The diversification of drug trafficking organizations: Testing Spatial–Temporal association between extortion and homicide in Mexico

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Abstract

In general, the literature associates face to face extortion with homicides, typically related to organized crime activities, since it is a form of violence that may end in death. In Mexico, it has been argued that diversification by the drug cartels has resulted in homicidal violence that facilitates extortion by these groups. However, despite a plausible theoretical and direct connection, there is still a lack of empirical studies that identify local and regional dynamics of homicidal violence that can be associated with the commission of the crime of extortion. This paper attempts to fill this gap by analyzing the spatial–temporal concentration of extortion and homicide on a municipal level from 2015 to 2020 in Mexico. Overall, we found that differences in spatial–temporal patterns between these activities suggest that these crimes emerge from different logics and, perhaps, criminal groups. As such, distinct public policies are required to deal with each of them.

Keywords Extortion · Homicide · Spatial analysis · Criminal groups · Time series

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Introduction

Extortion is a crime that causes permanent and irreversible emotional damage to victims, similar to that of kidnapping (Salgado Villegas 2010). The literature has documented the trauma associated with this crime (Calandra and Giorgi 2017) in terms of intrusion symptoms – psychological discomfort, identity dissociation -, persistent avoidance – failure to remember the traumatic situation-, negative cognitive alterations – negative beliefs, decreased interest, and feelings of detachment-, and alterations in activation and responses – constant state of alert- (Celedón et al. 2009; Gómez & Cárdenas 2012; Chávez-Valdez et al. 2020).

This type of crime generally refers to face to face extortion (as opposed to virtual extortion generally undertaken via telephone or electronically), where a regular, periodic payment is demanded and the victim is threatened with harm to their business, assaults on their families, or death (Estévez-Soto 2021; Mugellini 2013). Study of this crime is of interest as, in addition to the psychological effects on the victims, extortion is associated with a patrimonial loss by the general population as it may be committed against individuals, businesses, and government agents. In Mexico, extortion has practically doubled on a national level, from 5,739 registered cases in 2016 to 10,343 cases in 2022 (SESNSP 2022).

This type of extortion is usually committed by organized criminal groups as it demands a certain level of logistical organization, such as follow-ups, surveillance, real threat capacity, and generally refers to a type of tax or payment that organized crime groups charge companies and businesses to provide them with security within their territories (Díaz-Cayeros et al. 2015; Vilalta & Fondevila 2018).

Although, internationally, extortion is regularly viewed as the primary activity of certain forms of organized crime, for example, criminal syndicates and mafias (Asmundo and Lisciandra 2008; Aziani et al. 2020; Dugato et al. 2020; Varese 2011, 2014), in Mexico, the growth in extortion is generally seen as a side activity of organized criminal groups that participate in the drug market (Shirk & Wallman 2015). In this regard, some studies point out that the evolution of criminal organizations, dedicated to drug trafficking, has included the diversification of activities to include extortion within their "portfolio" of criminal activities (Corcoran 2013). Moreover, Locks (2015) directly attributes the almost explosive rise in the extortion industry to the War on Drugs.

For Correa-Cabrera et al. (2015), the propagation of violence in certain territories can be explained by the expansion of the criminal extortion networks of drug trafficking organizations, rather than by drug trafficking itself. In other words, Mexican criminal organizations appear to have transmuted from a few powerful groups involved in drug trafficking to a disperse and heterogenous subset of smaller, much more violent groups, expansively dedicated to the general criminal market, including extortion, kidnapping, and/or human trafficking (Bunker 2013; Shirk & Wallman 2015).

Although there is no specific work on the spatial concentration of extortion in Mexican municipalities, the literature has assumed a logical connection between this crime and homicides as a consequence of both the spatial association found

between homicides and dispossession (Meneses-Reyes et al. 2021) and that of homicides and drug trafficking (Osorio 2015; Massa et al. 2021). In this regard, it has been argued that local dynamics of homicidal violence may be generally associated with extortion in two ways. The first relates to the notion that extortion always implies a risk of violence through credible threats. For example, if a victim appeals to the police, does not pay, is reluctant to pay, or does not pay enough, it generally leads to a violent repercussion. Individuals or criminal organizations who have the capacity to violently follow through on a threat may thus use extortion as a means of obtaining resources, power, and/ or control over a geographic space (Meneses-Reyes et al. 2021).

Second, the association between the two crimes has been explained by the fact that they occur in the same territorial space and precisely where organized drug trafficking criminal groups operate. This has been the dominant hypothesis behind the change in public security policies implemented by the Mexican government since 2006, and was largely used to support the Mexican War on Drugs (Calderon et al. 2015; Correa-Cabrera et al. 2015; Osorio 2015). Based on this understanding, operations of organized criminal groups seem to explain the appearance of regional clusters where high homicide rates are concentrated in areas where a high incidence of drug trafficking and related crimes is also registered. Nevertheless, despite both being high impact crimes, until now, the spatial–temporal association between homicides and extortion has not been empirically explored in depth.

Building on the findings on the regionalization of drug-trafficking clusters and homicides in Mexico (Osorio 2015; Massa et al. 2021), our key research question asks: is there a spatial temporal direct relation between extortion and homicides in Mexico? Testing this association is important as it would facilitate the development of public policies specifically oriented towards the prevention of extortion on a regional or local level. Moreover, it could potentially lead to the further identification of whether drug dealing groups tend to expand their activities to other crimes, develop such crimes on the periphery to complement their "portfolios" with other criminal activities, or whether other groups (or individuals) are involved (Corcoran 2013).

The empirical strategy of this study consisted of first exploring the concentration of extortion and homicide on a municipal level between 2015 and 2020 in Mexico, and the spatial neighborhood effects of these crimes in contiguous municipalities. To implement this analysis, global and local indicators of spatial association of homicide and extortion –univariate and bivariate– were estimated in 2,471 municipalities (Anselin 2013). Our findings show different spatial temporal patterns for homicide and extortion. Although both crimes are concentrated within certain municipalities, the spatial clusters do not overlap. We thus found no significant evidence of municipalities with high rates of extortion within a context of homicidal violence. This could indicate that the two crimes are not directly linked, or even suggest that they are not organized by the same criminal groups. However, it may not be entirely reliable, as official data can have a significant limitation: the under-reporting of extortion by violent groups, as victims may suffer reprisals or consider the extortion to be "part of the business" (Asmundo and Lisciandra 2008).

To strengthen the spatial analysis, the second part of the empirical strategy constituted the implementation of three time series techniques, two related to the predictive capacity of the time series and the third one, to the formation of clusters with respect to the behavior of these trends. The results suggest that only a small proportion – around 5%– of Mexican municipalities present linear Granger causality, and virtually none – only one case- present nonlinear Granger causality. Additionally, the formation of clusters of the extortion time series does not coincide, neither in size nor in location, with the clusters of the homicide behavior time series. This advocates that the generalized behavior of extortion and homicide have neither a spatial nor a temporal association, and thus the theoretical link proposed in the literature on extortion and the activities of the Mexican cartels (Guerrero-Gutiérrez 2011), does not appear to stem directly from homicidal violence.

