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Abstract

We study how NAFTA changed the geography of violence in Mexico. We propose that this open border policy increased trafficking profits of Mexican cartels, resulting in violent competition among them. We test this hypothesis by comparing changes in drug-related homicides after NAFTA's introduction in 1994 across municipalities with and without drug-trafficking routes. Routes are predicted least cost paths connecting municipalities with a recent history of detected drug trafficking with U.S. land ports of entry. On these routes, homicides increase by 2.3 per 100,000 inhabitants, which is equivalent to 27% of the pre-NAFTA mean. These results cannot be explained by changes in worker's opportunity costs of using violence resulting from the trade shock.

JEL-Codes: K420, F140, D740, O540.

Keywords: violence, NAFTA, free trade, Mexico, illegal drug trafficking, conflict.

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1 Introduction

Trade agreements can create economic shocks that result in criminal activity and violence. The literature proposes two potential channels for this: an opportunity cost effect and a rapacity effect.[1] If shocks negatively affect labor markets, the resulting worker displacement can lead to increases in violence because of a decline in the opportunity costs of criminal activity. If shocks are favorable to natural resources, the resulting increase in income derived from their ownership is associated with violent conflict because of increased returns to appropriating the resources.

This paper advances a novel mechanism according to which positive trade shocks trigger the rapacity effect. The proposed mechanism is rooted in the complementarity between trade in legal and illegal goods that results from the clandestine cross-border transportation of illegal goods hidden between legal goods. We suggest that trade liberalization agreements, by facilitating the unchecked exchange of legal goods, unintentionally increase the profits from smuggling illicit goods. When experiencing such positive shocks, firms in the illicit goods sector compete over profits by using violence, due to the absence of legally enforced property rights. Therefore, according to our hypothesis, trade-induced positive shocks to illicit markets incentivize firms to invest in conflict and capture strategically important locations such as production sites or smuggling routes using violence.

We provide evidence for our hypothesis by exploiting the positive income shock to the drug-trafficking sector induced by Mexico's accession to the North American Free Trade Agreement (NAFTA). NAFTA came into force in 1994 and eliminated most barriers to trade between Mexico and the United States. By massively increasing the cross-border flow of legal goods while lowering inspection rates at the border, NAFTA lowered the cost of smuggling illegal drugs into the U.S. (Andreas, 1996, 2012). This increased profits in the Mexican drug-trafficking sector and thereby the value of controlling this illicit sector.

NAFTA increased profits of Mexican drug-trafficking organizations (DTOs) because their main expenses derive from the cost of transporting illegal drugs across the U.S. border into consumer markets. Next to trafficking locally produced cannabis and opium, from the mid-1980s, Mexican DTOs provided cocaine trafficking services to cartels in Colombia. Due to increased interdiction efforts, Andean cartels shifted from Caribbean maritime and air routes to Mexican overland routes. Mexican cartels thus were able to negotiate a 50% cut of the transported cocaine from Colombia and became major players in the cocaine business themselves (Cockburn and Clair, 1998).

Empirically, we test the hypothesis that Mexican regions traversed by drug-trafficking routes saw higher increases in drug-related violence after the introduction of NAFTA than other regions. To test this hypothesis, we combine municipal-level panel data on drug-related homicides with predicted optimal drug-trafficking routes. Optimal drug-trafficking routes are predicted by connecting locations of major drug eradication and seizures of illegal drugs in Mexico with all U.S. land ports

[1] For important contributions to this literature see, e.g., Becker (1968), Collier and Hoeffler (2004), Dal Bó and Dal Bó (2011), Dube and Vargas (2013), and Dell, Feigenberg and Teshima (2019).

of entry using Dijkstra's algorithm (Dijkstra, 1959). Using the full extent of the road network, we predict which Mexican municipality is located on a drug-trafficking route.

Our empirical strategy exploits the fact that the introduction of NAFTA in 1994 increased the value of controlling the corridors for transporting illegal drugs into the U.S. for DTOs. We thus expect that municipalities located on a drug-trafficking route experience an increase in drug-related violence after the implementation of the trade agreement. To analyze the consequences of NAFTA for drug-related violence, we use difference-in-differences models that compare the number of drug-related homicides per 100.000 inhabitants in municipalities with and without a drug-trafficking route before and after 1994.

The results confirm that the introduction of NAFTA is associated with an increase in drug-related homicides by approximately 2.3 per 100.000 inhabitants in municipalities with a predicted drug-trafficking route. The increase in homicides is economically sizable, i.e., NAFTA is associated with 27% more homicides compared to the pre-NAFTA mean. Furthermore, the results show a positive association between the length of routes within a municipality and drug-related homicides, suggesting that violence concentrated in municipalities with longer segments of trafficking routes. When studying violence alongside the routes, we find that violence increased more in upstream segments of routes after NAFTA's introduction.

We corroborate the validity of our identification strategy in several ways. First, using an event-study design, we show that trends in drug-related homicides did not differ across municipalities with and without routes prior to NAFTA. Second, using falsification tests, we show that the introduction of NAFTA is neither associated with changes in homicides of demographics that are typically not involved in the trafficking business, such as females and older people, nor with other causes of deaths, such as suicides and traffic fatalities. Third, using regions that predominantly produced maize that arguably suffered the strongest from import competition due to NAFTA as origins to generate placebo routes, we find no change in drug-related homicides in municipalities traversed by such a route after 1993. These checks confirm that the estimated increase in drug-related homicides in municipalities with a predicted drug-trafficking route is triggered by NAFTA and is not confounded by the detrimental effects of import competition in maize.

Clearly, NAFTA affected the Mexican economy in ways that potentially constitute alternative explanations for our estimated effects on violence. For example, Mexican producers faced increased trade competition leading to job losses, especially in the agricultural sector and particularly for maize farmers. This may have reduced the opportunity costs of using violence for farmers due lower agricultural incomes. Hence, if there is a spatial correlation between our predicted drug-trafficking routes and the local exposure to a negative trade shock, our results might not be driven by an increase in profits for Mexican cartels.

To rule out that our results are explained by the shock to legal trade directly, we add several control variables that aim to capture trade competition. Following the trade literature, we include variables that interact municipal-level employment shares with aggregate imports by sector. Other specifications control for changes in unemployment after NAFTA, an interaction term between the local maize suitability and the national maize price, and an interaction term between small farms focusing on maize production (ejidos) and the national maize price. The results suggest that the opportunity cost channel might indeed be present in the manufacturing sector but that this effect does not confound a rapacity effect of violent competition over rents from trafficking routes.

To study changes in the spatial distribution of drug-related violence after NAFTA's introduction, we run local polynomial regression to inspect differential changes depending on distance to trafficking routes. We find that violence was diverted from regions further away to those in close proximity of routes. Rather than increasing aggregate violence, NAFTA seems to have had displacement effects.

Finally, using homicides from the period 2007–2010, we inspect whether NAFTA had lasting consequences on the geography of violence and whether homicides on trafficking routes were indeed a result of inter-cartel competition. In cross-sectional regressions we show that municipalities traversed by routes still experienced higher levels of drug-related homicides in the 2000s. Furthermore, route location is significantly related to homicides resulting from inter-cartel conflict but not to homicides resulting from confrontations or aggression between cartels and the military or police forces. This aligns with our hypothesis that DTOs use violence to compete over trafficking routes.

We contribute to several branches of the literature. In its broadest sense, this paper contributes to the literature on income shocks and civil conflict. This literature studies how exactly income shocks are related to violence and conflict, i.e., by changing the opportunity costs of using violence and insurrection or by increasing the value of resources usually owned by the state and thereby increasing the incentives to seize the state (see, e.g., Collier and Hoeffler, 1998, 2004; Miguel, Satyanath and Sergenti, 2004; Angrist and Kugler, 2008; Dal Bó and Dal Bó, 2011; Dube and Vargas, 2013; Bazzi and Blattman, 2014; Berman and Couttenier, 2015; Berman et al., 2017). We add to this literature by highlighting that the complementarity between legal and illegal trade proposed by Russo (2014) results in positive income shocks for sectors engaged in illegal goods trade, thereby increasing the incentives to seize such sectors using violence in the absence of enforced property rights.[2]

Furthermore, our paper relates to a growing literature studying the relationship between trade liberalization and crime. This literature focuses on analyzing how trade shocks change labor market conditions, which ultimately induces violence and property crimes (see Iyer and Topalova, 2014; Deiana, 2016; Dix-Carneiro, Soares and Ulyssea, 2018). Dell, Feigenberg and Teshima (2019) show that job losses in the manufacturing industry in Mexico induced by trade competition with China, increased cocaine trafficking and violence. The authors argue that changes in local labor markets lower the opportunity cost of criminal activity, which led to an increase of violence and drug-trafficking. We contribute to this literature by providing evidence that next to the effect on labor markets, trade liberalization may affect illegal markets by changing profits for trafficking organizations due to a complementarity between legal and illegal trade.

[2]When studying the smuggling of illicit goods, the literature often implicity assumes such complementarities between legal and illegal trade. For examples, see Fisman and Wei (2009) on cultural property or Dube, Dube and García-Ponce (2013) on illegal weapons.

More narrowly, the intensity of the Mexican drug war has drawn the attention of economists. Between 2007 and 2010, the National Security Council registered over 50,000 drug-related homicides. In 2016 alone, Mexico registered 23,000 intentional homicides, equivalent to 17 intentional homicides per 100.000 inhabitants (IISS, 2017). Most of these homicides were arguably caused by conflicts between DTOs competing for the control of territories and by government interventions (Calderón et al., 2015; Dell, 2015; Osorio, 2015; Castillo and Kronick, 2020), an increase in the drug-profits for drug trafficking organizations (Castillo, Mejía and Restrepo, 2020; Sobrino, 2020), or increases in unemployment (Dell, Feigenberg and Teshima, 2019).

There are few studies that explore the early development of the drug industry in Mexico during the 1990s, the golden years of Mexican cartels that may have paved the path for current conflicts.[3] Dube, García-Ponce and Thom (2016) analyze how international commodity-price fluctuations, driven by the introduction of NAFTA in 1994, affect the illegal drug market in Mexico. Their findings imply that a decrease in maize prices increased the cultivation of cannabis and opium, leading to more intense activity of Mexican cartels and violence. Trejo and Ley (2018) show that Mexican cartels increasingly resorted to violence after they lost government protection due the increase in political competition starting in the 1990s. We contribute to this literature by providing evidence that the introduction of NAFTA is associated with a lasting increase of drug-related violence in places that were of strategic importance for drug trafficking.

The consequences of NAFTA's introduction have been largely discussed in the economic literature. By combining trade data with post-NAFTA survey studies, Burfisher, Robinson and Thierfelder (2001) find that both the U.S. and Mexico benefited from the trade agreement, with much larger relative benefits for Mexico.[4] By inspecting the consequences of NAFTA for an illegal market, we add a hitherto neglected perspective to this literature.

The rest of the paper is organized as follows. Section 2 provides the necessary context on Mexican DTOs, their use of violence, and the introduction of NAFTA before describing conceptual considerations. Section 3 presents the data. Section 4 introduces the empirical strategy, the main results, and the robustness checks. Section 5 inspects spillover and displacement effects. Section 6 provides evidence on inter-cartel competition over trafficking routes. Section 7 concludes.

2 Background

2.1 The rise of DTOs and violence in Mexico

Throughout the 1970s and 1980s illegal drugs, especially refined cocaine and heroin, were typically shipped from Latin American producers to U.S. consumer markets via maritime routes through the

[3] Murphy and Rossi (2020) show that the location of cartels in the 2000s can be traced to Chinese immigration of the early 20th century.

[4] Studies of NAFTA's effects on labor markets include Robertson (2000) who finds that the U.S.-Mexican labor market was highly integrated prior to NAFTA. Juhn, Ujhelyi and Villegas-Sanchez (2013) study the relationship between trade liberalization and gender equality, and provide evidence that the introduction of NAFTA increased relative wages and employment of women in blue-collar jobs, but not in white-collar jobs.

