-8.5610 ^{-4***} (1.8110 ⁻⁴)	1.32	
X_{12} : (Betweenness centrality) ²	3.1310 ^{-7***} (7.1210 ⁻⁸)	3.2210 ^{-7***} (7.4310 ⁻⁸)	0.70	
X_{13} : Embeddedness	1.38 ^{***} (3.4210 ⁻¹)	1.45 ^{***} (3.4110 ⁻¹)	4.77	
X_{14} : Logarithm of distance to U.S. border	-1.8810 ^{-1***} (5.9210 ⁻²)	-1.9210 ^{-1***} (5.6910 ⁻²)	5.53	5.53
X_{15} : Distance to coast	-1.1210 ^{-4***} (3.3510 ⁻⁵)	-1.0910 ^{-4***} (3.2910 ⁻⁵)	2.47	2.47
X_{16} : First-order correlation index	-3.9910 ^{-1***} (1.3910 ⁻¹)	-4.0310 ^{-1***} (1.3710 ⁻¹)	0.53	1.27
X_{17} : Adjusted first-order correlation index	1.9710 ^{-1***} (5.9010 ⁻²)	1.9910 ^{-1***} (5.8310 ⁻²)	0.74	
X_{18} : Intercept	-3.40 ^{***} (5.8910 ⁻¹)	-3.46 ^{***} (5.6710 ⁻¹)	—	—

Standard errors in parentheses. For both models, $n = 1879$.

$R^2_{PCSE} = 0.507$; $R^2_{OLS} = 0.470$.

[†] See Fig 6 for the details on the effects of Year.

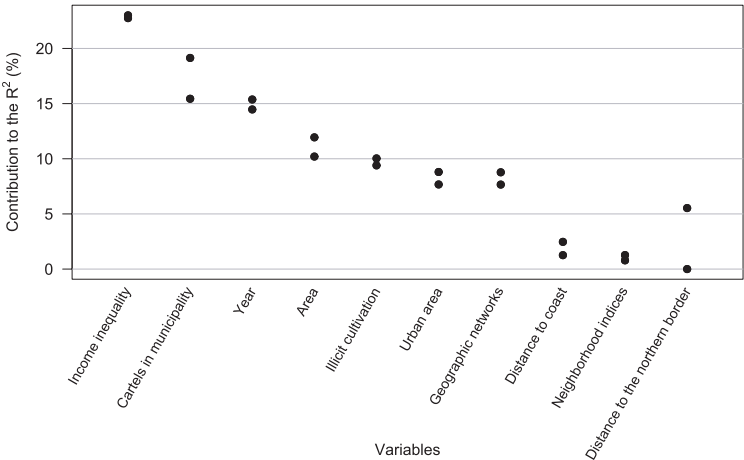
Significance levels: 0 ***0.01 **0.05 *0.1

Source: Authors' calculations.

1. Income inequality (quantified as the proportion of the population that earns less than two minimum wages a month). This factor has a nonlinear α -shaped relationship with homicide rates, which conforms to the results of earlier studies and can be modeled with the variables X_1 and X_2 . The homicide rate increases when income inequality increases in relatively homogeneous societies. The share of this group (variables X_1 and X_2 together) in the model's explanatory power is almost 23 % (Table 1). Even though income inequality may not explain high homicide rates, the variable is an underlying aspect of the violence phenomenon. The results confirm the observation by (Camara & Salama, 2004) that unequal income distribution in the population can lead to an increase in violence.

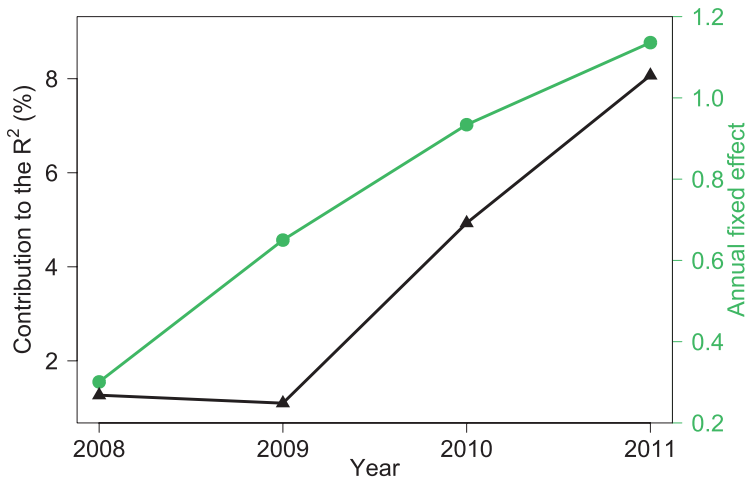
2. Confirmed presence of drug cartels in the municipality (X_3). With a positive elasticity and high statistical significance (p -value < 0.01), t new cartel in a municipality increases the rate of violence. This variable's share in the R^2 the model is between 15 and 19 % (Figure 2). More criminal groups in a town mean more significant fragmentation and less territorial control of the region by one group, which can increase the number of criminal incidents and violence in general. The control of cities or squares by criminal groups entails a power struggle that translates into homicides and acts of violence, usually with firearms.