Overall, our findings are consistent with previous research on organized crime in Italy, Colombia, and Mexico. Dugato et al. (2020) found that Italian mafias controlled extortion, but there was a weak correlation with their presence in other violent manifestations of organized crime, such as homicides. In Colombia, criminal gangs ("*Bacrim*") that emerged following the downfall of cartels from Medellin and Cali, are responsible for only 5% of extortions, while most of this crime (74%) is attributed to common crime (Ibarra 2016). For the Mexican case, Estévez-Soto et al. (2021) conclude that Mexican drug cartels tend not to become involved in extortion.

In this sense, our work calls into question the generally accepted idea that drug cartels have expanded their activities to include other common crimes such as extortion. The underlying hypothesis that could elucidate our results is that other organized criminal groups (or even individuals) may possibly carry out specific secondary tasks for the cartels, but do not directly belong to such criminal organizations. Rather, these are organized groups that take advantage of the environment of a weak state (related to the presence of the cartels) to operate in the shadow of the drug cartels, by establishing extortion networks.

These results have direct implications for public security policies related to both crimes. If the criminological patterns that cause homicides were related to extortion, the first order effects would be connected, as they would result from the activities of the same criminal groups. However, the spatial–temporal association between homicide and extortion is practically null. This neutrality suggests that extortion is not directly associated with homicidal violence at a regional level, and thus it is likely that other criminal activities lend credibility to threats of harm and can be studied on a level smaller than the municipal one: say city or neighborhood. As a result, public policies that deal with homicides associated with organized crime are unlikely to impact extortion, and vice-versa.

Extortion as a tool for organized crime

In the literature on organized crime, extortion appears to be associated with homicide in two ways: first, as part of a territorial competition in the market for extortion, and second, as one of the effects of a credible threat in extortion. The latter refers to the punishment of those who do not comply with or who resist the extortion,

generally translating into homicides, assaults, arson, and/or harassment (Guerrero-Gutiérrez 2011; Hale 2016). In Mexico, responses to such violence have ranged from the appearance of self-defense groups (Díaz-Cayeros et al. 2015; Shirk et al. 2014) to the forced displacement of the population (Salazar and Álvarez Lobato 2018).

Generally, extortion is aimed at micro, small and medium businesses (Vilalta & Fondevila 2018), however, it has spread significantly to include other vulnerable groups, for example, the migrant population in transit to the US (Pérez Morales et al. 2015). The latter case shows an asymmetry of power that underlies extortion (Luckenbill 1982) given that migrants are not even able to appeal to the authorities for protection or to report the crime.

Within this context, extortion is seen as "a causal driver of violence and a defining feature of urban criminal governance" (Reitano & Shaw 2018: 98) as different organized groups compete for control of parts of a territory or for extortion networks. The "protection" of businesses, understood as the most widespread form of extortion, is a key sector of illegal markets and one that generates the most violence. From the classic work of Reuter (1983), and Bouchard and Wilkins (2009) to that of Beckert and Dewey (2017), the sociology of illegal markets has studied the economics of extortion as part of the common activities of organized crime. This alludes to another aspect related to extortion: the political dimension (Anzola 2016). In Mexico, as well as in other contexts such as in Italy, extortion has served as a political device that helps consolidate criminal power at the local level (Peña González 2021). When this succeeds, criminal groups exercise control with extortion serving as a political tool (Elsenbroich et al. 2016) in both time and space.

However, despite extensive literature on the extractive role of mafias, based on threats and violence (Grossman 1999; Skaperdas & Syropoulos 1997), relatively few studies are dedicated exclusively to extortion (Konrad & Skaperdas 1997). For example, Varese (1996) classifies extortion into predatory, extortionary and protective, according to their function or interest, with all, eventually, generally reducing violence (mostly to avoid police attention), although, again, an expanding mafia may resort to violence when conquering new territories (Varese 2011).

In Latin America, the Colombian experience is notable, where the so-called *'Bacrim'* (short for *Bandas Criminales*, Spanish for criminal gangs or groups) contributed to an increase in violence following the loss of power by Medellin and Cali cartels (McDermott 2014; Prieto 2013; Rico 2013). Between 2003 and 2014, extortion decreased by 136% in the country, with 70% of reported cases concentrated in 57 municipalities with more than 100,000 inhabitants. However, the *Bacrim* were found to be involved in only 5% of extortion cases, while individuals associated with the guerilla participated in 11% of cases, and common criminals represented the remaining 74% (Ibarra 2016).

Within this context, extortion appears intrinsically associated with violence, in terms of, for example, the economy of organized crime (Garoupa 2000; Lotspeich 1997; Olken & Barron 2009), economic behavior (Konrad & Skaperdas 1997), as a form of entrepreneurship (Scandizzo & Ventura 2015) or a strictly commercial perspective (Schelling 1971). The association may also be argued from a social point of view, considering, for example, the violence in the social organization of extortion

(Best [1982](#)), the social consequences of such violence (Neumann & Elsenbroich [2017](#)) or violence as a determinant for compliance (Gambetta [1994](#); Luckenbill [1982](#); Varese [2001](#)).

Despite their importance, studies emerging from economics or sociology of illegal markets and mafias, generally offer an anecdotal association between extortion and violence, or scarce empirical evidence of their direct association. A clear example of this is the work of Guerrero-Gutiérrez ([2011](#): 50), that explained the increasing violence in the Mexican state of Guerrero through the "fragmentation process of the former Beltrán Leyva Organization, and the subsequent struggle for extortion and local drug markets in Acapulco". In fact, this author argues that the violence related to organized crime in Mexico is the result of competition for illegal protection markets based on extortion, and the consequence of the fragmentation of cartels of local mafia who exercise violence against rival groups and authorities to maintain or secure control over a territory.

These are local organizations, formed by disbanded cells of the large cartels, who have broadened their illegal dealings to incorporate extortion, kidnapping and car theft. The research shows that extortion almost tripled between 2004 and 2009, as did homicides, and that "the development of illegal protection markets, based on organizations ready to engage in intensive violence and to fight each other for control over such markets, accounts for this dramatic increase" (Guerrero-Gutiérrez [2011](#): 55).

While this may appear intuitively correct, no evidence is included that shows an empirical direct association between extortion and homicide. In fact, there are few studies that empirically study the violent consequences of the competition between gangs for the extortion market (Magaloni et al. [2020](#)). As indicated by Estévez Soto ([2021](#): 2), there is "anecdotal evidence of the dramatic consequences faced by those who refuse to comply with extortion demands" perhaps because "one would expect refusals to comply to be the exception, rather than the norm". However, some indirect evidence does exist. Brown et al. ([2024](#)) analyzed the determinants of extortion, and in particular, the causal effect of cooperation between gangs (ceasefires) that diminished violence (homicides) but increased extortion levels in a territory. In contrast to collusion in traditional environments, cooperation between criminal organizations appears to reduce violence, which generally allows gangs to increase rates of extortion.