Caribbean.[5] Mexico was the world's largest producer of cannabis (more than 50% of worldwide production) and also a source country for opium and methamphetamine consumed in the U.S. The U.S. was the world's largest market for the consumption of cocaine, which assumes approximately two thirds of U.S. total expenditures on illicit drugs (The White House, 1992, p. 78).

When authorities increased interdiction efforts in the mid-1980s, Colombian drug-lords shifted their operations from maritime to Mexican overland routes. Colombian cartels started to increasingly rely on Mexican DTOs, experienced in trafficking cannabis into the U.S., for the trafficking services in cocaine. The extensive land border with many ports of entry into the U.S. allowed Mexican DTOs to cross the border with small amounts at high frequency, thereby hedging the risk of detection and seizure as compared to large maritime shipments. Trafficking service became extremely profitable for Mexican cartels that exploited the bargaining power bestowed on them by their geographic location. In the early 1980s, they negotiated a 50% cut of the transported cocaine and moved from providing pure logistical services to becoming a major supplier of cocaine to U.S. markets (Cockburn and Clair, 1998, p. 361). The shift to Mexican routes is apparent in the data of the U.S. State Department, i.e., the percentage of cocaine entering the U.S. from Mexico shifts from negligible in the mid-1980s to 70% in 1995 (Andreas, 1996).[6] From 1992, the Southwest border also accounted for the majority of cocaine seized annually (DEA, 1995, p. 6).[7]

In the 1980s, the Mexican trafficking market was dominated by the Guadalajara Cartel under the leadership of Miguel Ángel Félix Gallardo, only competing with the Gulf cartel on the east coast. In 1987, Gallardo created the so-called *Federation* and divided his territory into "plazas", i.e., specified territories and trafficking corridors to the U.S. border, each controlled by individual drug lords that operated independently but were loyal to Gallardo. Following the arrest of Gallardo in 1989, the Federation was dismantled and broke into independent DTOs. Disputes and competition among the plazas led to an increasing use of violence. Table 1 shows the development of homicides and drug-related homicides (i.e. homicides of males age 15–39) in Mexico in the 1990s. This period marks the emergence of violent conflicts among drug cartels whose levels were surpassed only later during the massive outbursts of violence starting in 2006.

2.2 NAFTA and drug trade

Mexican drug traffickers primarily use private and commercial land vehicles to transport illegal drugs into the United States (DEA, 1995, p. 6). In 1990, a White House report acknowledged that such vehicles are "all but lost in the tremendous volume of legitimate trade and commerce

[5] Colombia, Peru, and Bolivia account for virtually the total worldwide coca leaf cultivation.

[6] This number is based on 'intelligence estimates' and can be found in the National Drug Control Strategy reports as early as 1994 (The White House, 1992, p. 55). Such estimates are largely based on the amount of seizures which declines after 1994, likely to the lower frequency of inspections under the free trade agreement (Dermota, 1999, p. 17). Today the share of cocaine entering from Mexico is estimated at 90 percent.

[7] The UNODC (2010, p. 103) estimates that gross profits in the U.S. cocaine market amounted to 35 billion USD in 2008. 0.5 billion (1.5% of gross profits) went to farmers in the Andean regions. 2.9 billion USD (8% of gross profits) went to traffickers moving cocaine across the southern U.S. border, mostly Mexican cartels. U.S. wholesalers and U.S. mid-level dealers capture 85% of gross profits. Due to the fact that Mexican cartels also participate in the selling of cocaine in the U.S., they hold substantial stakes in the U.S. cocaine market.

Table 1: The development of trade and violence in the 1990s

	Mexico to U.S. exports to GDP ratio	Homicides			
		all		male, ages 15-39	
		total	per 100k	total	per 100k
1990	7.1%	11,475	14.04	5,414	6.63
1991	6.0%	12,646	15.17	6,290	7.54
1992	10.3%	13,760	16.18	7,103	8.35
1993	8.6%	13,510	15.57	6,862	7.91
1994	9.7%	15,656	17.69	7,974	9.01
1995	18.4%	15,386	17.10	7,733	8.60
1996	19.4%	14,350	15.67	7,276	7.95
1997	18.6%	13,363	14.34	6,598	7.08
1998	19.4%	13,490	14.23	6,396	6.75
1999	20.1%	12,068	12.51	5,593	5.80

Notes: The table shows intentional homicides and intentional homicides of males (ages 15–39) per year as total sum and per 100,000 population, linearly interpolating population censuses in 1990, 1995, and 2000. Column 5 shows the worth of Mexican exports to United States in (2016) USD as a fraction of Mexican GDP in the respective years.

between the two countries" (The White House, 1990, p. 69). From January 1st, 1994, the North American Free Trade Agreement between Canada, the United States and Mexico entered into force and eliminated most tariff and non-tariff barriers to free trade between the three countries. Negotiations started in 1991 and ended in December 1992 with the singing of the treaty. As shown in Table 1, the value of exports to the U.S. as percentage of Mexican GDP more than doubled with the introduction of NAFTA.

According to Andreas (1996), NAFTA facilitated and encouraged the exports of illegal drugs via Mexico into the United States. Dermota (1999, p. 15) confirms that anything NAFTA did to promote regional trade also encouraged the trade of illicit drugs. For example, NAFTA led to a decline in inspections to avoid hampering commerce while at the same time the number of trucks crossing with cargo went from 1.9 million in 1993 to 2.8 million in 1994 to 3.5 million in 1996 (Andreas, 1996, p. 58; Dermota, 1999, p. 17). Indeed, the DEA confirms that detection rates at the ports of entry decline in the volume of trade (DEA, 2016). Thus, NAFTA most likely decreased the cost of concealing drug smuggling. Furthermore, NAFTA massively increased capital flows which made it easier to route drug profits out of the U.S. via Mexico (Dermota, 1999, p. 21).

Anecdotal evidence suggests that policy makers were aware of these potential unintended consequences. Assistant U.S. Attorney Glen MacTaggart said in 1993, "If Nafta provides opportunity for legitimate businesses, it may clearly provide opportunities for illegitimate businessmen," [...] "It's almost common sense" (Andreas, 1996, p. 57). A U.S. official involved in the fight against drug traffickers stated: "The free-trade agreement makes the United States more accessible and convenient for traffickers"[...] "It gives these people better opportunities to smuggle drugs" (Weiner and Golden, 1993, p. 1). However, in the NAFTA agreements there is no section addressing potential concerns about the impacts of the trade agreement on illegal markets. "This was in the 'too hot to handle' category" according to Gary Hufbauer (Weiner and Golden, 1993, p. 1).

In Dermota (1999, p. 15), a Colombian trafficker explains that the free trade agreement between Colombia and Venezuela that emerged in 1993 allowed him to increase profits by about 75%, just by reducing shipping costs to the U.S. He estimates that shipping costs per kilogram of cocaine decline from 8,000 USD to 2,000 USD when shipping the product from Venezuela instead of going directly from Columbia to the U.S. Shipping costs from Mexico to the U.S. ranged between 1,000 and 1,500 USD per kilogram of cocaine during the late 1990s. He thus expected to cut costs even further once being able to ship through Mexico.[8]

2.3 Conceptual considerations

Following the depiction of events described above, we conclude that the introduction of NAFTA increased profits of Mexican drug lords. There are at least four ways how NAFTA could have increased profits for Mexican DTOs. First, revenues may have increased because the amount of drugs trafficked into the U.S. increased. However, Table A.1 in the Appendix shows that, except for methamphetamine, volumes of U.S. drug consumption are stable or slightly declining in the 1990s, while prices are mostly declining. Second, trafficking revenues may have increased because the share of drugs entering the U.S. via Mexico increased. While there is some evidence for this (see, e.g., Watt and Zepeda, 2012, p. 105), estimates of trafficking market shares are hard to obtain and we cannot conclude with certainty that this is the main channel. Thirdly, costs of trafficking declined because Mexico-U.S. ports of entry were less policed and seizures became less likely. Following the above mentioned example by the Colombian trafficker, NAFTA clearly lowered the unit costs of trafficking due to a decline in the risk of detection and kickbacks paid to officials. Combining two and three, the overall net profits of trafficking and selling drugs accruing to Mexican DTOs may have increased. Fourth, the cost of money laundering declined because it was easier to conceal drug money in the increased capital flows from the U.S. to Mexico. Examples of the Mexican president Carlos Salinas using Citibank branches in New York and Mexico to transfer drug money to branches in London and Switzerland support this notion.

Following theoretical considerations in the literature (Sobrino, 2020; Castillo and Kronick, 2020), we develop the hypothesis that the positive drug profit shock introduced by NAFTA was accompanied by violent competition over trafficking routes into the U.S. among DTOs in Mexico because controlling the routes guaranteed a constant stream of income.[9] In the absence of interference by a formal legal system, illegal markets such as the drug market induce participants to use violence to compete for profits or territory (Goldstein, 1985; Reuter, 2009; Jacques, 2010). Following Sobrino (2020) and Castillo and Kronick (2020), we argue that the increase in profits due to NAFTA led to more violent competition among DTOs. This altered the geography of drug-

[8]According to Scott Stewart, Vice President of Tactical Analysis of Stratfor, the price of cocaine "increases considerably once it leaves the production areas and is transported closer to consumption markets". The same kilogram of cocaine that can be purchased in Colombia's jungle for $2200 will cost between $5500 and $7000 in Colombian maritime ports, $10.000 in Central America, $12.000 in southern Mexico, $16.000 in northern Mexico, and ultimately between $24.000 and $27.000 in U.S. wholesale markets (Stewart, 2016).

[9]Note that DTOs controlling a specific plaza were able to impose a tax on drugs moved on their routes by other DTOs.

related violence in Mexico by concentrating the conflict on strategically important drug-trafficking routes. Castillo and Kronick (2020) develop a (repeated) contest model in which increases in drug-related profits break low violence agreements and fuel violence among traffickers. Here, interdiction such as seizures of large drug shipments lead to violence if drug profits increase in the presence of an inelastic demand. If revenues increase by more than costs, i.e., the revenues generated from owning trafficking routes increase by more than the cost of acquiring the routes, cartels will invest in conflict. Similarly, in the theoretical framework of Sobrino (2020) positive demand shocks in illegal markets increase violence because they increase the value of controlling drug production and trafficking routes. In her model, the demand shock incentivizes cartels to invest into military capacity and to enter into violent competition over more valuable production sites.

We combine the evidence accumulated in this section with the recent theoretical consideration in the literature to argue that NAFTA's open border policy increased profits of Mexican DTOs, resulting in increased returns to owning trafficking routes, leading to more violent competition over territories containing these routes.

3 Data

To estimate the reduced form effect of the NAFTA-induced increase in drug-trafficking profits on violence in Mexico, we exploit panel data at the municipality level. Municipalities are the second-administrative level beneath the 31 states. Our sample includes all 2,398 municipalities that were part of the 1990 census. If a municipality was divided after this year, we aggregate the data to the administrative boundaries as of 1990.

We restrict the panel to the period 1990–1999 for two reasons. First, data on homicides at the municipality level are available only from 1990. Second the geography of violence in Mexico may have changed after 2000 when the National Action Party (PAN) formed the new government after 70 years of the Institutional Revolutionary Party (PRI) in power. Summary statistics are presented in Table A.2 in the Appendix.

Drug-related homicides. In the absence of a direct measure of drug-related homicides, we use the number of male homicides between the age of 15 and 39 per 100,000 inhabitants for the period 1990–1999 from the Mexican *Instituto Nacional de Estadística y Geografía* (INEGI) as a proxy.[10] In doing so, we follow Calderón et al. (2015, p. 1462) who argue that homicides in this gender-age cohort group in Mexico best resemble drug-related homicides.[11]

[10] The only available data that specifically distinguishes drug-related homicides was collected by the Federal Mexican Government and measures the "Deaths presumably related to Drug Trafficking Organizations (DTOs)" from December 2006 to December 2010. We use these data in Section 6 to distinguish between conflict parties. The spatial correlation between post-NAFTA male homicides between the age of 15 and 39 (1994–99) and drug-related homicides (2006–2010) is 0.15.