Figure 2. Contribution of the variables in explanation of the homicide rate variability at the municipal level, from the PCSE and OLS models.



Source: Own elaboration from the Base CIDE-PPD.

Figure 3. Contribution of the variables in explanation of the homicide rate variability at the municipal level, from the PCSE and OLS models.



Source: Own elaboration from the Base CIDE-PPD.

3. Fixed annual effects (X_4). Estimated coefficients for this variable confirm that the intensity of the confrontations and the number of homicides increased in 2007-2011, with the most deaths recorded in 2011. This phenomenon reflects the contagion effect between the municipalities and confirms the vengeance and payback arguments about criminal groups with out-of-control growth. As Figure 4 shows, the estimated fixed effects of year consistently rise and share of this variable in total R^2 increases in time.

4. Municipality area (X_5) also contributes to the increase in the number of deaths, mainly due to the limited municipal and state police control over territories in the mostly rural areas of the largest municipalities.

5. Presence of illegal crops in the municipality (X_6) and intensity of crop eradication (X_7) are variables linked closely to the municipal homicide rate. They are among the most influential factors related to the hypothesis of the existence of enclaves of violence at the municipal level in Mexico. These variables explain almost 10 % of the R^2 ; they are linked to the presence of criminal groups and army, navy, and police control groups in the region, which increases the likelihood of confrontations.

6. Urban area (X_8) is also positively and significantly related to homicide rates. It confirms findings from the reviewed literature suggesting that the growth of urban areas can fracture and decrease employment

opportunities, introduce informal employment with strictly survival-level wages, bolster income inequality, and lead to increased violence.

7. Geographic networks ($X_9 - X_{13}$). The model results show a statistically significant association of the network variables with the homicide rates attributed to criminal cartels. This confirms some sationality of the criminal groups in fighting for the critical regions. The combined share of these network variables in the model's total R^2 is almost 9 %, half of which belongs to the embeddedness (X_{13}), followed by node degree (X_9). Thus, the localized centrality of a region is more important for the dispersed representatives of criminal groups.

Closeness centrality (X_{10}) is negatively associated with homicide rates, which implies that centrally positioned municipalities (not necessarily in the geographic center, but with the shortest average distance to all other municipalities in the geographic network) have fewer homicides. This phenomenon can be explained by: 1) criminal solid groups already control these regions of global network centrality; 2) the criminal groups are dispersed so that they focus on local importance rather than global, or 3) the central position of these regions makes them also reachable from many other municipalities, including by governmental forces, what stops the criminal groups from an open demonstration of violence.

The relationship between homicide rates and betweenness centrality is represented by the right side of an upward opening parabola (X_{11} and), indicating rates an accelerated increase in homicide rates with a rise in betweenness centrality. Since betweenness centrality quantifies whether a network node is more often located on the shortest path between any other two nodes, the model results can be explained by the importance of specific municipalities located on the routes for a transition of drugs, and firearms by the organized crime. Hence, higher violence is observed as those groups strive to remain in control of those regions.

8. Distance to the U.S. border (X_{14}) is negatively related to homicides, meaning the farther from the edge, the fewer homicides happen (exceptions are some municipalities with high levels of violence in the southern part of the country). This distance confirms the presence of enclaves of violence on the northern border.

9. Distance to coast (X_{15}). Even though this variable shows a low correlation with the aspect studied, it confirms the concept of enclaves of

violence with certain social traits with access to coasts and regions with little police presence and less territorial control by only one organized crime group.

10. Spatial correlations (X_{16} and X_{17}) explore the regions of continuity in the studied period and show how the expansion of the intensity of violence is used as a type of territorial control. If combined, these variables explain only about 1 % of the violence within organized crime, but they are still crucial for understanding the spatial patterns of homicides.

The enclaves of violence in Mexico are linked to the control of valuable territories for criminal activities. These territories are usually close to the borders, allowing for the easy transportation of goods into and out of the country. They are also those that are near the coasts, thus facilitating logistics and transportation maneuvering. Additionally, mountainous regions are preferred for the production and storage of illegal substances. The areas that are conducive to the transportation and distribution of drugs, as well as those that allow for the diversification of illegal activities such as kidnappings and extortion, are also targeted. Furthermore, regions that have become production areas for illegal substances such as poppy, marijuana, and cocaine are also at risk of violence.

The size of towns, densely populated areas with high levels of inequality, and proximity to violent acts are also factors that contribute to the prevalence of enclaves of violence in Mexico. The implications of the results are analyzed in the discussion, emphasizing the issues of income inequality and the spatial management of conflicts, among others.