In this regard, Agostinelli ([2019](#)) provides further background to show a clear relationship between extortion and homicides as punishment. Findings indicate that municipalities in El Salvador with high business density had higher homicide rates (of victims) than municipalities with low business density from 2012 to 2017. These results show that comparatively, high business density municipalities became disproportionately more violent. At the same time, within these municipalities, extortion was concentrated in specific types of businesses which appears to confirm the situational vulnerability of certain businesses, for example, small and medium businesses providing direct attention to the public: the service industry (sale and cleaning of clothes, tires), food (restaurants, businesses for take-out food), and transport (taxis and collective transport), among others (Anzola [2016](#); Chin et al. [1992](#); Estévez-Soto et al. [2021](#); Schelling [1971](#); Vilalta & Fondevila [2018](#)).

Data and methods

Extortion in Mexico is legally defined as the use of violence over people to obtain a benefit affecting the patrimony of such persons (Código Penal Federal 2021). Federal entities report complaints of this crime and that of homicide to the Se*cretariado Ejecutivo del Sistema Nacional de Seguridad Publica* (SESNSP 2022). The database analyzed comprises the crimes registered monthly from January 2015 to December 2020 in 2,741 municipalities. For the calculation of crime rates per 100,000 inhabitants for each municipality, data from the 2020 population census was used, undertaken by the *Instituto Nacional de Estadística y Geografía* (Instituto Nacional de Estadística y Geografía, 2020).

While extortion may occur both directly (protection charge) and indirectly (for example, virtual kidnapping), this study groups together these crime modalities to account for the numbers of registered cases, in accordance with national recommendations and practices (Instituto Nacional de Ciencias Penales 2019). This is especially relevant given that not every extortion registered in the SESNSP is associated with a larger organized crime or criminal group phenomenon (Vilalta & Fondevila 2018; 2019) with which, in principle, it may be possible to understand the general behavior of crime in the country.

Environmental criminology considers the municipality to be the most salient geographic level for studying crimes such as extortion, as groups of organized crime control certain regions or economic sectors and act as an "alternative government" or "criminal governance" (Pansters 2018; Gil 2020), controlling smaller areas than a state or national government (Kleemans 2018). According to research into organized crime, extortion is a local crime, given that collusion between criminal groups and politicians, public administrators and local businesspeople is simpler and more profitable (Savona and Zanella 2019). To our knowledge, ours is the first study that examines spatial and temporal association between homicide and extorsion, with the municipalities of Mexico as the unit of analysis.

Using the spatial analysis of polygons to estimate first order spatial effects, the global Moran's I was calculated for each crime individually and the bivariate Moran's I as a measure of spatial autocorrelation (Cliff and Ord 1981; Anselin 2013). To calculate the bivariate Moran's I, homicide rates were used as the lagged variable of extortion rates. Through the implementation of bivariate statistics, we sought to prove the hypothesis that the activities of organized crime, typically related to the control of territory and drug distribution networks, concentrate homicide and extortion in areas of conflict and in nearby municipalities.

Control of territory generally precedes the expansion of other, secondary criminal activities. This is the case of dispossession in Mexican municipalities, where evidence suggests that homicides destabilize property relationships and increase dispossession (Meneses-Reyes et al. 2021). Building on said theoretical link, it would be expected that the presence of high homicide incidence would be directly associated with high levels of extortion rates in neighboring municipalities, reflecting the territorial presence of criminal organizations and the expansion of their activities (Bunker 2013; Shirk & Wallman 2015).

To study spatial dependence, local indicators of spatial association (LISA) were calculated with local Moran's I to analyze the presence of clusters for each crime, and bivariate for both crimes with homicide as the lag variable. The result of the LISA allowed for the development of maps and the identification of spatial clusters (Geoda) with a significance filter of 0.01. For the tests of statistical significance of the global statistics and LISA, 999 conditional Monte Carlo permutations were used. Rook contiguity was employed for the spatial analysis. The databases were built and managed with R and Qgis.

In terms of the interpretation of the spatial statistics, a positive value of the estimation of the global Moran's I indicates that municipalities with a similar crime incidence are grouped in space (high-high and low-low). In contrast, a negative value of the spatial statistic shows that municipalities with dissimilar values are grouped in space. That is, municipalities with low crime levels have neighboring localities with high levels of the crime under study and vice versa (low–high and high-low). Finally, a value of 0 or close to 0 in Moran's I indicates no spatial association between the crime levels of neighboring municipalities.

To strengthen the spatial analysis, a time series analysis was carried out in two ways: first, two Granger (1969) causality analyses, one linear and the other nonlinear, were conducted between the homicide and extortion time series for each municipality. Additionally, a group-based trajectory analysis was undertaken for all series of each crime. The objective of the first tools was to identify the existence of a predictive capacity (linear and/or nonlinear) between the time series for each municipality. Granger causality implies that if a variable X Granger-causes Y, then X is said to contain useful information that can explain $Y's$ future behavior that is not present in the lagged values of Y itself.

The following causal directions may thus be identified: 1) lagged values of the reported homicides provide significant information that may be used to improve the prediction of future values of the reported extortion cases; 2) lagged values for the reported extortion cases provide significant information that may be used to predict future values of the reported homicide cases; 3) both series, simultaneously, contain information that could improve the prediction of the other; 4) the series do not contain information that improve the prediction of the other. Evidence of any of the first three cases would suggest the existence of a temporal direct association between the variables in each municipality. If no evidence of Granger causality is found, both series are said to be independent in the corresponding linear and/or nonlinear form.

The second tool, the group-based trajectory analysis, is a finite mixture models application aimed at identifying whether significant groups are formed within a population, and whether they follow a distinct path or trajectory over time. Nagin (2005) describes the statistical foundations of this method, and Nagin and Piquero (2010) present a discussion of the advantages and disadvantages of its use for the study of criminal activity trajectories. In the case of this study, this tool was used for the formation of groups or clusters of municipalities where common behavior in the time series was noted for each type of crime analyzed. The objective of this step was to compare whether the formation of the identified groups or clusters for the reported cases of extortion were similar in size and membership to those identified for reported cases of homicides. The R 'traj' package, based on the three-step
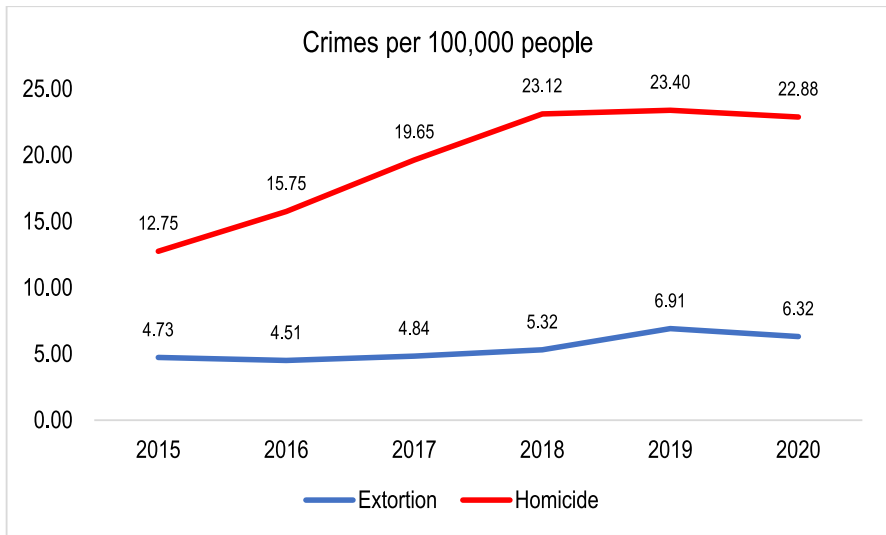
Fig. 1 Rates of Extortion and Homicide by year in Mexico, Own elaboration with information from SESNSP (2022)