[11] The authors reach this conclusion after comparing the minimum mean squared error of drug-related homicides in the period 2006–2010 and of all homicides in combinations of 5-year age cohorts between 15 and 64 years in the period 2006–2010.

The map in Figure A.1 in the Appendix shows the change in drug-related homicides comparing the periods 1990–93 and 1994–99, before and after the introduction of NAFTA. Changes in drug-related homicides have substantial spatial variation and are not concentrated in specific regions.

Drug-trafficking routes. We predict the location of drug-trafficking routes using Dijkstra's algorithm (Dijkstra, 1959) similar to Dell (2015). Using this algorithm, we identify optimal paths based on distance between origins and destinations within the Mexican network of main roads and highways drawn from The Digital Chart of the World (DCW). For simplicity we assume that each origin ships one unit of "drug" to the closest destination following the road network.

Destinations consist of all 22 Mexico-U.S. land border-crossings since the majority of drug-traffic into the U.S. occurs at land ports of entries (see DEA, 2016). To select origins, we expand the approach of Dell (2015) who focuses only on drug-producing municipalities and add drug-trafficking municipalities. Drug-producing are municipalities that are above the 95th percentile of cannabis and opium poppy eradication in hectares per area between 1990 and 1993. Drug-trafficking are municipalities in which there was a positive amount of cocaine seized between 1990 and 1993. These amount to 76 origin municipalities. We rely on pre-NAFTA eradication and seizures, to avoid endogenous changes in routing and policing due to open borders. For the same reason, we abstain for using time-varying routes. The data on eradication and seizure are obtained from Dube, García-Ponce and Thom (2016).

Figure A.2 in the Appendix shows the predicted optimal drug-trafficking routes. This information is used to create an indicator variable that assumes the value one if a municipality is traversed by at least one predicted drug-trafficking route. Alternatively, we measure the length of the route in a municipality in km. This allows us to test whether NAFTA changed violence when the segment of a route located within a municipality is longer. Furthermore, we create a variable that counts the number of tributaries that had flown into the route upstream from a traversed municipality. Following the concept of a stream order to indicate the branching of a river system introduced by Shreve (1966), this variable adds the accumulated tributaries at any confluence of two routes. This allows us to test if NAFTA changed violence by more in upstream or downstream locations.

Since we do not have information on actual trafficking routes, we cannot assess the quality of our predictions. We expect measurement error to be classical, leading to attenuation bias. However, it is conceivable that cartels systematically used more remote highways to avoid violent conflict, leading to systematic measurement error in our predicted routes. This concern is again mollified by the use of routes predicted with pre-NAFTA data that are not prone to changes in errors due to the introduction of NAFTA.

Baseline control variables. In our preferred specification, the empirical analysis includes several control variables. These aim to exclude potentially confounding factors at the municipality level that may affect their location on a predicted drug-trafficking route but also deferentially affect violence after the introduction of NAFTA. All baseline control variables are time invariant but will be allowed to have time varying effects in the analysis.

A first set of controls aims at excluding confounding geographical characteristics. These include temperature and precipitation (Fick and Hijmans, 2017), the soil pH (IGBP-DIS, 1998), and the agro-climatically attainable maize yields (FAO).

We further add controls for the potential cultivation of cannabis and opium poppies. For legal reasons, FAO-GAEZ crop suitability indices are not available for illegal crops. Therefore, we create separate suitability measures based on the optimal conditions for the cultivation of *papaver somniferum* (opium poppy) and *Cannabidaceae* (cannabis) based on the FAO EcoCrop database. This procedure follows Sviatschi (2022) and Daniele, Le Moglie and Masera (2020) and measures the optimal conditions for cultivating illegal crops. We define optimal suitability in terms of precipitation, temperature, and soil pH.[12]

While it is conceivable that the strategic importance of territory increased with proximity to the U.S. border after the introduction of NAFTA, this is not the mechanism we have in mind. Hence, our set of baseline control variables includes the geographic distance to the U.S. border. Finally, we include the number of inhabitants in 1990 (INEGI) to account for differences in demographic characteristics at the municipality level.

Map Figure 1 depicts the main variables and the source of variation in our analysis in a single map. The fact that changes in drug-related homicides after 1993 seem to cluster alongside our predicted trafficking routes provides visual support of our subsequent econometric analysis. Figure A.3 in the Appendix shows average drug-related homicides by municipalities with and without routes over time. A discernible jump in violence occurs in treated municipalities right after the introduction of NAFTA in 1994 and 1995. The resulting gap persists until the end of our study period despite the decline in both types of regions.

4 Empirical analysis

4.1 Empirical framework

Our main hypothesis is that NAFTA's open border policy resulted in higher profits for DTOs, leading to an increase in violent competition over trafficking routes. To test our hypothesis, we use a difference-in-differences (DiD) strategy and compare the change in drug-related homicides per 100.000 inhabitants after 1994 between municipalities with and without a predicted optimal

[12] According to EcoCrop, the optimal temperature to grow opium poppies (cannabis) is between 15 and 24 (15–28) degrees Celsius; annual precipitation should be between 800 and 1200 (600–1200) mm; and soil pH between 6.5 and 7.5 (6–7). To define which areas of Mexico are suitable for growing opium poppies, we collect temperature and precipitation data from the WorldClim database (Fick and Hijmans, 2017) and soil pH data from the Atlas of the Biosphere (IGBP-DIS, 1998). Second, we divide Mexico's area into grid cells of 0.05 x 0.05 degrees of latitude by longitude and create an indicator variable that takes the value one if cell i falls within the optimal intervals for growing opium poppy and 0 otherwise. Finally, we calculate the share of cells within each municipality suitable for cultivating poppies and cannabis.

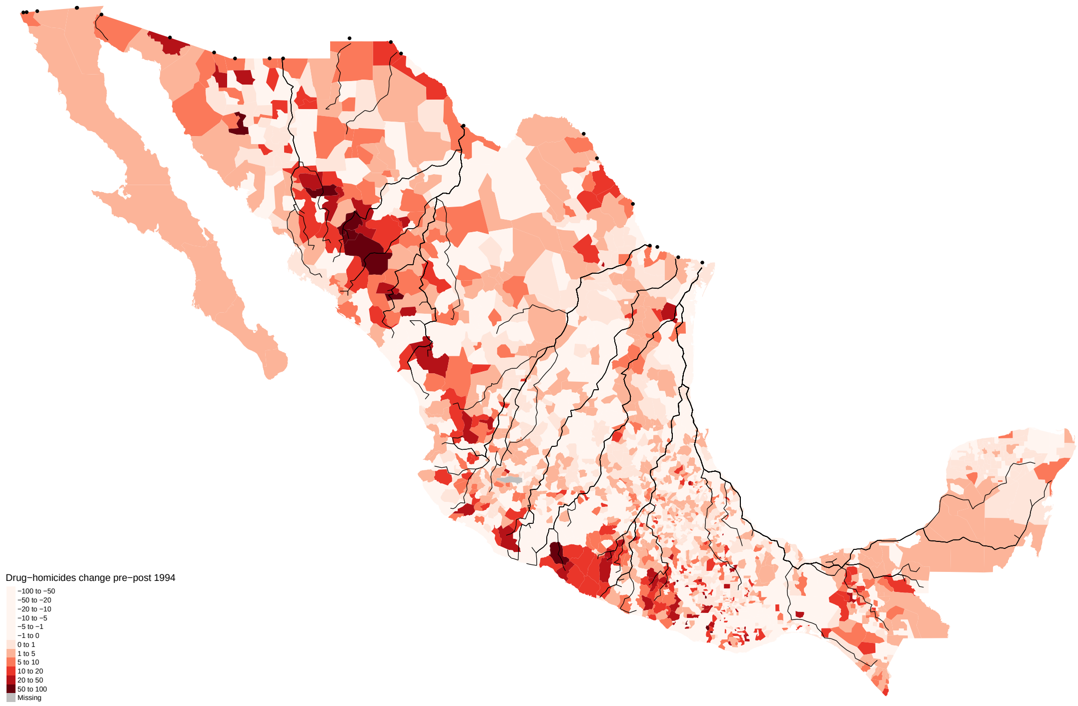

FIGURE 1: Predicted drug trafficking routes and changes in drug-related homicides

This figure relates changes in drug-related homicides across Mexican municipalities to predicted drug trafficking routes. Darker shades of red indicate higher positive changes in drug-related homicides, i.e., homicides of males aged 15–39 per 100,000 inhabitants, comparing the periods 1990–93 and 1994–1999. Optimal predicted drug-trafficking routes are shown as black lines. Black dots depict the 22 land ports of entry on the Mexico-U.S. border.

drug-trafficking route. We apply the following specification:

$$Drug\, homicides_{it} = \alpha_i + \tau_t + \beta(Route_i \times post\, NAFTA_t) + \Gamma(X_i \times post\, NAFTA_t) + \epsilon_{it} \qquad (1)$$

where the dependent variable $Drug\, homicides_{it}$ is the number of drug-related homicides per 100.000 inhabitants in municipality i during years t ($t \in 1990 - 99$). α_i are municipality-fixed effects that control for time-invariant characteristics. τ_t are year-fixed effects that control for common shocks to all municipalities in a specific year t. $Route_i$ is an indicator variable that takes the value one if municipality i is traversed by a predicted drug-trafficking route and 0 otherwise. In an alternative specification, this measure is replaced by the length of the route in a given municipality.[13] $post\, NAFTA_t$ is an indicator, which assumes the value one for all years after 1994 and 0 otherwise. The time-invariant baseline control variables captured in the vector X_i' are allowed to have differential effects following NAFTA's introduction via the inclusion of an

[13]In Section 5 we also explore how the geography of violence changed in distance to the route.

interaction with the indicator $post\,NAFTA$. In all of our regressions standard errors are clustered at the municipality level.

The coefficient of interest β captures differences in the change in drug-related homicides between municipalities with and without a predicted drug-trafficking route after the introduction of NAFTA. The validity of our identification strategy relies on the assumption that in the absence of NAFTA, drug-related homicides would have followed parallel trends between municipalities with and without drug-trafficking routes. We provide evidence for the absence of diverging trends prior to NAFTA using an event-study type specification following equation 2:

$$Drughomicides_{it} = \alpha_i + \tau_t + \sum_{t=1990}^{1999} \beta_t (Route_i \times year_t) + \sum_{t=1990}^{1999} \Gamma_t (X_i \times year_t) + \epsilon_{it}. \quad (2)$$

Equation 2 expands equation 1 by replacing the simple $post\,NAFTA_t$ indicator with time indicators ($year_t$). This specification allows us to observe whether drug-related homicides vary between municipalities with and without routes each year relative to the omitted baseline year 1993, the year before NAFTA's introduction.

4.2 Main results

4.2.1 Simple DiD results

Table 2: Drug trafficking routes and drug-related homicides after NAFTA

Dep. var.:	Drug-related homicides per 100.000 inhabitants			
	(1)	(2)	(3)	(4)
Route × post NAFTA	2.378***	2.253***		3.174***
	(0.574)	(0.588)		(0.776)
Length of route × post NAFTA			1.245***	
			(0.366)	
Number of tributaries × post NAFTA				−0.194***
				(0.056)
Municipality FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
Baseline controls		✓	✓	✓
Mean homicides pre-Nafta	8.218	8.218	8.218	8.218
Observations	23,980	23,980	23,980	23,980

Notes: The table shows results from estimating equation 1. The unit of observation is a municipality. *Length of route* is standardized with zero mean and unit standard deviation. The variable *Number of tributaries* counts the number of tributaries that had flown into the route upstream from a traversed municipality. Baseline controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors clustered at the municipality level in parenthesis. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 2 presents the results from estimating equation 1. Column 1 shows results when including only municipality- and time-fixed effects whereas column 2 adds the baseline control variables described in Section 3. Our coefficient of interest is positive and statistically different from zero in both specifications. The β coefficient in our preferred specification in column 2 shows that the introduction of NAFTA is associated with an increase of approximately 2.3 homicides per 100,000 inhabitants in municipalities on a drug-trafficking route. This reflects a substantial increase relative to the pre-NAFTA mean of approximately 8.2 homicides per 100,000, i.e., an increase of 27.42% with respect to the mean.