Discussion

Overall, the model aligns with the theoretical framework. Specifically, it affirms the connection between income inequality and homicide rates. The analysis underscores that violence is not solely driven by poverty but by imbalance: higher levels of inequality correlate with increased violence, while a more equal income distribution corresponds to lower violence (Camara y Salama, 2004). The variable used to measure income inequality in this study is the percentage of people earning less than two minimum wages.

Evidence points to the fragmentation of organized crime and cartels' territorial struggles in municipalities, manifested in the presence of multiple

cartels in a town (Atuesta & Pérez-Dávila, 2018). This presence is demonstrated through shows of force, signs, or messages in regions experiencing violence, particularly homicides and armed attacks. Such activity is directly related to the analyzed increase in homicide rates (Phillips & Ríos, 2020). Numerous criminal groups concentrate on individual municipalities.

The development of enclaves as a symptom of a social epidemic of violence is evident in the annual increase in deaths and the significance of the temporal factor in the model. While seemingly redundant to confirm with the econometric model, the municipal trend of rising violence indicates that if adequate measures are not taken to stop and restrict it, the contagion of violence in Mexico will have future repercussions.

The primary objective of this study was to identify the characteristics of municipalities where this social epidemic is present or may emerge in the future due to socioeconomic and geographic traits. The model reinforces the concept of territorial enclaves by revealing that geographic conditions such as coastlines, distance to the United States, and the presence of illegal crops contribute to the perpetuation of violence in specific regions. Coupled with the lack of economic opportunities in low-income populations, the cartels' territorial struggles and their escalating use of violence lead to enclaves of violence, requiring intervention through public policy.

Compared to neighborhood-based indices, the high explanatory power of network variables demonstrates that violence propagation in space cannot be exclusively captured by examining directly neighboring regions. Spatial dependence is more complex, involving the relative positions of municipalities in the spatial network. Among the considered network centrality indices, embeddedness has the most definite link with high homicide rates, while betweenness demonstrates a quadratic relationship. Interestingly, closeness centrality is negatively related to homicides, suggesting that being highly visible and in a prominent position brings some degree of safety, as seen in various social interactions.

Delving into the understanding of violence through the study of patterns of enclaves reveals that extreme violence increases the risk in the drug trade. This does not negate the existence of more powerful groups or the intensification of violence when they lose control or face reduced income. Despite power disparities and cartel fragmentation, the business of violence has consolidated, and the drug trade remains profitable.

The increase in the number of criminal organizations and the low likelihood of effective government intervention in diversifying fragmented groups suggest that market disorganization has not weakened the main criminal groups' capabilities. On the contrary, smaller groups serving larger ones have emerged, operating as gangsters offering protection in a high-stakes business (Atuesta & Ponce, 2017).

Territorial occupation patterns by violence may reflect the vulnerability of some criminal groups and the organizational capacities of others. Criminal groups, constantly reconfiguring entities, cannot be broken down into wholly defined patterns. The extreme violence context in Mexico has strengthened the historical characteristics of drug trafficking, emphasizing constant adaptation and coexistence with death in an evolving scenario (Fuerte-Celis, Pérez-Luján & Ponce, 2019).

Considering the configuration of violence patterns and territory occupation in the context of the "war on drugs" led by President Felipe Calderón requires a deeper analysis of territory characteristics, conflict dynamics, and external factors. As clashes and aggressions increase, the conflict intensifies, leading to a greater occurrence of violent events and the evolution of other forms of violence. Despite data limitations, this study presents new perspectives on understanding violence in Mexico, proposing four determinants: 1) violence-generating agents; 2) propagation instruments; 3) susceptible population, and 4) local space characteristics. Each variable's presence in municipalities allows the consolidation of enclaves, defined as homogeneous spaces with unique geographical characteristics, the presence of illegal markets, and social conditions, making them susceptible to organized crime control.

The theory holds when understanding violence as a rational behavior extended across territories. Highly fragmented organized crime cartels, particularly in municipalities with multiple cartels, correlate with a higher probability of increased homicides. These actors seek territorial control, market domination, and the appropriation of natural resources to expand their economic capacity. The main propagation instrument of organized crime groups is violence, spreading to nearby municipalities. The spatial networks approach helps understand violence spread in Mexico and its link to geographical distribution, revealing the rationality of organized crime based on spatial distribution. This approach also aids in comprehending the differentiated effect of violence in Mexico,

visualizing violence, geographic structures, and the positioning of localities in a territorial control pattern.

Organized criminal groups aim to expand illegal activities into disputed territories and control them through violence, such as extortion, kidnapping, and robbery. Cartels have moved from traditional drug trafficking practices to establishing relationships with the population, where fear becomes a tool of control, escalating further in conflicts with rival groups and opposing forces (Arteaga-Botello, 2009). The susceptible population in this study refers to the population of municipalities infected by violence, observable through violent deaths.