procedure proposed by Leffondré et al. (2004), was used for the selection of optimal number of groups, as well as for the estimation of the parameters used for the formation of clusters for each type of crime.

For the time series analysis, it is noteworthy that over the past few years, a reconfiguration of municipalities has been implemented in Mexico, particularly in the state of Oaxaca, which explains why not all municipalities are comparable through time. For this reason, we have only included those municipalities that had registered one or more than one crime of each case during the period under consideration.

Results

Figure 1 shows that, in principle, the evolution of both crimes in time is somewhat similar. The homicide and extortion time series reveal an average upward trend, followed by a decrease in rates for the last year. From 2015 to 2019, the incidence rate for homicide cases per 100,000 people increased from 12.75 to 23.4 yearly, while for extortion, rates increased from 4.73 to 6.91 registered cases. In 2020, presumably as a consequence of the COVID pandemic,[1] both crimes registered a decline to 22.88 and 6.32 cases per 100,000 people respectively. With regards the concentration of crime, Table 1 indicates that, on average, half the annual extortions were concentrated in approximately 41 municipalities. That is, these municipalities registered an

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[1] With the outbreak of the COVID-19 pandemic in 2020, drastic changes occurred that completely altered the criminal landscape of the country (Vilalta, et al. 2023).

Table 1 Registered homicide and extortion cases, with the number of municipalities which concentrate 50% of their occurrence, Own elaboration with information from SESNSP (2022)

Year	Homicide cases	Extortion cases	Municipalities that concentrate 50% of the homicide cases	Municipalities that concentrate 50% of the extortion cases
2015	16,044	5,953	65	39
2016	19,822	5,675	67	37
2017	24,721	6,086	55	41
2018	29,092	6,691	55	43
2019	29,437	8,699	57	43
2020	28,792	7,947	53	42

average of 3,421 extortions per 100,000 people per year. Similarly, annually, half of the homicides (12,326 per 100,000 people) were concentrated in an average of 59 municipalities. Considering that there are 2,741 municipalities in Mexico, this indicates a high concentration of both crimes in only a few municipalities of the country. Given this, it is interesting to note where these municipalities are located and whether it is possible to identify the formation of spatial clusters. This is illustrated in Map 1, which shows that the spatial clusters of homicides and extortion differ, and that there is a reconfiguration of these over time.

In order to statistically support this finding, Table 2 presents the results of the global Moran's I for the individual cases as well as the bivariate. These estimations demonstrate that individually, both homicides and extortion are spatially concentrated in certain Mexican municipalities. This concentration is also evident in the bivariate case. However, the temporal evolution of this concentration does not appear to follow the same dynamic in the individual cases. That is, when the annual value of the global Moran's I is observed for the homicide cases, a gradual decrease is detected, from approximately 0.34 in 2015 to approximately 0.16 in 2020. Despite the increasing levels of homicide in the country, depicted in Fig. 1, this crime has become more dispersed across the territory, as illustrated in Map 1.

In contrast, the extortion clusters have remained relatively constant, with the exception of the last year of measurement (2020), in which there were more numerous spatial clusters of municipalities with similar levels of extortion. Altogether, Table 2 illustrates that, in recent years, extortion has remained concentrated in certain areas of the country, while homicide has gradually dispersed, and thus the direction of concentration tendency is reversed.

To explore the nature and direction of association of the combined concentration illustrated by the Bivariate Moran's I in Table 2, spatial clusters were developed with the identified municipalities. The result is shown in Table 3. In contrast to the first order effect that shows significant clusters in Mexico for each crime, few municipalities with high homicide levels appear to neighbor municipalities with similar levels of extortion (Column 1 of Table 3), in comparison with the other three spatial clusters presented. This finding appears to contradict the theoretical assumption of the spatial association between extortion and homicide: if homicidal violence is

Map 1 Univariate local moran's I. homicide(left) and extortion (right) (2015–2020), own elaboration with information from SESNSP (2022)
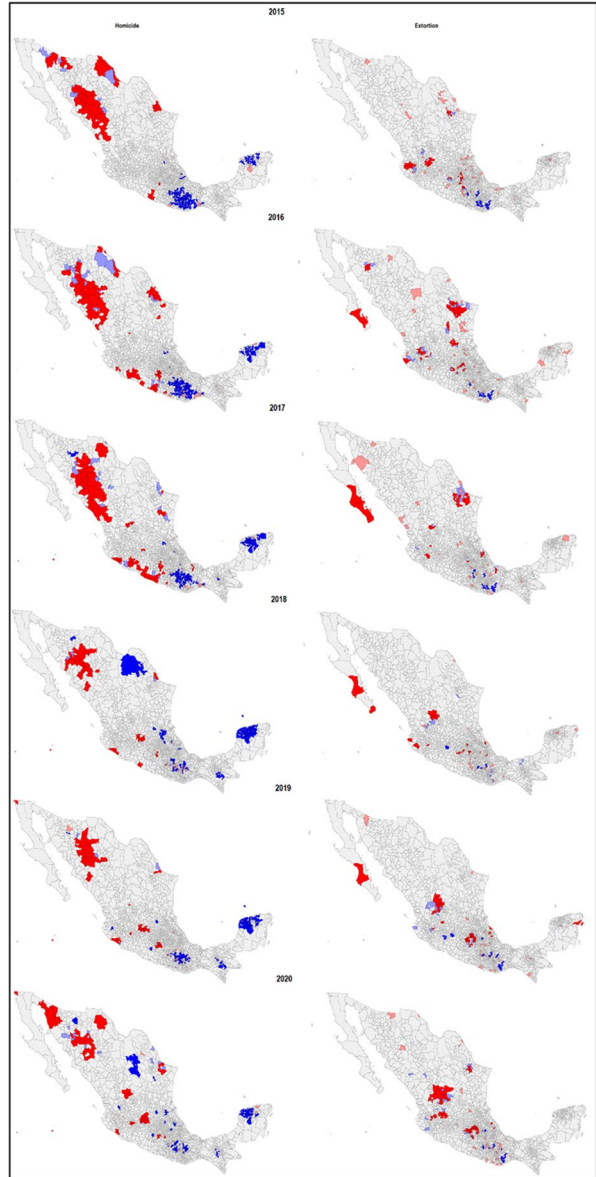
used as a mechanism for extortion, a higher number of municipalities belonging to the "High-high" spatial cluster would be expected.