In column 3, we replace the route indicator with the length of the route. This measure is standardized with zero mean and unit standard deviation. The coefficient thus implies that a one standard deviation increase in the length of the route is associated with an increase in approximately 1.2 homicides per 100.000 inhabitants, i.e., 15% with respect to the mean. This result suggests that violence increased by more if a municipality contains longer segments of routes.

Column 4 tests whether violence increased by more in upstream or downstream municipalities among those traversed by a route following NAFTA. We add the Shreve stream order, i.e., a count of the number of tributaries that flow into the route upstream from the traversed municipality, interacted with the $post\,NAFTA$ dummy. Higher numbers reflect more downstream locations. We find a small but significant negative coefficient that can be interpreted to show that violence declines the further a municipality is located downstream. An increase in the stream order by one is associated with a decline of 0.194 homicides per 100.000.

4.2.2 Event-study results

The validity of our DiD identification strategy relies on the common trends assumption, which requires that in the absence of the free trade agreement, violence would have followed parallel trends in treated and untreated municipalities. To inspect the validity of this assumption, we estimate the relationship of interest using an event-study design. This further allows us to study the dynamics of violence after the policy was introduced.

Figure 2 plots the β_t coefficients from an estimation of equation 2 over time. The figure shows differences in drug-related homicides between municipalities with and without a drug-trafficking route for each year with respect to 1993. Coefficients for all years after NAFTA's introduction are positive and significantly different from zero. This jump in violence occurs immediately in 1994 and remains of roughly the same magnitude (ca. 2.6 homicides per 100.000 inhabitants) until the end of our study period in 1999. The three pre-treatment coefficients are small and statistically indistinguishable from zero. Estimates comparing the average number of homicides between municipalities with and without routes before and after NAFTA with respect to their difference in 1993 (point estimates are indicated by red lines) confirm these findings. The absence of diverging trends corroborates the common trends assumption and thereby the validity of our identification strategy.

Figure C.1 in the Appendix inspects the other measures of drug-trafficking route exposure using the event-study design. Similar to the established pattern in Figure 2, violence is increasing in the length of the route immediately after 1993, again without significant differences in the years

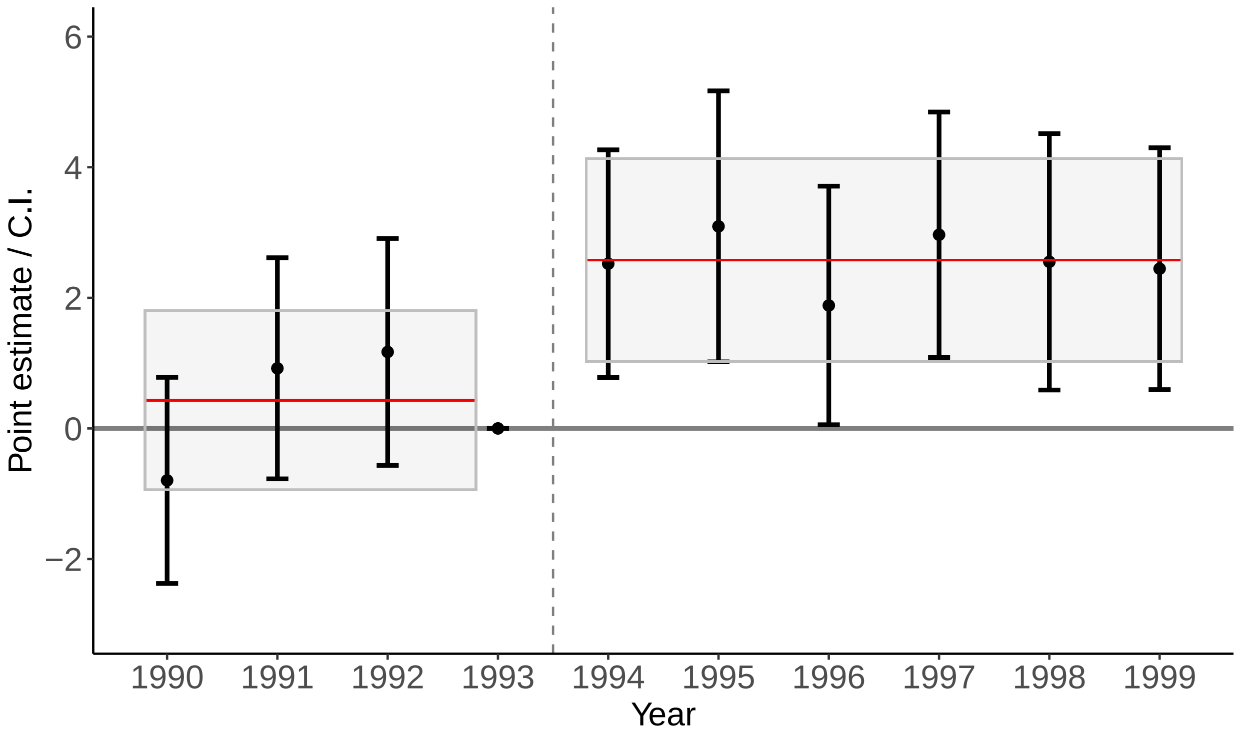

Figure 2: Main results: dynamic effects of drug-trafficking route location on violence

The figure plots β_τ coefficients estimated from equation 2 with 95% confidence intervals. The omitted year is 1993. The dependent variable measures drug-related homicides per 100,000 inhabitants. The main explanatory variables are indicators that assume the value one if a municipality is traversed by a predicted optimal drug-trafficking route interacted with year dummies. Control variables include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors are clustered at the municipality level.

leading up to NAFTA (subfigure C.1a). Violence is also decreasing in the number of tributaries immediately after 1993, with no discernible pre-trends (see Figure C.1b). These graphs confirm findings from Table 2 and suggest that violence increases in locations with longer segments of a route but decreases in more downstream locations.

Results in this section support our findings and suggest that violence jumped to another level immediately after the introduction of NAFTA, whereas the absence of diverging pre-trends mollifies the concern of anticipatory effects.

4.3 Robustness checks

4.3.1 Alternative transformations and sample restrictions

In this section, we show that our main results, estimated using equation 1, are robust to alternative transformations of the dependent variable and sample restrictions. The results of these exercises are presented in Table C.1 in the Appendix.

In columns 1–3, we use the logarithmic, the inverse hyperbolic sine, and the Castillo, Mejía and Restrepo (2020) transformation of the dependent variable, respectively.[14] These transformations aim to remove skewness in our dependent variable that occurs due to a large number of municipalities with zero homicides. The coefficient of interest is positive and statistically significant across all specifications suggesting that skewness is not driving our results.

In column 4, we add an indicator variable for origin municipalities interacted with the $post\, NAFTA$ indicator as a control variable. This aims to rule out that our results are in fact driven by violence in drug-producing regions rather than regions on trafficking routes. Indeed, we find that origins experience a significant increase in homicides of about 3.2 per 100,000. However, our main results remain qualitatively similar.

In columns 5 and 6, we remove potential outliers from our sample. We exclude the top 1% and top 5% of municipalities in the distribution of drug-related homicides before the introduction of NAFTA, respectively. The coefficient of interest remains stable in comparison to our baseline specification.

4.3.2 Trade shocks and unemployment

Our results can be interpreted to reflect the consequences of an increase in drug-trafficking profits if the predicted routes were indeed used for transporting drugs to the U.S. border. However, due to the complementarity between legal and illegal trade, it is conceivable that our routes overlap with general trade routes leading to an omitted variable bias if the change in legal trade due to NAFTA differentially affected regions alongside these routes. For example, if regions alongside the predicted routes suffered by more from import competition with U.S. producers, this may have increased unemployment, leading to a decrease in the opportunity costs of using violence that may create an upward bias on our estimated coefficient.

A similar bias could arise if the predicted routes are correlated with larger local agricultural or manufacturing sectors that suffer from import competition. In line with this argument, Dell, Feigenberg and Teshima (2019) provide evidence that increased Chinese manufacturing exports to the U.S. negatively affected the Mexican manufacturing sector and caused job losses. The authors argue that the increased in unemployment due to competition with China increased cocaine trafficking and violence in the 2000s. In our case, an increase in exports from the U.S. to Mexico due to NAFTA could negatively affect Mexican workers pushing them to participate in the drug-trafficking industry leading to a rise in drug-related violence.

To test whether job losses induced by changes in trade with the U.S. after the introduction of NAFTA affect our results, we adopt two strategies: first, we check whether Mexican municipalities that were more exposed to imports from the U.S. to Mexico suffer higher levels of drug-related homicides, and second, we test whether municipalities that suffered higher increases in unemployment rates after the introduction to NAFTA suffer higher levels of drug-related homicides.

[14] Castillo, Mejía and Restrepo (2020) use the following transformation: $ln(h_{it} + r)$, where h is the homicide rate in municipality i at time t and r is the homicide rate at the 90th percentile of distribution.

To calculate the magnitude of the trade shock for different sectors at the local level, we follow the trade literature and use a simple shift share approach. In our setting, the (time-invariant) share reflects the fraction of the respective population in municipality i that is employed in the primary or secondary sector in 1990 using data from the *Instiuto Nacional para el Federalismo y Desarrollo Municipal* (INAFED).[15] The (time-varying) aggregate shift is calculated as the sector-specific (agricultural or industrial) value of imports of goods and services from the U.S. to Mexico in U.S. dollars as a fraction of the Mexican GDP from 1991 to 1999. These data were obtained from the World Bank's WITS database which does not contain information for the year 1990, resulting in a smaller sample.

The proxies for local sector-specific trade shocks are added to our preferred specification in Table 3. For better comparability these variables are standardized with mean zero and unit standard deviation. Since sector-specific exports are unavailable for 1990, we estimate our relationship in a sample for 1991–99 in column 1 for comparison. Column 2 controls for the exposure to the trade shock in the primary sector. Following trade liberalization, agricultural imports, especially of maize constituted a substantial negative shock for the agricultural sector in Mexico. A large number of small farms were no longer able to compete with U.S. maize after tariffs were abolished. We find that this negative shock does not significantly affect violence. Column 3, adds a similarly defined control variable that accounts for the trade shock in the secondary sector. We find that increased competition with the U.S. manufacturers led to an increase in violence in regions more exposed to this shock. This finding resonates with Dell, Feigenberg and Teshima (2019) who argue that increased competition with China decreased the opportunity cost of violence for Mexican workers in the manufacturing sector. Across these specifications, our main findings remain qualitatively unchanged.

To capture the bias arising purely from changes in unemployment after the introduction of NAFTA, we add controls for the municipality-level change in unemployment for males and females from the *Instiuto Nacional para el Federalismo y Desarrollo Municipal* (INAFED). These data were originally collected by INEGI in the decennial General Census of Population and Housing and are thus only available for 1990 and 2000. Hence, we calculate the change in the gender-specific unemployment rate between these two years. Adding these variables in column 4, we do not find a significant relationship between an increase of male or female unemployment after the introduction of NAFTA and the increase of drug-violence.

Adding all of the controls at the same time in column 5, we find that the interaction term $Route \times post\, NAFTA$ remains positive and statistically significant with a magnitude of 1.86, which is not statistically different from our preferred specification in column 1. These results suggest that after the introduction of NAFTA, the increase of drug-related homicides in municipalities with a predicted drug-trafficking route is not driven by the shock to legal trade or increasing unemployment.

[15] INEGI originally collected these data in the decennial General Census of Population and Housing in 1990. These data reflect the spatial distribution of sector-specific activity at the municipality level.