The number of criminal organizations has increased, and the likelihood that the government intervenes effectively in diversifying fragmented groups is low. The disorganization of the market has not weakened the main criminal groups' administrative, technological, intelligence, and weaponry capabilities (Fuerte-Celis, Pérez-Luján & Ponce, 2019). On the contrary, they have created smaller groups at the service of larger ones, in which the former act like gangsters, offering protection in a business where lives are always at stake.

Conclusion

The issue of violence in Mexico is a complex and multifaceted problem that warrants careful consideration from various perspectives. Although this study has its limitations, it provides valuable insights into the factors that contribute to the high levels of homicide in specific areas of the country. A key finding of this study is that violence in Mexico is not a random occurrence. Instead, it is the outcome of a complex interplay of social, economic, and geographic factors that tend to be concentrated in particular municipalities. These factors include poverty, inequality, corruption, and limited access to education and other resources. Additionally, territorial control by drug cartels is a significant contributing factor to the high levels of violence in Mexico.

Empirical evidence manifests clear patterns in the evolution of violence in different parts of the country. For instance, areas with high levels of poverty and inequality are more prone to higher homicide rates than more prosperous areas. Similarly, municipalities situated near major drug trafficking routes are more likely to encounter high levels of violence.

One of the most alarming aspects of violence in Mexico is its impact on ordinary citizens. Violence has a significant impact on the daily lives of individuals, hindering their ability to carry out fundamental activities such as attending school or work. Additionally, the fear of violence can inhibit individuals from speaking out against corruption or other injustices, perpetuating a cycle of violence and impunity.

To effectively address the issue of violence in Mexico, a comprehensive approach must be taken, taking into account all contributing factors. This may necessitate enhancing access to education and resources, addressing corruption and inequality, and working to weaken the influence of drug cartels. Only by addressing these underlying issues can Mexico hope to decrease the levels of violence and establish a safer and more prosperous society for all citizens. The persistence of income inequality remains the fundamental structural phenomenon underpinning violence. Regions that exhibit greater income disparities also experience higher incidences of violence. While geographical variables alone do not account for violent activities, they assume greater significance when studied in conjunction with other factors. This approach enhances the analytical models and reinforces the notion of violence hotspots. Consequently, it is imperative to examine geographical factors to comprehend the essential characteristics of violence in Mexico.

This research contributes to understanding violence and the strategic locations within organized crime. The demonstrated spatial network approach allows us to explain the rationality of organized crime in Mexico based on its spatial distribution. It is an approach for understanding the differentiated effect of violence in Mexico, visualizing violence and the link between geographic structures and the positioning of the towns in a geographic pattern of territorial control for the production and transport of drugs and other illegal activities.

Organized criminal syndicates endeavor to broaden their illicit operations into contested territories and establish dominion over the newly acquired land, utilizing forceful measures such as blackmail, abduction, and theft. These areas are utilized by cartels that have transitioned from conventional drug trafficking and aggressive annexation practices to forging connections with the populace, predicated upon instilling fear. Nevertheless, these associations devolve into even more violent exchanges when these groups clash with rival factions and opposing forces.

When analyzing violence in Mexico, it is essential to consider information limitations, such as the lack of reliable data on youth recruitment by criminal organizations, illicit crops and their eradication, and the various factors associated with regional violence. The complexity and opacity of criminal organizations make it difficult to access accurate information on their operations and structures, which impedes detailed analysis. In addition, there is a lack of coordination between the different sources of information, which leads to a lack of coherence and precision in understanding the factors associated with regional violence. Alternative sources, such as the media, can provide helpful information to fill this data gap, although caution should be exercised due to their potential limitations and biases.

Bibliography

- Aparicio, J., & Márquez, J. (2005). Diagnóstico y especificación de modelos panel en stata. Studylib. <https://studylib.es/doc/151343/diagnostico-y-especificaci%C3%B3n-de-modelos-panel-en-stata>
- Arteaga Botello, N. (2009). Decapitaciones y mutilaciones en el México contemporáneo. *Espacio Abierto*, 18(3), 463-486. <https://www.redalyc.org/pdf/122/12211825004.pdf>
- Asal, V., Forest, J., & Nussbaum B. (2015). Why do ethnopolitical organisations turn to crime? *Global Crime*, 16(4), 306-327. <https://doi.org/10.1080/17440572.2015.1081818>
- Astorga, L. (2015). *¿Qué querían que hiciera?: Inseguridad y delincuencia organizada en el gobierno de Felipe Calderón*. Grijalbo.
- Atuesta, L. H., & Pérez-Dávila, Y. S. (2018). Fragmentation and cooperation: The evolution of organized crime in Mexico. *Trends in Organized Crime*, 21(3), 235-261. <https://doi.org/10.1007/s12117-017-9301-z>
- Atuesta, L. H., & Ponce, A. F. (2017). Meet the Narco: Increased competition among criminal organisations and the explosion of violence in Mexico. *Global Crime*, 18(4), 375-402. <https://doi.org/10.1080/17440572.2017.1354520>
- Atuesta, L. H., Siordia, O. S., & Madrazo, A. M. (2019). The “War on Drugs” in Mexico: (Official) Database of Events between December 2006 and November 2011. *Journal of Conflict Resolution*, 63(7), 1765-1789. <https://doi.org/10.1177/0022002718817093>
- Auyero, J., & Bertì, M. F. (2013). *La violencia en los márgenes: una maestra y un sociólogo en el conurbano bonaerense* (Vol. 2040). Katz Editores. <https://doi.org/10.4067/S0718-65682014000100032>