In 2018, the new federal administration implemented changes to the policy regarding drug cartels. One of the pillars of this new security policy was that the newly created police body, the *Guardia Nacional* (National Guard), would broaden its operations through an aggressive strategy of territorial occupation through the establishment of barracks in strategic points of the country (Tirado & Canjura

Table 2 Univariate and Bivariate Local Indicators of Spatial Association (LISA)

	Homicide	Extortion	Homicide and Extortion
Year	Global Moran's I	Global Moran's I	Bivariate Moran's I
2015	0.342**	0.213**	0.050**
2016	0.397**	0.267**	0.067**
2017	0.401**	0.219**	0.080**
2018	0.243**	0.224**	−0.005**
2019	0.287**	0.295**	0.021**
2020	0.161**	0.355**	0.048**

[**]Level of significance (0.01)

Table 3 Municipalities in spatial clusters on the Bivariate Local Moran's I by year

Extortion-Homicide/Year	High-High	Low-Low	Low–High	High-Low
2015	10	151	48	6
2016	27	167	71	7
2017	26	161	73	6
2018	3	142	48	13
2019	18	151	58	9
2020	22	115	63	7

Table 4 Municipalities in hotspots (spatial cluster: high-high) by year

Year	Homicide & Extortion	Extortion	Homicide
2015	10	39	50
2016	27	54	80
2017	26	35	80
2018	3	28	44
2019	18	76	64
2020	22	102	69

2022). Interestingly, with the exception of 2018, the annual number of municipalities with low extortion levels and high homicide levels (column 3 of Table 3) maintain a ratio of 3 to 1 in comparison with the number of municipalities in the spatial cluster with high levels of both crimes. When combined with the information from Map 1, a process of reconfiguration of regional spatial clusters, beginning in 2018, can be identified, for both homicide and extortion.

In this regard, as shown in column 2 of Table 4, the number of municipalities that form part of regional hotspots (areas with a high crime incidence) for extortion, increased notably between 2019 and 2020. On the right panel of Map 1, these hotspots are concentrated towards the center of the country in municipalities of the

states of Zacatecas and Mexico. On the other hand, the spatial pattern of municipalities in homicide hotspots changed to create spatial clusters of 64 to 69 municipalities in this same period (column 3 of Table 4). As is evident in the left panel of Map 1, these clusters are mostly located in municipalities of states situated along the US border, but conformation appears to be smaller. In addition, a new region of municipalities with similar characteristics emerged in the central part of the country, mainly in municipalities of the state of Guanajuato.

Finally, when grouping municipalities with a high crime incidence within the federal entities, a clear differentiation in the regions between homicide and extortion can also be seen. From 2015 to 2017, homicide clusters were located in the northeast of the country, in Chihuahua and Sonora, and along the Pacific coast in the state of Guerrero. The extortion hotspots, on the other hand, were concentrated in the State of Mexico in 2015, and in Nuevo Leon from 2015 to 2017. As has been mentioned, spatial patterns of homicide and extortion changed after 2018, coinciding with changes in security policy by the new federal administration. In the case of homicides, the municipalities of Guanajuato emerged as new clusters with high crime rates for every 100,000 people, as did those of Morelos, south of Mexico City. In the case of extortion, in 2018, Zacatecas became one of the states with the highest number of municipalities that formed clusters of extortion, on a par with the State of Mexico.

Altogether, findings regarding the spatial association of extortion and homicide suggest a territorial distinction between these crimes that became more evident in the 2018–2020 period. This could serve to illustrate differences in the underlying criminological patterns of these crimes. In order to expand the study of the behavior of criminal patterns, two time series techniques were implemented that sought to explore both the predictive capacity of criminal behavior in the series, as well as to identify the trends shared over time.

The time series analyses were conducted for 954 municipalities for both the homicide and the extortion time series, per municipality. The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root test was implemented for each of the 1,908 series to identify whether they were stationary. All were found to be I(1), indicating that they were not stationary in levels but were in first differences. The series were therefore transformed to work with their first differences, as a result of which, the number of observations for each series was reduced to 71. Map 2 shows the results of the linear Granger causality test for the municipalities. It can be seen that some type of causal direction in the Granger sense is only found in 127 municipalities. In 52 municipalities, a causal direction was found from extortion to homicide, that is, that the change in the lagged values of the reported extortion cases provides significant information that can be used to improve the prediction of future changes in the values of the reported homicide cases. On the other hand, in 61 municipalities, the causal direction was the opposite, that is from homicide to extortion, while in only 14 municipalities, the causal relationship was bidirectional.

In order to make the analysis of the linear Granger causality more robust, two additional correlation tests were undertaken: the first used Kendall's rank correlation tau for the series in levels, and the second used Pearson's product-moment correlation rho for the series in first differences. In the first case, the rank correlation
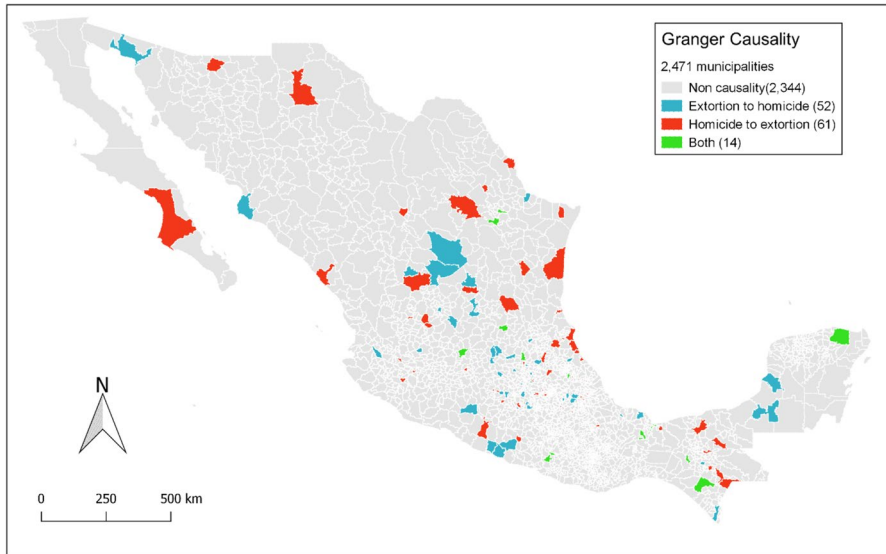
Map 2 Granger causality map

tau was significantly distinct from zero in the case of only 92 municipalities, while in the second, a rho distinct from zero was found for 115 municipalities. This suggests that in fact, the direct association between the extortion and homicide series is limited, located at around 5%. That is, on a municipal level, the behavior of the extortion or homicide series does not appear to predominantly explain the other in a direct linear fashion.