Table 3: Robustness to the shock in legal trade due to NAFTA

Dep. var.:	Drug-related homicides per 100.000 inhabitants				
	(1)	(2)	(3)	(4)	(5)
Route × post NAFTA	1.880***	1.871***	1.858***	2.238***	1.860***
	(0.626)	(0.624)	(0.625)	(0.591)	(0.628)
1st sector emp. 1990 × Agricultural imports		−0.138			0.797
		(0.821)			(0.889)
2nd sector emp. 1990 × Industrial imports			1.090**		1.348**
			(0.487)		(0.527)
Δ male unemp. (1990-2000) × post NAFTA				−0.413	−0.416
				(0.622)	(0.756)
Δ female unemp. (1990-2000) × post NAFTA				0.079	0.015
				(0.273)	(0.311)
Municipality FE	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓
Mean homicides pre-Nafta	8.30	8.30	8.30	8.19	8.32
Observations	21,582	21,582	21,582	23,930	21,537

Notes: The table shows results from estimating equation 1. The unit of observation is a municipality. All control variables introduced in this table are standardized with zero mean and unit standard deviation. Baseline controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors clustered at the municipality level in parenthesis. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

4.3.3 Other omitted variables

This section addresses concerns with respect to the various potential drivers of violence in Mexico discussed in the literature. Again, we add these determinants as control variables to our preferred specification to account for the potential bias arising from omitted variables. Results of these robustness tests are displayed in Table 4.

In column 1, we include a control variable that aims to capture a detrimental NAFTA shock that especially affected maize farmers. This control is inspired by Dube, García-Ponce and Thom (2016) who show that decreasing maize prices induced farmers to shift toward the cultivation of illegal crops in municipalities more suited to growing maize. NAFTA led to a decline in the price of maize in Mexico due to increased competition with U.S. producers, arguably leading to the estimated increase in the cultivation of illegal crops. To rule out that the increase in drug-related violence on trafficking routes is driven by an increase in the cultivation of illegal crops rather than drug-trafficking, we add an interaction term between the municipal-level attainable yields for maize from the FAO-GAEZ database and the annual fluctuation in the national price of maize in the 1990s as a control variable.

The results imply that the decrease in the national maize price actually decreased violence. While we have no explanation for this finding, we find that our coefficient of interest, the interaction term between *Route* and $post\,NAFTA$, is stable in size respect to or baseline specification.

TABLE 4: Robustness to alternative mechanisms

Dep. var.:	Drug-related homicides per 100.000 inhabitants			
	(1)	(2)	(3)	(4)
Route × post NAFTA	2.253***	2.248***	2.038***	2.045***
	(0.588)	(0.584)	(0.568)	(0.565)
Maize suitability × maize price	3.735***			3.302***
	(1.053)			(1.072)
Ejidos area × maize price		−0.161		−0.210
		(0.774)		(0.769)
Municipality alternation			−0.149	−0.201
			(0.365)	(0.363)
State alternation			2.945***	2.804***
			(0.661)	(0.666)
Municipality FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓
Mean homicides pre-Nafta	8.22	8.22	8.22	8.22
Observations	23,980	23,980	23,980	23,980

Notes: The table shows results from estimating equation 1. The unit of observation is a municipality. *Maize suitability × maize price* and *Ejidos area × maize price* are standardized with zero mean and unit standard deviation. Baseline controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors clustered at the municipality level in parenthesis. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

In column 2, we aim to account for the fact that the decline in maize prices may have especially affected small farms called *ejidos*, created under communal land reforms since 1930. De Janvry, Sadoulet and De Anda (1995) argue that most of these farms used obsolete technology and were relatively unproductive so that farmers lived in poverty already before NAFTA. In 1992, Mexico passed legislation for the privatization and sale of the such land potentially further confounding our effects.[16] Hence, we include an interaction term between the cumulative number of hectares reformed through the *ejido* systems until 1990 per hectares of a municipality's area and the national price of maize as control variable.[17] While the coefficient on this variable indeed shows that municipalities with more ejidos reacted to declining maize prices with an increase in violence, this does not confound our drug-trafficking effect.

In column 3, we aim to control for the fact that the political landscape started to change for the first time during the 1990s in Mexico. Trejo and Ley (2018) argue that political alteration and

[16] Murphy and Rossi (2016) document an association between land reform and homicides in Mexico occurring after the 1992 liberalization of the ejido sector. The authors show that homicides decreased in municipalities that were more exposed to the land reform after 1992.

[17] We thank Aldo Elizalde for sharing these data from the *"Padron e Historial de Nucleos Agrarios" (PHINA)*, originally collected by the *Mexican Secretaría de Desarrollo Agrario, Territorial y Urbano (SEDATU)*. This institution provides information about the number of hectares reformed through the ejido system by municipality in intervals of 10-years between 1930 and 1990.

the rotation of parties increased the degree of inter-cartel violence by undermining the informal networks of protection that had facilitated the cartels' operations under the one-party rule of PAN. When a different party came to power, the informal network of protection was dismantled, and cartels fought for territories, because they lost the protection of the formal institutions.

Based on the data from Trejo and Ley (2018), we create two indicator variables to measure party alternation at the state and at the municipality level. The variable *state alternation* (*municipality alternation*) switches from zero to one after an incumbent governor (mayor) from the PRI was replaced by a candidate from a different party. Information on party alternation is only provided for the time period 1995–2006. However, since we are interested to exclude a confounding effect that coincides with NAFTA, this shortcoming seems less crucial. Furthermore, the results are in line with Trejo and Ley (2018), who show that alternation of political parties at the state level but not at the municipal level is associated with an increased in drug-related homicides. Our coefficient of interest remains positive and statistically different from zero.

In column 4, we include all control variables at the same time. The result shows that the introduction of NAFTA is associated with an increase in 2.0 drug-related homicides per 100.000 inhabitants in municipalities with a drug-trafficking route compared to municipalities without a drug-trafficking route. This result is not statistically different from our main specification.

4.4 Falsification tests

We conduct two falsification tests to check the validity of our results. These either use homicides that are expected to be unrelated to drug trafficking as outcomes or use optimal routes for legal trade as the treatment variable.

Drug-unrelated deaths In line with our hypothesis, we expect that the introduction of NAFTA is only associated with drug-related homicides which predominantly occur among males at the age of 15 to 39. Hence, inspecting the effect of NAFTA's introduction on homicides in other demographic groups constitutes a valid falsification of our hypothesis. We do not expect routes to predict changes in homicides of females and older people, or deaths from suicides or traffic fatalities. To conduct these falsification tests, we estimate event study models as embedded in equation 2 and replace the dependent variable for homicides of young females (15–39 years), homicides of older males or females (55–64 years), deaths from suicides, and traffic fatalities. Figure C.2 in the Appendix plots the point estimates of the different falsification tests over time. None of the plots show a pattern of higher post-NAFTA increases in placebo deaths in municipalities on a route. These results support our interpretation that the estimated increases in drug-related homicides in our main specification reflect competition over trafficking routes.

Placebo routes An alternative interpretation of our results suggests that violence increases on routes that are used for trade in general. In a second falsification test, we again exploit the fact that maize was Mexico's primary export commodity which was especially affected by the introduction of NAFTA. If municipalities alongside trade routes that connected maize producing regions with the U.S. suffered more strongly from the trade shock, these might have experienced a stronger decrease in the opportunity costs of using violence. To address this issue, we estimate the event-study model embedded in equation 2 substituting our predicted optimal drug-trafficking route indicator with a predicted optimal maize-trading route indicator. To create such optimal placebo routes, we use Dijkstra's algorithm (Dijkstra, 1959) to connect U.S. land ports of entry with maize producing municipalities as origins, i.e., municipalities above the 90th percentile of attainable maize yields.[18] Figure C.3 in the Appendix plots the point estimates when using the placebo routes as the dependent variable. The plot does not indicate a differential increase in drug-related homicides across municipalities with and without optimal maize-trading routes after the introduction of NAFTA. These results support our interpretation of predicted routes as actual trafficking routes.

5 Spillover and displacement effects

This section investigates how NAFTA affected the spatial distribution of drug-related violence.

Spillover effects DTOs typically strive to control substantial territories and plazas instead of scattered pockets. This may lead to violence in regions that are not traversed by a trafficking route simply because DTOs try to conjoin territory. To study such spillovers, we investigate the effects of NAFTA's introduction on municipalities that are immediate neighbors of regions with a trafficking route.

Table D.1 in the Appendix estimates equation 1 and replicates the main table 2 but adds an indicator for being the neighbor of a trafficking municipality after NAFTA's introduction. A neighbor is defined as a municipality j that shares a side or an edge with a municipality i with a predicted drug-trafficking route. The results in columns 1–3 show that the interaction term $Neighbor \times post\,NAFTA$ is always positive and statistically different from zero with a size of approximately 2.3 homicides per 100,000. At the same time, compared to our baseline specification, the coefficient for municipalities traversed by a route increases substantially from 2.3 to 3.2 or 4.1 respectively. This result suggests that violence spilled over to neighboring municipalities. When not accounting for such spillovers, we underestimate the true increase in violence concentrating on the most valuable municipalities.

To inspect the dynamics of the main effect and the spillovers, we estimate equation 2 including the $Neighbor_j$ indicator interacted with time dummies ($year_t$). Figure D.1 in the Appendix shows the point estimates (β_t) of this flexible difference-in-differences approach for municipalities i that are traversed by routes in panel A and for neighboring municipalities j in panel B. Results in panel A and B show a similar pattern of no discernible pre-trends in violence between treated and control group municipalities. Upon the introduction of NAFTA, both route and neighbor municipalities

[18] Results are robust to using municipalities above the median and above the 95th percentile of attainable maize yields as origins.

experience a lasting shift in violence that is, however, only significantly different from zero for municipalities on routes. The smaller and slightly declining effect in neighbor municipalities shows that these regions are less contested.

Displacement effects Figure A.3 in the Appendix shows that municipalities on routes saw an increase of violence after NAFTA whereas municipalities off routes eventually saw a decrease, compared to pre-NAFTA levels. Hence, we aim to understand whether NAFTA induced a reorganization of violence in Mexico such that violence was diverted from low trafficking regions and concentrated on regions that were strategically more valuable to traffickers.

Figure D.2 in the Appendix shows local polynomial regressions of the (conditional) change in violence before and after NAFTA on the arcsinh transformed distance in km between a municipality's centroid and the closest predicted optimal drug trafficking route. The estimated coefficient on homicides is positive for distances up to ca. 55 km and becomes negative for municipalities further away. The graph also shows explicit humps for municipalities whose centroid is directly on the line and for those in 10–55 km distance. Given their average area is 809 km^2, these will typically be municipalities traversed by a route. This figure illustrates that NAFTA generated substantial displacement effects at the local level. Violence was diverted from remote regions to municipalities in close proximity to trafficking routes.

6 Evidence for lasting competition between DTOs

In this section, we use data on detected drug-related homicides between 2007 and 2010 to study whether NAFTA had lasting consequences on the geography of violence in Mexico and whether this violence is indeed driven by competition between DTOs. Starting in 2007, the newly elected president Felipe Calderón dispatched the military to fight the cartels and reduce drug violence. This marked a shift towards unprecedented levels of violence accumulating to 50,000 drug-related homicides during Calderón's term. Next to the fact that the 2007–2010 data collected by the Office of the Mexican Attorney-General specifically count homicides classified as drug trade-related by the officials, they also distinguish between inter-cartel homicides, i.e., those resulting from rivalries between DTOs, and homicides resulting from aggression and confrontations between drug-trafficking organizations and the police and military forces.