- Bagley, B. (2011). Carteles de la droga: de Medellín a Sinaloa. *Criterios, Cuadernos de Ciencias Jurídicas y Política Internacional*, 4(1), 233-247. doi: 10.21500/20115733.1946
- Beck, N., & Katz, J. (1995). What to Do (and Not to Do) with Time-Series Cross-Section Data. *American Political Science Review*, 89(3), 634-647. doi:10.2307/2082979
- Bergman, M. (2018). The Business Structure of Illegal Drugs: Concentration-Fragmentation, Cartels, and Extreme Violence. En: M. Bergman (Ed.), *Illegal Drugs, Drug Trafficking and Violence in Latin America* (pp. 43-59). Springer International Publishing. https://doi.org/10.1007/978-3-319-73153-7_4
- Braga, A. A., Papachristos, A. V., & Hureau, D. M. (2010). The concentration and stability of gun violence at micro places in Boston, 1980-2008. *Journal of Quantitative Criminology*, 26(1), 33-53. <https://doi.org/10.1007/s10940-009-9082-x>
- Calderón, G., Robles, G., Díaz-Cayeros, A., & Magaloni, B. (2015). The Beheading of Criminal Organizations and the Dynamics of Violence in Mexico. *Journal of Conflict Resolution*, 59(8), 1455-1485. <https://doi.org/10.1177/0022002715587053>
- Camara, M., & Salama, P. (2004). Homicidios en América del Sur: ¿los pobres son peligrosos? *Revista de Economía Institucional*, 6(10), 159-181.
- Checkel, J. T. (2017). Socialization and violence: Introduction and framework. *Journal of Peace Research*, 54(5), 592-605. <https://doi.org/10.1177/0022343317721813>
- Cliff, A. D., & Ord, J. K. (1981). *Spatial Processes: Models & Applications*. Pion.
- Coe, N. M., Hess, M., Yeung, H. W. C., Dicken, P., & Henderson, J. (2004). "Globalizing" regional development: A global production networks perspective. *Transactions of the Institute of British Geographers*, 29(4), 468-484. <https://doi.org/10.1111/j.0020-2754.2004.00142.x>
- Cohen, J., & Tita, G. (1999). Diffusion in Homicide: Exploring a General Method for Detecting Spatial Diffusion Processes. *Journal of Quantitative Criminology*, 15(4), 451-493. <https://doi.org/10.1023/A:1007596225550>
- Cook, P. J., & Laub, J. H. (2002). After the Epidemic: Recent Trends in Youth Violence in the United States. *Crime and Justice*, 29, 1-37. <https://doi.org/10.1086/652218>
- Dey, A., Yuvaraj, M., Lyubchich, V., Gel, Y., & Poor, H. V. (2021, December). Topological Clustering of Multilayer Networks. In *AGU Fall Meeting Abstracts* (Vol. 2021, pp. IN54B-08). <https://doi.org/10.1073/pnas.2019994118>