To explore the presence of a possible direct, but nonlinear, association between the series, a test was implemented based on artificial neural networks (ANN) contained in the R 'NlinTS' package. For this, two ANN were developed with 2 hidden layers of the univariate model and 4 hidden layers of the bivariate model, estimated with a stochastic gradient descent optimization algorithm with 50 iterations, a 0.1 learning rate, and a batch size of 30 for the back-propagation algorithm, for the one to four lags.[2] For this analysis, only one municipality displayed a nonlinear Granger causality from homicide to extortion for lags 1 and 2, but none in the cases of lags 3 and 4. Overall, it can be seen that only a small proportion – around 5%- of Mexican municipalities present some type of linear Granger causality, and virtually none demonstrated its nonlinear version.[3]

The group-based trajectory analysis considers a similar behavior (statistical characteristics of their distribution) of the included series as a base to propose the conformation of a group. In this sense, rather than visualizing the time series'

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[2] Complete results of this implementation are not included but are available upon request.

[3] Based on this partial result, the calculation of a nonlinear correlation coefficient was deemed unnecessary, as no evidence for Granger causality would support it.

performance individually, we consider that presenting the formation of clusters obtained from the group-based trajectory analysis for each type of crime follows the general objective of this study. Map 3 illustrates these groups. In the case of extortion, the optimal number of resulting groups was 8, across which the municipalities were distributed as follows: 108 municipalities in the first group, 48 in the second, 362 in the third, 248 in the fourth, 17 in the fifth, 96 in the sixth, 56 in the seventh, and 19 in the eighth.
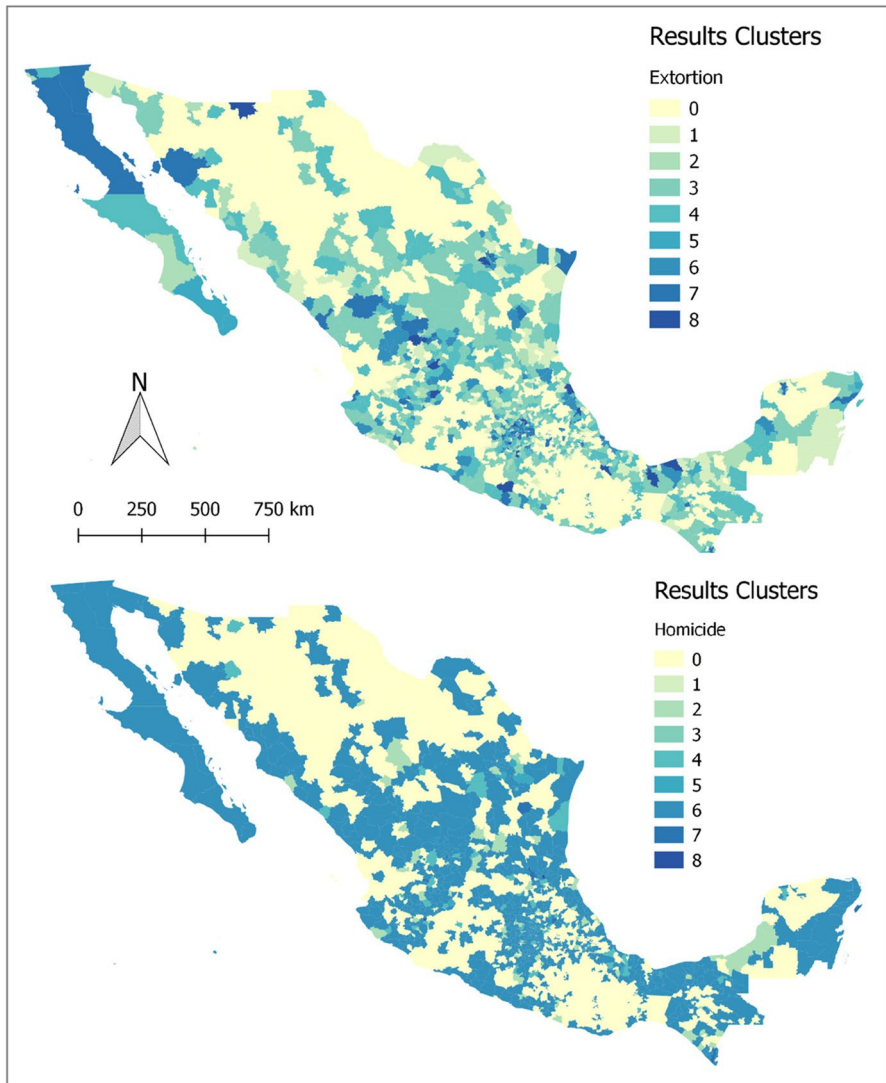
Map 3 Results cluster map

If the regional behavior of one crime was considered similar to that of the other, it may be expected that the formation and size of the groups would be similar. However, this did not appear to be the case for extortion and homicide as the resulting clusters of the latter were only present in one municipality of the first and second groups, and 8 in the third, while there was a large concentration (802 municipalities) in the fourth group. The distribution concluded with 48 municipalities in the fifth group, 14 in the sixth, 2 in the seventh, and 78 in the eighth. Overall, the tools of time series analysis appear to suggest that no generalized associated behavior exists between extortion and homicide, on either a municipal or regional level. These results are consistent with those of the spatial analysis.

Discussion

As can be observed, the regional clusters of extortion and homicide do not overlap in the geographical areas of the municipalities. This finding suggests that those clusters could be the result of different underlying criminological conditions in the localities. On the other hand, the absence of Granger causality (in both the linear and nonlinear sense) in most municipalities suggests a lack of a direct temporal association, as the homicide series do not contain information that would better predict extortion in these same municipalities. Similarly, group-based trajectory analysis shows that the temporal clusters of extortion and homicide are significantly different. The local Moran's I also registered the absence of spatial association given that the values of the statistic for each year are close to zero with a 99% confidence level. Overall, our findings suggest a neutrality condition for these crimes.

Determining that extortion is not directly related to homicides intimates that extortion is committed by individuals or independent groups with a limited capacity to fulfil the threat of violence or they may also be organized crime groups that do not need to resort to homicide, but possibly turn to other types of criminal violence that have not yet been empirically studied in the case of Mexico. Thus, extortion cannot be attributed –at least not without further empirical evidence– to the same crime groups responsible for homicides. This idea is consistent with studies that maintain that Mexican drug cartels tend not to become involved in extortion (Estévez-Soto et al. 2021), as well as with those that argue that extortion originates from opportunistic individuals or groups who are not necessarily part of organized crime (Vilalta & Fondevila 2019).