To study whether NAFTA had lasting consequences for the spatial distribution of violence across Mexican municipalities, we use the following cross-sectional specification:

$$Drug\,homicides_{i,2007-10} = \alpha + \beta Route_i + \delta Drug\,homicides_{i,1990-93} + X_i'\Gamma + \epsilon_i \qquad (3)$$

where, $Drug\,homicides_{i,2007-10}$ reflects the average number of drug-related homicides by category during 2007–2010 per 100.000 inhabitants in 2005 in municipality i. Categories include homicides arising from a) conflicts between cartels, b) aggression from cartels toward state forces, and c) confrontations of cartels by state forces. To increase comparability, these variables are standardized with zero mean and unit standard deviation. $Route_i$ is the indicator variable established in Section 4 that assumes the value one if a municipality i is traversed by a predicted optimal drug-trafficking route. $Drug\,homicides_{i,1990-1993}$ reflects the average number of male homicides between the age of 15 and 39 during 1990–1993 per 100.000 inhabitants in 1990. This variable captures the pre-NAFTA level of violence. X_i' represents our baseline set of control variables including temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, and population size in 1990. We use robust standard errors in all specifications.

TABLE 5: Distinguishing violence among DTOs or between DTOs and the state

Dep. var.:	Drug-related homicides (2007–10) per 100.000 inhabitants due to:		
	inter-cartel conflict	aggression towards state	confrontations with state
	(1)	(2)	(3)
Route	0.225***	0.095	0.088
	(0.058)	(0.059)	(0.058)
Drug-related homicides 1990–93	✓	✓	✓
Baseline controls	✓	✓	✓
Observations	2,398	2,398	2,398

Notes: The table shows results from estimating equation 3. The unit of observation is a municipality. Dependent variables are standardized with zero means and unit standard deviations. Baseline controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Robust standard errors in parenthesis. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 5 presents the results from estimating equation 3 by category of homicides. The results show that our predicted drug-trafficking routes are positively associated with any of the violence categories. However, we find that drug-trafficking routes are only significantly related to inter-cartel conflict in column 1, whereas they are not significantly related to aggression from cartels toward state forces in column 2 or confrontations of cartels by state forces in column 3. Homicides from inter-cartel conflict are 23% of a standard deviation more prevalent in municipalities traversed by a route. This result confirms our hypothesis that DTOs use violence when competing for trafficking routes. The results further suggest that drug-related violence continues to be higher in regions that became more valuable after NAFTA's introduction.

7 Conclusion

This paper investigates the consequences of the introduction of the North American Free Trade Agreement in 1994 on drug-related violence in Mexico. We argue that due to the complementarity between trade in legal and illegal goods, NAFTA's open border policy increased profits in the Mexican drugs-trafficking sector. This triggered the so-called rapacity effect leading to an increase in violent competition over smuggling routes among DTOs that ultimately changed the geography of violence in Mexico in the 1990s.

Using a flexible diff-in-diff model, we compare drug-related homicides per 100,000 inhabitants in municipalities with and without an optimal drug-trafficking route, before and after the introduction of NAFTA. Trafficking routes are determined via the least-cost-paths between U.S. points of entry and regions suitable for opium production. Results show that after NAFTA introduction, homicides increase by an additional 2.25 deaths per 100,000 inhabitants in municipalities with an optimal drug-trafficking route, equivalent to an increase of 27% relative to the pre-NAFTA mean.

We think that our findings generalize to all types of illegal goods that are smuggled across borders and extend to human trafficking. When considering the gains from trade liberalization, policy makers need to consider the fact that also the trade costs of illegal goods decline, triggering the rapacity of criminals. However, we also think that our findings only generalize to countries with weak institutions where corruption is a major source of income for the government officials.

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Appendix A Descriptives

Table A.1: The size of the U.S. illegal drugs market

Year	Cocaine		Heroin		Cannabis		Methamphetamine	
	Consum.	Expen.	Consum.	Expen.	Consum.	Expen.	Consum.	Expen.
1990	447	69.9	14	22.5	837	15.0	16	5.7
1991	335	57.1	12	20.3	793	14.0	10	3.7
1992	346	49.9	12	17.2	761	14.6	14	4.8
1993	331	45.0	11	13.8	791	12.0	19	5.1
1994	323	42.8	11	13.2	874	12.2	34	7.6
1995	321	40.0	12	13.2	848	10.2	54	9.2
1996	301	39.2	13	12.8	874	9.5	54	10.1
1997	275	34.7	12	11.4	960	10.5	35	9.3
1998	267	34.9	14	11.1	952	10.8	27	8
1999	271	35.6	14	10.1	1028	10.6	18	5.8

Notes: Table shows size of the U.S. drug market based on prices and quantities. *Consum.* is annual quantity of consumption in metric tons. *Expen.* is annual expenditures in Billions of 2000 USD. Source: The White House (2003).

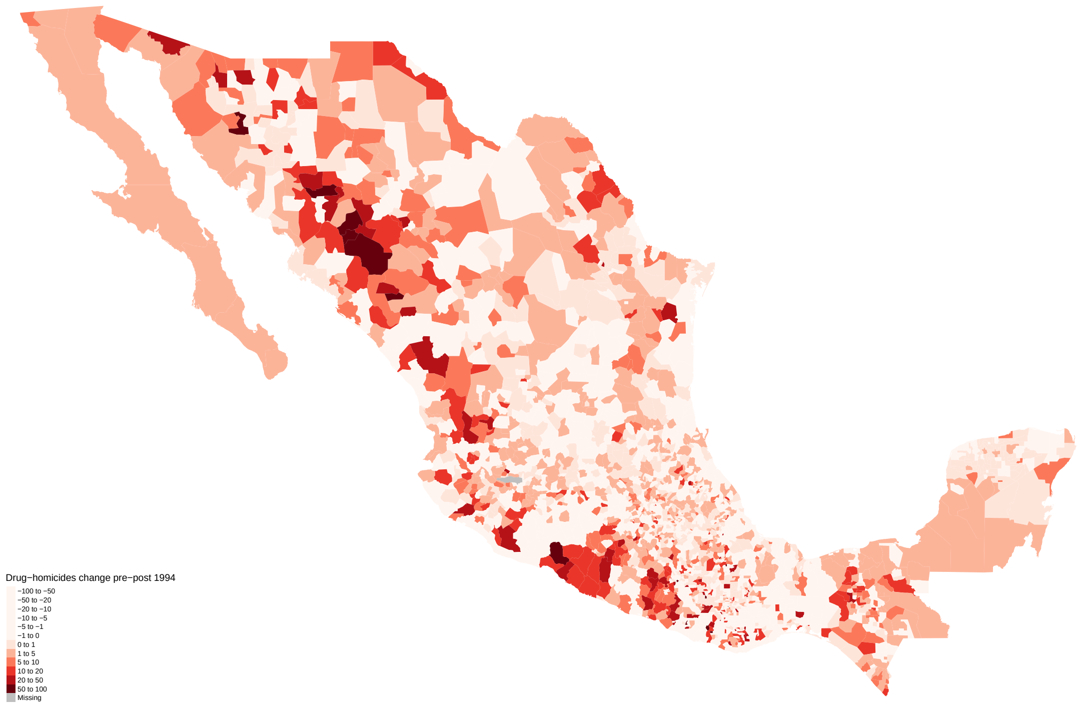


FIGURE A.1: Change in drug-related homicides after NAFTA's introduction

This figure illustrates average changes in drug-related homicides, i.e., homicides of makes aged 15–39 per 100,000 inhabitants, comparing the periods 1990–93 and 1994–1999. Darker shades of red indicate higher increases after 1994.

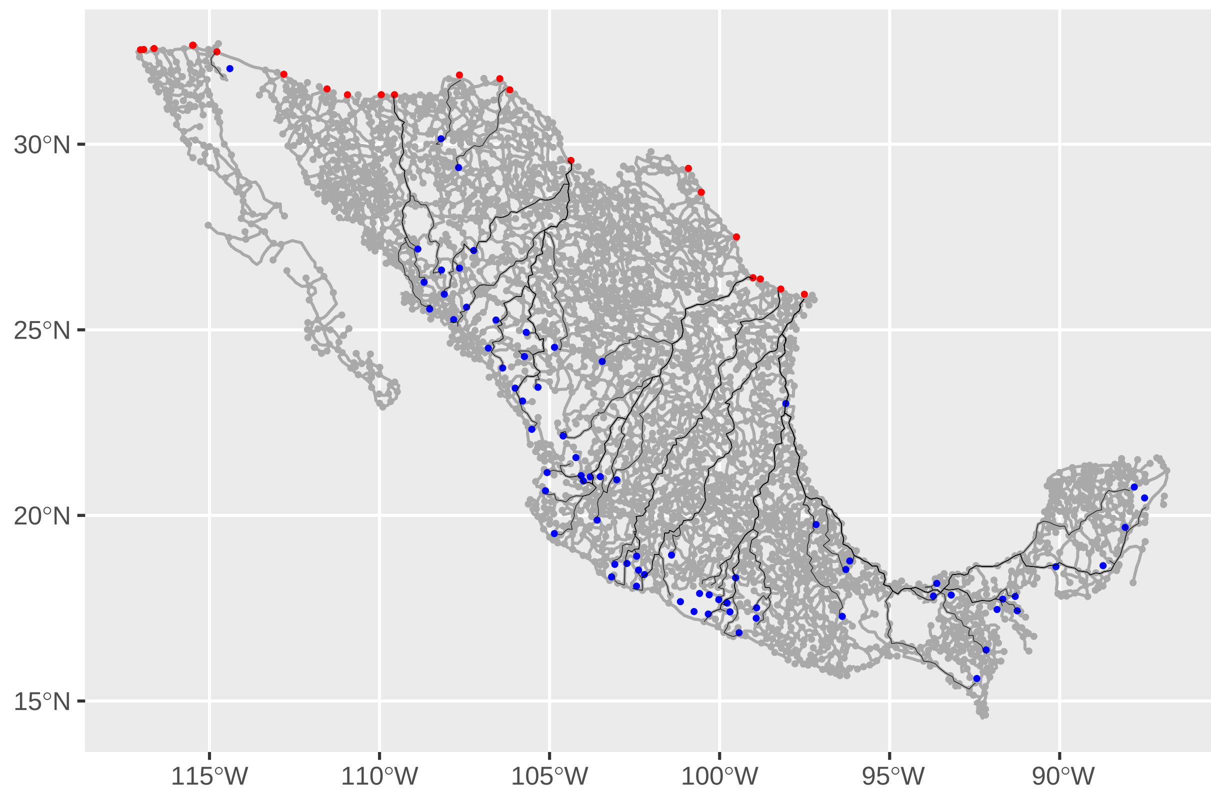


Figure A.2: Predicted drug-trafficking routes

This figure shows the optimal predicted drug-trafficking routes as black lines. Grey lines indicate the full road network in Mexico as of 1993. Red dots depict the 22 land ports of entry on the Mexican-U.S. border. Blue dots depict major known drug-producing and drug-trafficking municipalities (see Section 3 for details).

FIGURE A.3: Drug-related homicides by routes in the 1990s

This figure depicts the evolution of drug-related homicides by municipality with (solid) and without (dashed) a predicted drug-trafficking route over time.