- Dishman, C. (2005). The Leaderless Nexus: When Crime and Terror Converge. *Studies in Conflict & Terrorism*, 28(3), 237-252. <https://doi.org/10.1080/10576100590928124>
- Dulin, A. L., & Patiño, J. (2020). Mexican cartel expansion: A quantitative examination of factors associated with territorial claims. *Crime, Law and Social Change*, 73(3), 315-336. <https://doi.org/10.1007/s10611-019-09864-3>
- Fagan, J., & Wilkinson, D. (1998). Guns, Youth Violence, and Social Identity in Inner Cities. *Crime & Just.*, 24, 105. <https://doi.org/10.1086/449279>
- Fuerte-Celis, M. del P. (2016). Geografía de la violencia en México. Un acercamiento a la reconfiguración territorial de la violencia generada por el crimen organizado. En *Cuadernos de trabajo del monitor del programa de política de drogas*, 15 (p. 42). Centro de Investigación y Docencia Económicas. <https://docplayer.es/77441045-Geografia-de-la-violencia-en-mexico-un-acercamiento-a-la-reconfiguracion-territorial-de-la-violencia-generada-por-el-crimen-organizado.html>
- Fuerte-Celis, M. del P., Pérez-Luján, E., & Ponce, R. C. (2019). Crimen organizado, violencia y disputa territorial en México (2007-2011). *Tendencias Organ Crime*, 22, 188-209. <https://doi.org/10.1007/s12117-018-9341-z>
- Fuerte-Celis, M. del P., & Sánchez-Castañeda, D. (2021). Clusters of Violence in Mexico: An Analysis of Homicide Rates from 2000 to 2012. *Journal of Latin American Geography*, 20(1), 99-134. <https://doi.org/10.1353/lag.2021.0004>
- Gamlin, J. (2015). Violence and homicide in Mexico: A global health issue. *The Lancet*, 385(9968), 605-606. [https://doi.org/10.1016/S0140-6736\(15\)60234-3](https://doi.org/10.1016/S0140-6736(15)60234-3)
- Getis, A., & Ord, J. K. (1992). The Analysis of Spatial Association by Use of Distance Statistics. *Geographical Analysis*, 24(3), 189-206. <https://doi.org/10.1111/j.1538-4632.1992.tb00261.x>
- Granovetter, M. (1985). Economic Action and Social Structure: The Problem of Embeddedness. *American Journal of Sociology*, 91(3). <https://www.journals.uchicago.edu/doi/10.1086/228311>
- Guerrero, E. (julio de 2013). Nuevas coordenadas de la violencia. Nexos. <https://www.nexos.com.mx/?p=15374>
- Hamby, S. (2017). On defining violence, and why it matters. *Psychology of Violence*, 7(2), 167-180. <https://doi.org/10.1037/vio0000117>
- Huettner, F., & Sunder, M. (2012). Axiomatic arguments for decomposing goodness of fit according to Shapley and Owen values. *Electronic Journal of Statistics*, 6 1239-1250. <https://doi.org/10.1214/12-EJS710>
- Johnston, R., Gregory, D., & Smith, D. (1987). *Diccionario de geografía humana*. Alianza. <https://www.iberlibro.com/9788420652245/>

Diccionario-geograf%C3%ADa-humana-Alianza-Diccionarios-8420652245/plp

- Kolaczyk, E., & Csárdi, G. (2014). *Statistical Analysis of Network Data with R*. Springer. <https://link.springer.com/book/10.1007/978-1-4939-0983-4>
- Kort-Butler, L. A., & Habecker, P. (2018). Framing and Cultivating the Story of Crime: The Effects of Media Use, Victimization, and Social Networks on Attitudes About Crime. *Criminal Justice Review*, 43(2), 127-146. <https://doi.org/10.1177/0734016817710696>
- Lessing, B. (2015). Logics of Violence in Criminal War. *Journal of Conflict Resolution*, 59(8), 1486-1516. <https://doi.org/10.1177/0022002715587100>
- Lomnitz, C. (2022). *El tejido social rasgado*. (1a ed.). Era. https://www.edicionesera.com.mx/libro/el-tejido-social-rasgado_142802/
- Lyubchich, V., Newlands, N., Ghahari, A., Mahdi, T., & Gel, Y. (2019). *Insurance risk assessment in the face of climate change: Integrating data science and statistics*. Wiley Interdisciplinary Reviews: Computational Statistics, 11, e1462. <https://doi.org/10.1002/wics.1462>
- Merino, J. (2011). Los operativos conjuntos y la tasa de homicidios: Una medición. *Nexos*. <https://www.nexos.com.mx/?p=14319>
- Muggah, R. (2017). El auge de la seguridad ciudadana en América Latina y el Caribe (J. Mc Lauchlan, Trad.). *International Development Policy/Revue internationale de politique de développement*, 9, Article 9. <https://doi.org/10.4000/poldev.2512>
- Olivera-Villarroel, M., & Fuerte-Celis, M. del P. (2020). Poppy Cultivation and Eradication in Mexico, 2000-2018: The Effects of Climate. En: *Evaluating Climate Change Impacts* (1st ed., p. 363-380). Chapman and Hall/CRC.
- Osorio, J. (2015). The Contagion of Drug Violence: Spatiotemporal Dynamics of the Mexican War on Drugs. *Journal of Conflict Resolution*, 59(8), 1403-1432. <https://doi.org/10.1177/0022002715587048>
- Oyarbide, C. M. (2011). El fracaso de una estrategia: Una crítica a la guerra contra el narcotráfico en México, sus justificaciones y efectos. *Nueva Sociedad*, 231, 4-13. <https://biblat.unam.mx/hevila/Nueva-sociedad/2011/no231/1.pdf>
- Papachristos, A. V. (2009). Murder by Structure: Dominance Relations and the Social Structure of Gang Homicide. *American Journal of Sociology*, 115(1), 74-128. <https://doi.org/10.1086/597791>
- Piñeyro, J. L. (2010). Las fuerzas armadas mexicanas en la seguridad pública y la seguridad nacional. En Alvarado, A. y Serrano, M. (Coords.), *Los grandes problemas de México*. Capítulo XV: Seguridad nacional y seguridad interior (pp. 155-189). El Colegio de México.