In this regard, local and regional dynamics of homicidal violence do not appear to facilitate the threat of damage, at least not in the areas of operation of the large drug cartels. In these areas, the diversification of criminal activities to incorporate extortion cannot be assumed, as this crime is spatially and temporally concentrated in other Mexican municipalities. The lack of connection between homicides and extortion in Mexican municipalities contrasts with recent studies that found high levels of dispossession in areas in which the drug cartels generally operate with homicidal violence (Meneses-Reyes et al. 2021). Dispossession increases to the degree that homicides increase in neighboring municipalities, although this is probably not the case with extortion. Nevertheless, these results do match the findings of Dugato

et al. (2020) who analyzed the use of extortion as a valid proxy for measuring the local presence of Italian mafias (Calderoni 2011). The authors noticed a weak correlation of this crime with other more direct manifestations of organized crime. Along the same lines, although extortion and homicide were spatially concentrated at the municipal level (between 2015 and 2020), our results do not detect a spatial–temporal direct association between them.

Thus, the direct connection proposed in the literature on Mexico, regarding the diversification of activities by the drug cartels, is not supported by the empirical evidence presented in this study.

During the period analyzed, homicides are concentrated in municipalities of the states of Chihuahua and Guanajuato (north-east and the Bajío region of the country), while extortion is concentrated in municipalities of the State of Mexico and Zacatecas (center and the west of the country). These crime clusters appear to indicate different criminological patterns in these regions, and thus is it difficult to support the existence of a direct relationship between homicidal violence (by drug trafficking organizations or by splinter groups operating in the same territory) and extortion.

Finally, our results are somewhat different to those of Brown et al. (2024). These authors explored the correlation between extortion and municipal characteristics and indicated a positive association between homicides directly linked to gang competition and extortion. However, the authors also recognize that it is difficult to determine whether homicides, as a result of gang competition for dominance over territory, cause higher levels of extortion. If official records and/ or reliable proxies for the competition between criminal groups on a municipal level were available, this relationship could, perhaps, be further addressed by the implementation of techniques such as instrumental variable analysis or others similar. In this sense, future research should look at other crimes to study whether the drug cartels are linked to extortion and the nature of that relationship, as, at least in the case of Mexico, they do not appear to be directly connected to homicidal violence.

A major limitation of our study results from the quality of the data analyzed. Extortion is significantly under-registered in government databases, as not all extortion is reported to authorities. It is estimated that 97.9% of extortions are not formally reported (Encuesta Nacional de Victimización y Percepción sobre Seguridad Pública 2022), and thus, should there be a spatial temporal link between homicides and extortion, these could be identified with better registers of the crimes and a better classification that distinguishes between direct and indirect extortion in official records. Similarly, the characteristics and motivation to report a crime also vary between crimes, states, and municipalities, altering the likelihood of reporting the corresponding crime (Heredia-González et al. 2022).

A possible explanation for the lack of evidence of association found in our work, may be that extortion committed by criminal groups tends (hypothetically) to be less reported than that committed by individuals or smaller organizations. This may be considered in terms of the capacity to exercise a credible threat and/ or the possibility of collusion with police bodies. While it may be necessary to complement these

results with other analyses, better data and, perhaps qualitative work regarding the causes of this type of crime, overall, homicide and extortion in Mexico appear to respond to distinct criminal dynamics.

Conclusion

Although at first glance, these results may appear counterintuitive, in reality, antecedents exist that foreshadow this separation between extortion and homicides by organized crime. In the work of Vilalta and Fondevila (2018) on extortion in Ciudad Juarez, qualitative interviews with inmates sentenced for extortion revealed that the majority of respondents did not belong to an organized criminal group. Rather, they were opportunistic offenders who copied extortion schemes (calls with threats to families and businesses), bolstered by the violent reputation of organized crime. This behavior is of particular interest for the area of study regarding social learning of crime by imitation (Akers 2002; Akers and Jennings 2019), particularly in relatively young populations (Mennis & Harris 2011). In the typology of Forsyth and Gibbs (2020), reference is made to the role of contagion entrepreneurs, that is, individuals beginning in criminal tasks who copy mechanisms learnt through the media.

According to Vilalta and Fondevila (2018), the usual mechanism used was phone calls to the victims, where the caller (or callers) claimed to be part of an organized crime group, threatening their family or business in order to make them pay a certain quantity into a bank account. These are young, pirate extortionists (Gambetta 1994) or the type of imposter described by Smith and Varese (2001), pretending to be members of an organized crime group. Such a reputation influences the subjective perceptions of victims to accept the extortion, and has, on occasions, more impact than the real probability of violence (Gambetta 1994; Smith & Varese 2001). In these cases, victims opt to comply as the cost of non-compliance is uncertain (Konrad & Skaperdas 1997). The critical element involved is the credibility of the threat. In this sense, complementary explanations for the lack of association between the crimes of extortion and homicide are that a) extortions are committed by organized crime groups that do not need to recur to violence to establish a credible threat, and/or b) that the extortion committed by violent organized crime groups are largely not reported due to fear of retaliation or because victims consider them "part of the business" (Asmundo and Lisciandra 2008).

In sum, our findings may serve as a possible indirect confirmation that certain groups use the fear engendered by the drug cartels to establish extortion networks, even though they do not actually belong to these criminal groups. At the same time, the findings question the general idea contained in certain literature that maintains that drug cartels function as criminal enterprises that have diversified into other crimes. The hypothesis that the War on Drugs provoked a wave of crime, and particularly extortion (Locks 2015) should be maintained, but perhaps it is necessary to relativize that extortion may be a secondary mechanism of rent extraction by criminal groups linked to drug trafficking. It is

possible that the rise in homicidal violence, beyond the specific episodes summarized by Guerrero-Gutiérrez (2011), is connected to this mechanism. While extortion has been understandably linked to particularly spectacular episodes of violence that constitute milestones in the public perception of organized crime, such as the arson attack on a Monterrey casino (Insight Crime 2011), the evidence shows that it is a far more complex problem in social terms and requires specific measures.

That said, in terms of public policy, neutrality implies that extortion is not directly connected to homicide, therefore the crime should be dealt with differently given that a reduction of violence will not necessarily affect extortion levels. Experience suggests the need to refocus strategies in the Mexican case, as extortion does not appear to be related to homicides, and thus probably depends on a different logic and criminal groups. It is also possible that the increase in extortion in recent years is due to the fragmentation of large criminal groups as a result of the War on Drugs and the militarization of public security.