Table A.2: Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Panel data					
Drug-related homicides 1990-1999	23,980	8.17	20.07	0	607.29
Drug-related homicides 1990-1993	9,592	8.22	21.67	0	571.43
Drug-related homicides 1994-1999	14,388	8.14	18.92	0	607.29
Female (age 15–39) homicides	23,980	0.33	1.70	0	48.50
Older male (55–64) homicides	23,980	2.67	7.74	0	283.29
Older female (55–64) homicides	23,980	0.24	2.60	0	283.29
Traffic fatalities	23,980	8.75	17.04	0	636.94
Suicides	23,980	0.38	2.28	0	109.65
State alternation	14,388	0.10	0.30	0	1
Municipality alternation	14,388	0.19	0.39	0	1
Number DTOs	23,980	0.01	0.11	0	2
Cross-section					
Inter-cartel conflict homicides	2,398	5.79	17.38	0	368.93
Aggression deaths	2,398	0.15	1.37	0	39.96
Confrontation deaths	2,398	1.39	11.40	0	271.45
Route	2,398	0.25	0.43	0	1
Length of route	2,398	13.22	27.81	0	239.24
Number of tributaries	2,398	1.20	3.43	0	35
Distance to route	2,398	42,112.47	42,020.36	1.98	369,022.10
Neighbour	2,398	0.28	0.45	0	1
Temperature	2,398	19.93	3.94	10.68	27.93
Precipitation	2,398	1,025.31	550.71	77.99	3,925.58
Soil pH	2,398	64.86	9.74	1.33	85.74
Cannabis suitability	2,398	0.24	0.32	0	1
Opium suitability	2,398	0.06	0.15	0	1
Maize suitability	2,398	4.86	1.80	0	8
Distance to U.S. border	2,398	733,146.80	272,202.50	0	1,334,989
Δ male unemp. 1990–2000	2,397	−0.02	0.04	−0.88	0.44
Δ female unemp. 1990–2000	2,393	−0.02	0.04	−1.00	0.11
1st sector emp. 1990	2,398	0.53	0.24	0	1.00
2nd sector emp. 1990	2,398	0.18	0.13	0	0.85
Ejidos area	2,398	0.30	0.31	0	6.67
Pop 1990	2,398	33,857.04	100,953.10	149	1,650,205
Time Series					
Agricultural imports	9	0.72	0.15	0.52	1.02
Industiral imports	9	13.43	4.18	7.60	17.84
Maize price	10	3.70	0.76	2.46	4.75

Notes: The table shows summary statistic for all variables included in the empirical analysis.

Appendix B Variable description

B.1 Dependent variables: homicides and deaths

Drug-related homicides. The number of homicides of males between the age of 15 and 39 per 100,000 inhabitants in 1990 in each Mexican municipality for the period 1990–1999. Data obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Female (age 15–39) homicides. The number of homicides of females between the age of 15 and 39 per 100,000 inhabitants in 1990 in each Mexican municipality for the period 1990–1999. Data obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Older male (55–64) homicides. The number of homicides of males between the age of 55 and 64 per 100,000 inhabitants in 1990 in each Mexican municipality for the period 1990–1999. Data obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Older female (55–64) homicides. The number of homicides of females between the age of 55 and 64 per 100,000 inhabitants in 1990 in each Mexican municipality for the period 1990–1999. Data obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Suicides. The number of suicides per 100,000 inhabitants in 1990 in each Mexican municipality for the period 1990–1999. Data obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Traffic fatalities. The number of deaths due to traffic accidents per 100,000 inhabitants in 1990 in each Mexican municipality for the period 1990–1999. Data obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Inter-cartel conflict homicides. The number of homicides related to drug-trafficking organization rivalry per 100,000 inhabitants in 2005 in each Mexican municipality for the period 2007-2010. Data obtained from Empirical Studies of Conflict (ESOC). Total population in 2005 obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Aggression deaths. The number of deaths related to DTO attacks against military and police forces per 100,000 inhabitants in 2005 in each Mexican municipality for the period 2007-2010. Data obtained from Empirical Studies of Conflict (ESOC). Total population in 2005 obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

Confrontation deaths. The number of deaths observed during a government intervention per 100,000 inhabitants in 2005 in each Mexican municipality for the period 2007-2010. Data obtained from Empirical Studies of Conflict (ESOC). Total population in 2005 obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

B.2 Main explanatory variables: routes for drug-trafficking

Route. Indicator that takes value 1 if municipality i is traversed by a predicted optimal drug-trafficking route, created using Dijkstra's algorithm (Dijkstra, 1959). Dijkstra's algorithm creates optimal transportation paths from origins to destinations following a network. The network is the main roads and highways in Mexico as of 1985, drawn from The Digital Chart of the World (DCW). Destinations consist of all 22 Mexico-U.S. land border-crossings collected from the Bureau of Transportation Statistics. Origins are municipalities of drug production or transit. We classify municipalities as origins if they are above the 95th percentile of cannabis and opium poppy eradication in hectares per area between 1990 and 1993, or if there was a positive amount of cocaine seized between 1990 and 1993. These amount to 76 origin municipalities. Data are obtained from Dube, García-Ponce and Thom (2016).

Length of route. This variable measures the length predicted drug-trafficking routes in kilometers in each municipality. See '*Routes*' for prediction of routes.

Number of tributaries. This variable counts the number of tributaries that had flown into the routes upstream from an traversed municipality. Following the concept of a stream order to indicate the branching of a river system introduced by Shreve (1966), this variable adds the accumulated tributaries at any confluence of two routes. See '*Routes*' for prediction of routes.

Distance to route. This variable measures the euclidean distance from a municipality centroid to the nearest predicted drug-trafficking route in kilometers. See '*Routes*' for prediction of routes.

Neighbor. Indicator that takes value 1 if municipality j shares a side or an edge with a municipality i with a predicted drug-trafficking route. See '*Routes*' for prediction of routes.

B.3 Baseline controls

Temperature. The average temperature in degrees Celsius in a municipality, calculated as the average temperature of all grid-cells in the municipality during the 1970—2000 period, constructed by temporally and spatially aggregating time series information on mean monthly temperature at a geospatial resolution of 30 arc seconds, obtained from WorldClim (version 2) by Fick and Hijmans (2017).

Precipitation. The average precipitation in hundreds of millimeters in a municipality, calculated as the average precipitation of all grid-cells in the municipality during the 1970—2000 period, constructed by temporally and spatially aggregating time series information on mean monthly precipitation at a geospatial resolution of 30 arc seconds, obtained from WorldClim (version 2) by Fick and Hijmans (2017).

Soil pH. The average soil pH in a municipality, calculated as the average soil pH of all grid-cells in the municipality, constructed information at a geospatial resolution of 30 arc seconds. The pH scale runs logarithmically from 0 to 14, where 0 is a highly acidic value, 14 is highly alkaline, and 7 is neutral. Data obtained from the Atlas of the Biosphere by IGBP-DIS (1998).

Cannabis suitability. Index which captures the suitability of a municipality to grow cannabis. To create this index, we divide Mexico's area into grid cells of 0.05 x 0.05 degrees of latitude by longitude and create a dummy variable that takes a value 1 if cell i falls within the optimal intervals for growing cannabis and 0 otherwise. We define the optimal suitability for growing cannabis in terms of precipitation, temperature, and soil pH (see variable descriptions above). According to FAO EcoCrop, the optimal temperature to grow cannabis is between 15–28 degrees Celsius; annual precipitation should be between 600–1200 mm; and soil pH between 6–7. Using this information, we calculate the share of 0.05 x 0.05 grid cells within each municipality that potentially could grow cannabis.

Opium suitability. Index which captures the suitability of a municipality to grow opium poppies. To create this index, we divide Mexico's area into grid cells of 0.05 x 0.05 degrees of latitude by longitude and create a dummy variable that takes a value 1 if cell i falls within the optimal intervals for growing opium poppies and 0 otherwise. We define the optimal suitability for growing opium poppies in terms of precipitation, temperature, and soil pH (see variable descriptions above). According to FAO EcoCrop, the optimal temperature to grow opium poppies is between 15 and 24 degrees Celsius; annual precipitation should be between 800–1200 mm; and soil pH between 6.5–7.5. Using this information, we calculate the share of 0.05 x 0.05 grid cells within each municipality that potentially could grow opium poppies.

Maize suitability. The average agroclimatic attainable yield for maize at the municipality level at a geospatial resolution of 30 arc seconds. We calculate the average of low-input-level, intermediate-input-level, and high-input-level rain-fed for maize at the municipality level. Data obtained from from FAO-GAEZ V3.

Distance to U.S. border. The euclidean distance in kilometers from a municipality centroid to the nearest Mexico-U.S. land port of Entry.

Total population 1990. Total population in 1990 at the municipality level obtained from Mexican Instituto Nacional de Estadística y Geografía (INEGI).

B.4 Robustness controls

1st sector emp. 1990. The population working in the primary sector in 1990 at the municipality level, divided by the total active population in 1990 at the municipality level. Data obtained from Instituto Nacional para el Federalismo y el Desarrollo Nacional.

2nd sector emp. 1990. The population working in the secondary sector in 1990 at the municipality level, divided by the total active population in 1990 at the municipality level. Data obtained from Instituto Nacional para el Federalismo y el Desarrollo Nacional.

Agricultural imports. The total value of agricultural goods and services imported from the United States to Mexico as a percentage of the total Mexican GDP from 1991 to 1999. Data obtained from World Integrated Trade Solution (WITS). The WITS provides information about the value in USD of imports of different industries, we classify as agricultural sector: animal, vegetable.

Industrial imports. The total value of industrial goods and services imported from the United States to Mexico as a percentage of the total Mexican GDP from 1991 to 1999. Data obtained from World Integrated Trade Solution (WITS). The WITS provides information about the value in USD of imports of different industries, we classify as industrial sector: chemicals, food products, footwear, fuels, hides and skins, mach and elec, metals, minerals, miscellaneous, plastic or rubber, stone and glass, textiles and clothing, transportation, wood.

Δ male unemp. 1990–2000. The percentage change in male unemployment rates between 1990 and 2000 at the municipality level. Data obtained from Instituto Nacional para el Federalismo y el Desarrollo Nacional.

Δ female unemp. 1990–2000. The percentage change in male unemployment rates between 1990 and 2000 at the municipality level. Data obtained from Instituto Nacional para el Federalismo y el Desarrollo Nacional.

Maize price. National maize price in 2010 thousand Mexican pesos, obtained from Dube, García-Ponce and Thom (2016) originally collected by *Servicio de Información Agroalimentaria y Pesquera (SIAP)*.

Ejidos area. The cumulative area of the land redistributed under the *ejido* system divided by total area of a municipality in 1990. Data obtained from Elizalde (2020).

Municipality Alternation. Indicator variable assuming the value 1 if the major of the municipality is not affiliated with the PRI and 0 if the PRI candidate maintained power at the municipality level from 1995 to 1999. Data obtained from Trejo and Ley (2018).

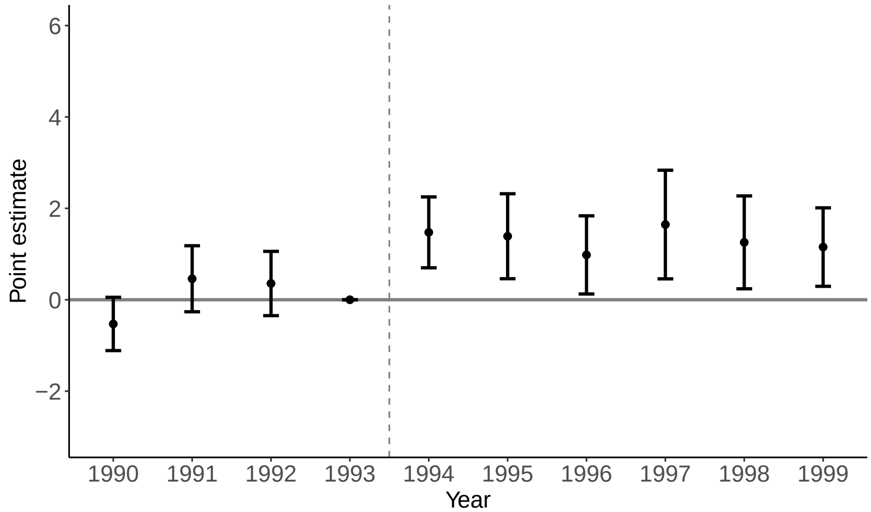
State Alternation. Indicator variable assuming the value 1 for all municipalities in a state if the state governor is not affiliated with the PRI and 0 if the PRI candidate mantained power from 1995 to 1999. Data obtained from Trejo and Ley (2018).