- Querales-Mendoza, M. (2020). "No se pueden llevar a mi esposo": Desaparición forzada y desplazamiento interno forzado en el contexto de la guerra contra el narcotráfico en Michoacán (México). *Revista Historia y Sociedad*, 39, 105-129. <https://doi.org/10.15446/hys.n39.82973>
- Phillips, B. J., & Ríos, V. (2020). Narco-Messages: Competition and Public Communication by Criminal Groups. *Latin American Politics and Society*, 62(1), 1-24. <https://doi.org/10.1017/lap.2019.43>
- Ríos, V. (2013). Why did Mexico become so violent? A self-reinforcing violent equilibrium caused by competition and enforcement. *Trends in Organized Crime*, 16(2), 138-155. <https://doi.org/10.1007/s12117-012-9175-z>
- Sánchez Munguía, V. S. (2009). La gobernabilidad de las ciudades fronterizas del norte de México y los desafíos para mejorar la calidad de vida en la región. En: *Dirección general del noreste, fenómenos sociales y urbanos transfronterizos entre México y Estados Unidos* (pp. 131-151). El Colegio de la Frontera Norte.
- Serrano, M. (2007). México: narcotráfico y gobernabilidad. *Pensamiento Iberoamericano*, 1(1), 251-278. <https://generaconocimiento.segob.gob.mx/sites/default/files/document/biblioteca/732/20230102-mexico-narcotrafico-y-gobernabilidad.pdf>
- Shirk, D., & Wallman, J. (2015). Understanding Mexico's Drug Violence. *Journal of Conflict Resolution*, 59(8), 1348-1376. <https://doi.org/10.1177/0022002715587049>
- Swyngedouw, E. (2004). Globalisation or 'glocalisation'? Networks, territories and rescaling. *Cambridge Review of International Affairs*, 17(1), 25-48. <https://doi.org/10.1080/0955757042000203632>
- Valdés, G. (2013). *Historia del narcotráfico en Mexico*. Aguilar. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1870-35692014000100008
- Waller, L. A., & Gotway, C. A. (2004). *Applied Spatial Statistics for Public Health Data*. John Wiley & Sons.
- Zeoli, A. M., Grady, S., Pizarro, J. M., & Melde, C. (2015). Modeling the Movement of Homicide by Type to Inform Public Health Prevention Efforts. *American Journal of Public Health*, 105(10), 2035-2041. <https://doi.org/10.2105/AJPH.2015.302732>
- Zeoli, A. M., Pizarro, J. M., Grady, S. C., & Melde, C. (2014). Homicide as Infectious Disease: Using Public Health Methods to Investigate the Diffusion of Homicide. *Justice Quarterly*, 31(3), 609-632. <https://doi.org/10.1080/07418825.2012.732100>
- Zepeda Gil, R. (2018). Siete tesis explicativas sobre el aumento de la violencia en México. *Política y Gobierno*, 25(1), 185-211. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1665-20372018000100185&lng=es&tlng=es

Appendix

Description of the CIDE-PPD database, 2006-2011

Researchers attached to the Drug Policy Program of the Center for Research and Teaching in Economics (CIDE) published in 2016 a workbook entitled *La Guerra Contra las Drogas en México: registros (oficiales) de eventos durante el periodo de diciembre de 2006 a noviembre de 2011* (The 'War on Drugs' in Mexico: (official) records of events during the period from December 2006 to November 2011). The text describes the characteristics of the so-called CIDE-PPD Base, which accounts for 1894 municipalities that had a death perpetrated by organized crime.

This database originates from files received anonymously, which, after a process of validation and codification, it was determined that they were very similar to those published in the "Database of deaths occurred by alleged criminal rivalry" (called "Base Presidency"), published on the website of the Presidency of the Republic in January 2011, so it was concluded that the information received, which they called "Base Mother" is the source from which the information that was made public in the Base Presidency was extracted.

The CIDE-PPD Database results from the systematic validation and codification of the original information contained in the Mother Base. As for its limitations, the main one is that since it is information received anonymously, there is no official source. However, a careful validation and codification exercise carried out by the CIDE verified that this information is not fictitious and does indeed correspond to events in Mexico in the context of the so-called "War on drugs".

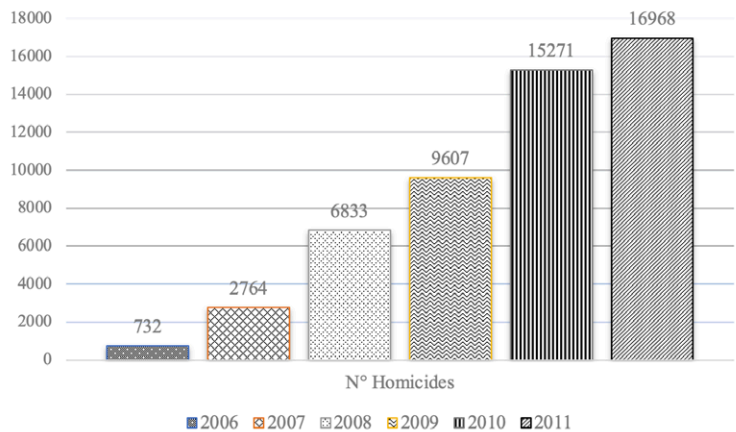
On the other hand, a second limitation is that if we do not know the source, we also do not know the methodology used to generate the information. In this regard, it is assumed that if the Mother Base is indeed the source of the so-called Presidency Base, the methodology for its collection is described in the methodological annex contained in the publication of the Base Presidency. We assume then that the origin of the data is the reports prepared by the various agencies responsible for public security and national security, i.e., the various police, the army, the navy, and the CISEN.