This fragmentation perhaps led to a re-organization into smaller groups that included extortion among their activities. However, what is most crucial, is that the criminal logic of extortion does not correlate with that of homicide (Estévez-Soto 2021; Vilalta & Fondevila 2019). In this regard, the Mexican case appears to correspond to that of Italy (see the case of Apulia-Pinotti 2015) where mafias controlled extortion, but where there was also a weak correlation between this crime and other more direct manifestations of organized crime, such as homicides (Dugato et al. 2020).
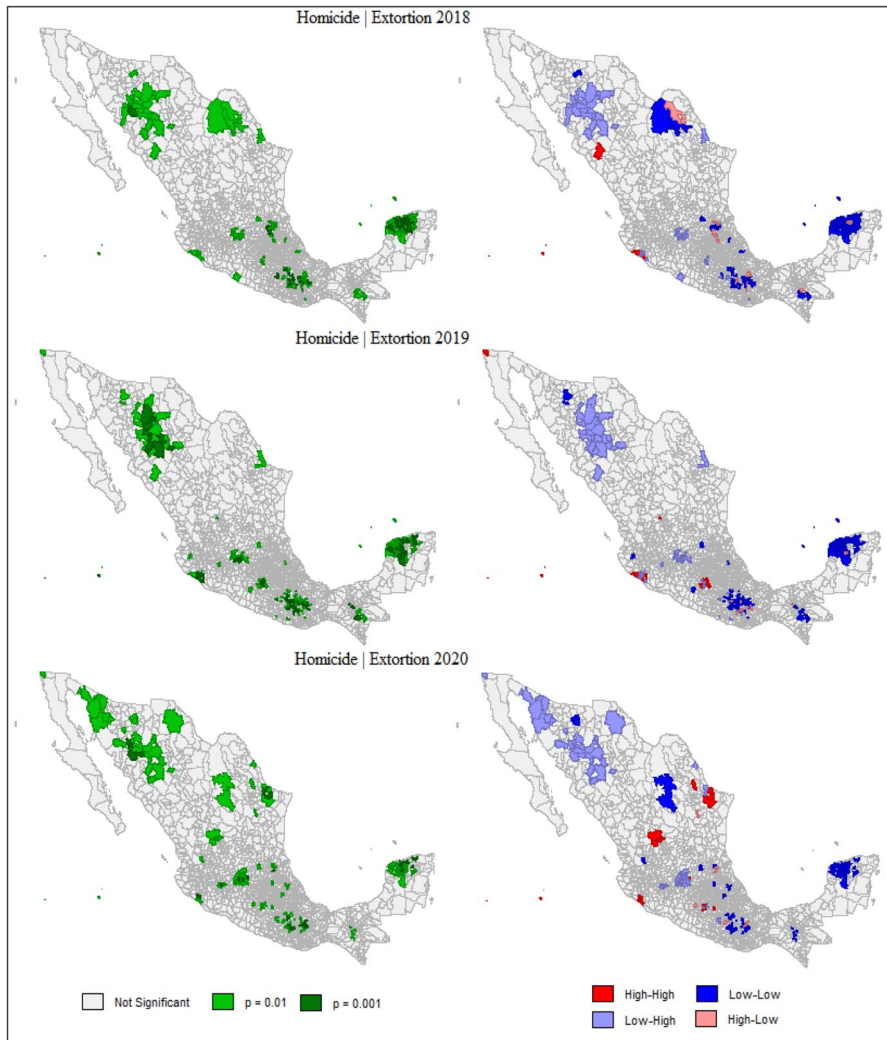
Thus, it is necessary to develop more specific public policies, that develop criminal intelligence on a micro level such as telephone interventions, registers of banking transfers, interviews with victims, and/or surveillance of suspects. In other words, a police strategy that differs from that used to disarticulate large networks operated by organized crime is needed, especially given that the militarization of security in Mexico as a strategy to counteract violence does not appear to be the best way of dealing with the problem (at least, not for extortion).

Appendix

See Map 4.
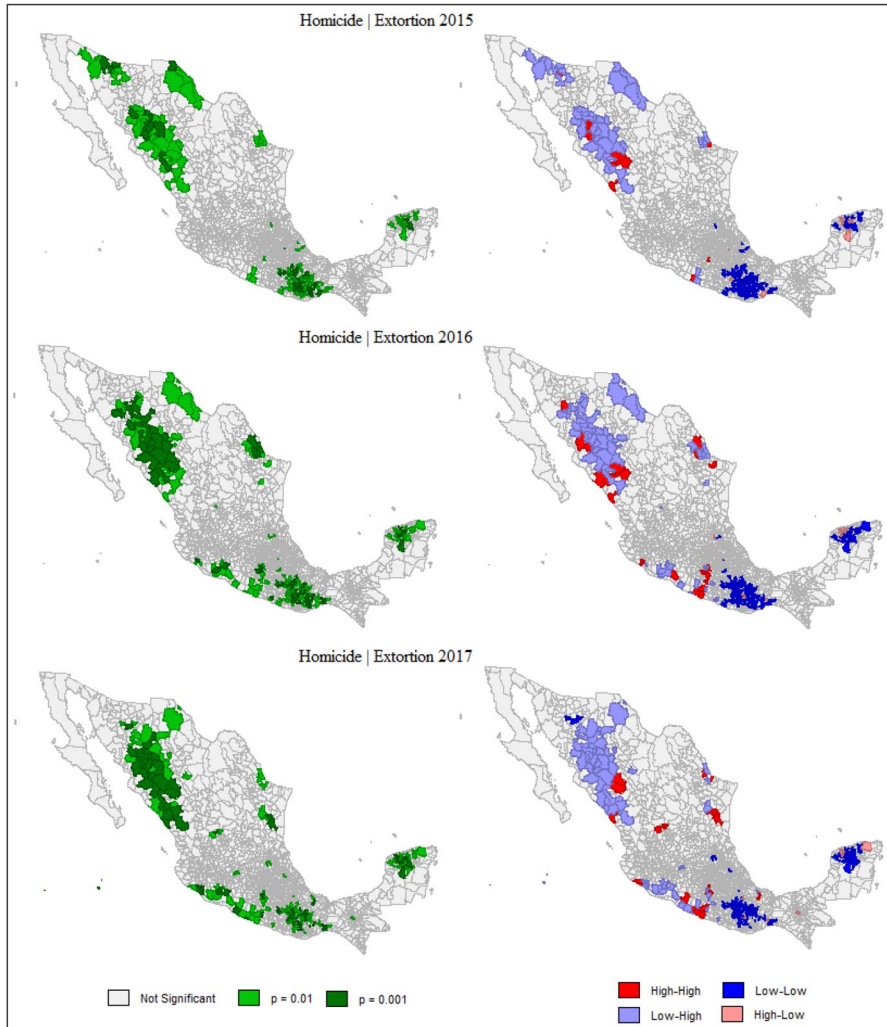
Map 4 Bivariate Local Moran's I. Homicide and Extortion (2015–2020), Bivariate Local Moran's I. Homicide and Extortion (2015–2020)

Map 4 (continued)

Declarations

Informed consent Research does not contain any studies with human participants performed by any of the authors.

Research involving Human Participants and/or Animals Research does not contain any studies with human participants or animals performed by any of the authors.

Conflicts of interest All authors declare that they have no conflicts of interest.

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