However, even in the methodological annex of the Base Presidency, it needs to be clarified which entities or government agencies were responsible for collecting the information. The only clear thing is that it is a variety of sources and includes information obtained by various agencies at the three levels of government. Moreover, this method of data collection shows at least two biases.

One is that by relying on official sources, the reports contained in the Mother Base indicate that all confrontations between criminals and authorities occurred because of aggression by the criminals but never as an initiative of the public forces. The other bias is that the collection of information depends on an assessment made by the different agencies involved, and each one may have followed different criteria to identify the events to be recorded and to define the type of information to be included in each report.

However, considering the limitations of the database and the biases inherent in the methodology used to collect the information, the use of the CIDE-PPD database helps outline a geography of violence in Mexico.

Figure 4. Evolution of the homicide record in Mexico, 2006-2011.



** Extrapolated data for the missing months in 2006 and 2011, based on the monthly average recorded.*
Source: Own elaboration from the Base CIDE-PPD.

Table 2. Data description and sources.

Data		
Variable	Description	Source
Y : Homicide rate	Number of homicides per 100,000 inhabitants	CIDE-PPD and own calculations
X_1 : Income inequality	Municipal GDP	CONEVAL
X_2 : (Income inequality) ²	Municipal GDP squared	Own calculation
X_3 : Number of cartels	Number of organized crime organizations in each municipality per year	CIDE-PPD
X_4 : Year as a categorical variable	—	—
X_5 : Logarithm of municipality area	Area of the municipality	INEGI
X_6 : Presence of illegal crops	Reports of the Navy and Army of the existence of illicit crops in the municipality per year	SEDENA
X_7 : Intensity of eradication of illegal crop	Number of times the Navy and the army reported going to the municipality to eradicate illicit crops (marijuana / poppy) per year	SEDENA
X_8 : Urban area	Municipal areas classified as urban	CONAPO
X_9 : Network node degree	Centrality of a node in a network	Own calculation
X_{10} : Closeness centrality	Centrality of a node in a network	Own calculation
X_{11} : Betweenness	Centrality of a node in a network	Own calculation
X_{12} : (Betweenness centrality) ²	Centrality of a node in a network	Own calculation
X_{13} : Embeddedness	Centrality of a node in a network	Own calculation
X_{14} : Logarithm of distance to U.S. border	Distance from the center of the municipality to the northern border of Mexico	Own calculation
X_{15} : Distance to coast	Distance from the center of the municipality to the nearest coast	Own calculation
X_{16} : First-order correlation index	The spatial association of organized crime deaths	CIDE-PPD
X_{17} : Adjusted first-order correlation index	The spatial adjusted association of organized crime deaths	CIDE-PPD

The number of deaths related to the presumed criminal activity is obtained from the database published by the CIDE-PPD.

The information on population, population density, urban or rural classification of the municipalities, economic development, and GDP at the municipal level is provided by the INEGI, CONEVAL, and CONAPO.

The number of hectares of cannabis destroyed by the military forces was provided by the Ministry of Defense (SEDENA). The variable of classification of zones urban areas has been provided by the estimates developed by the National Population Council (CONAPO). All the variables are annual, except wherein a dam, and added at the municipal level.

Annual rates of homicides related to organized crime are calculated for each municipality as the total number of homicides in that year per 100,000 inhabitants- CIDE-PPD. The population density is calculated as the population per square kilometer. Distance to the northern border and distance to the coasts are calculated as the distance from the central point of the polygon of the municipality to the nearest point of international migration on the northern border and the nearest seaport of entry and exit of merchandise, respectively.

Based on the CIDE-PPD data, we constructed a binary variable that indicates any criminal organization's presence and a variable that gives the number of organized criminal groups.

The compiled data are available from the authors upon request.

Table 3. Moran's spatial correlation test for annual homicide rates.

Year	<i>I</i>	<i>E (I)</i>	<i>Var(I)</i>	<i>P-value</i>
2007	0.01363	0.00041	0.0003	0.4175
2008	0.00472	0.00041	0.0002	0.7169
2009	0.00364	0.00041	0.0001	0.6856
2010	0.00646	0.00041	0.0002	0.6272
2011	0.01239	0.00041	0.0003	0.4599