Appendix C Robustness checks

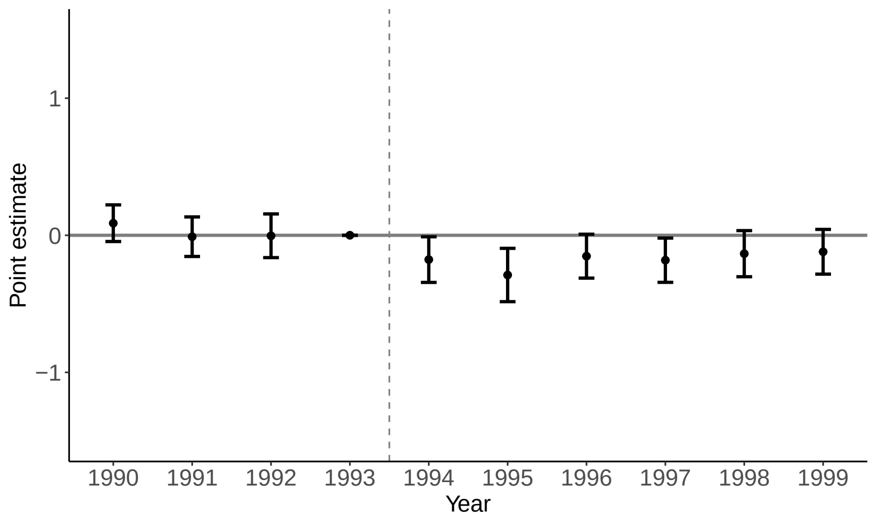
Table C.1: Robustness to alternative transformations and sample restrictions

Dep. var.:	Drug-related homicides per 100.000 inhabitants					
	Ln+1	Arcsinh	Ln+q.90	Origins	Drop top 1%	Drop top 5%
	(1)	(2)	(3)	(4)	(5)	(6)
Route x post NAFTA	0.106***	0.119***	2.253***	1.883***	2.271***	2.500***
	(0.038)	(0.045)	(0.588)	(0.594)	(0.591)	(0.602)
Origins x post NAFTA				3.231*		
				(1.821)		
Municipality FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓	✓
N	23,980	23,980	23,980	23,980	23,740	22,820

Notes: The table shows results from estimating equation 1. The unit of observation is a municipality. Column 1 transforms the dependents variable using the natural logarithm, adding 1; column 2 uses the inverse hyperbolic since transformation; column 3 uses the natural logarithm, adding the value at the 90th percentile of the homicides distribution. Column 4 adds an indicator for municipalities that are identified as origins for the routes. Columns 5 and 6 drop municipalities in the top 1% and top 5% of the homicides distribution. Baseline controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Robust standard errors in parenthesis. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.



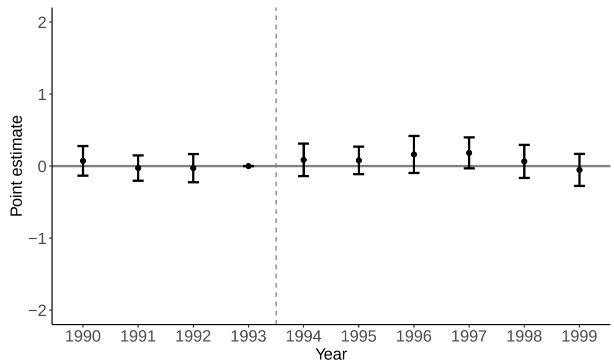
(A) Length of the route



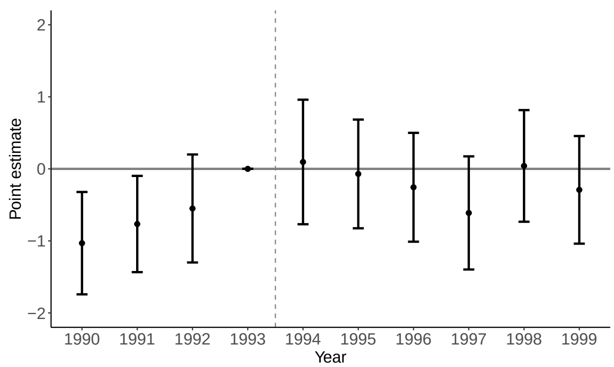
(B) Number of tributaries

FIGURE C.1: Event study estimates using alternative measures of drug-trafficking route exposure

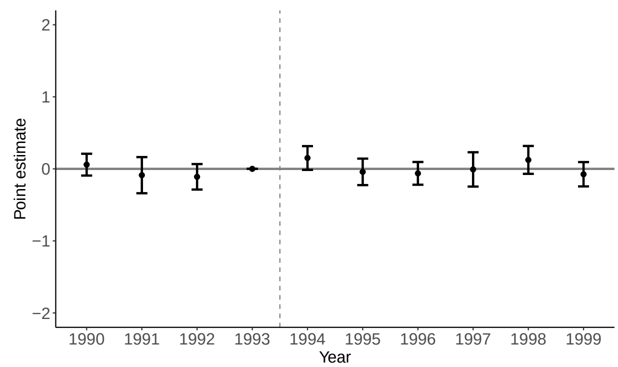
These figures show event-study estimates based on equation 2 using alternative measures of drug-trafficking route exposure. Panel A plots the estimated point coefficient from a variable that measures the length of trafficking routes in a municipality, interacted with time dummies. Panel B plots the estimated point coefficient from a variable that counts the number tributaries that flow into the route upstream from the traversed municipality, interacted with time dummies. This estimation is conditional on a route indicator, interacted with time dummies. The unit of observation is a municipality. Controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors are clustered at the municipality level. 95% confidence band shown.



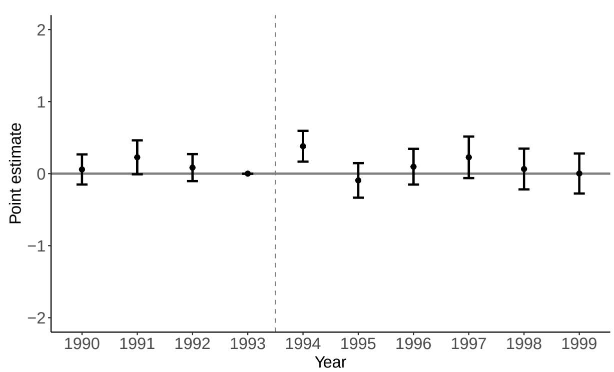
(A) Female (age 15–39) homicides



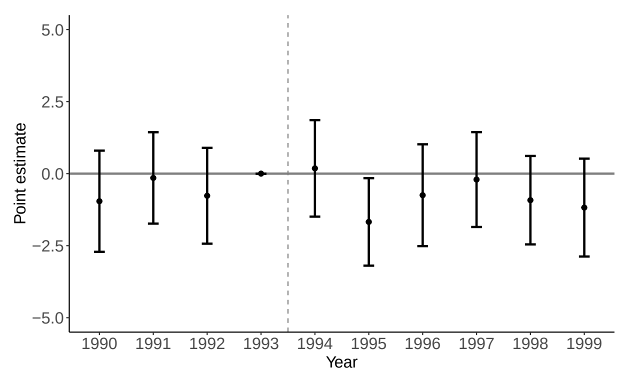
(B) Older male (55–64) homicides



(C) Older female (55–64) homicides



(D) Suicides



(E) Traffic fatalities

FIGURE C.2: Falsification test: drug-unrelated deaths

These figures show event-study estimates based on equation 2 using (arguably) drug-unrelated death rates as outcomes for falsification purposes. Panel A uses homicides of females aged 15–39; Panel B uses homicides of males aged 55-64; Panel B uses homicides of females aged 55-64; Panel D uses all suicides, Panel E uses traffic fatalities. The unit of observation is a municipality. Controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors are clustered at the municipality level. 95% confidence band shown.

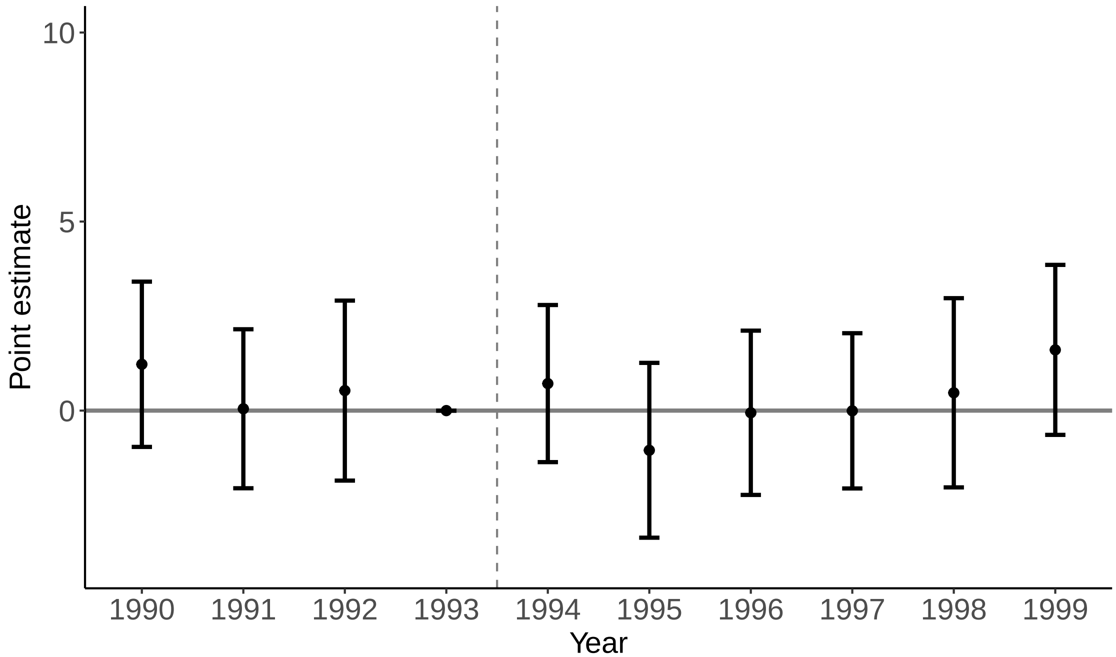


Figure C.3: Falsification test: optimal maize trading routes

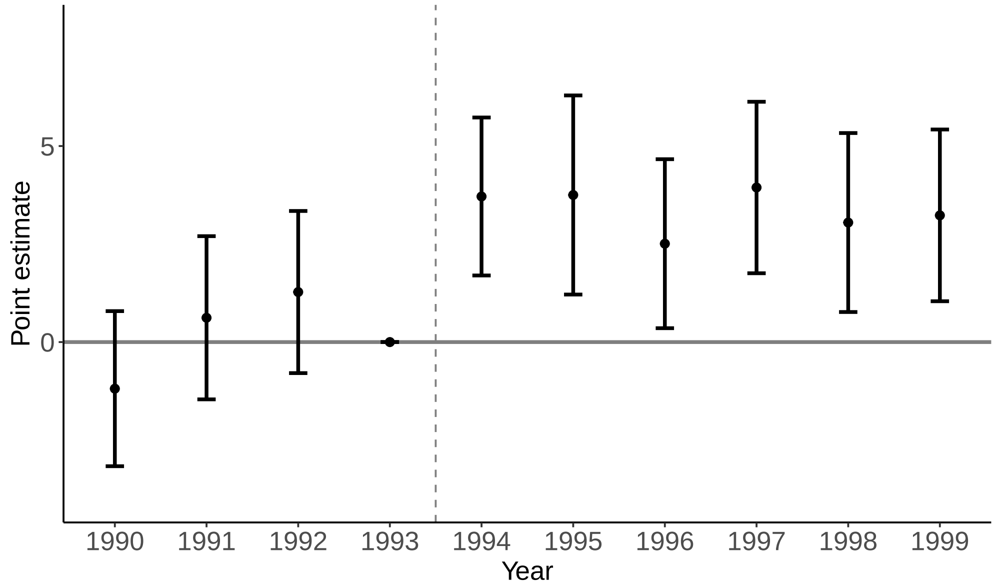
This figure shows event-study estimates based on equation 2 using predicted optimal maize-trading routes as placebo treatment indicators. Optimal maize-trading routes are predicted least cost paths using municipalities among the 90th percentile of maize production as origins instead of (known) drug-producing or drug-trafficking regions. The unit of observation is a municipality. Controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors are clustered at the municipality level. 95% confidence band shown.

Appendix D Spillovers and displacement

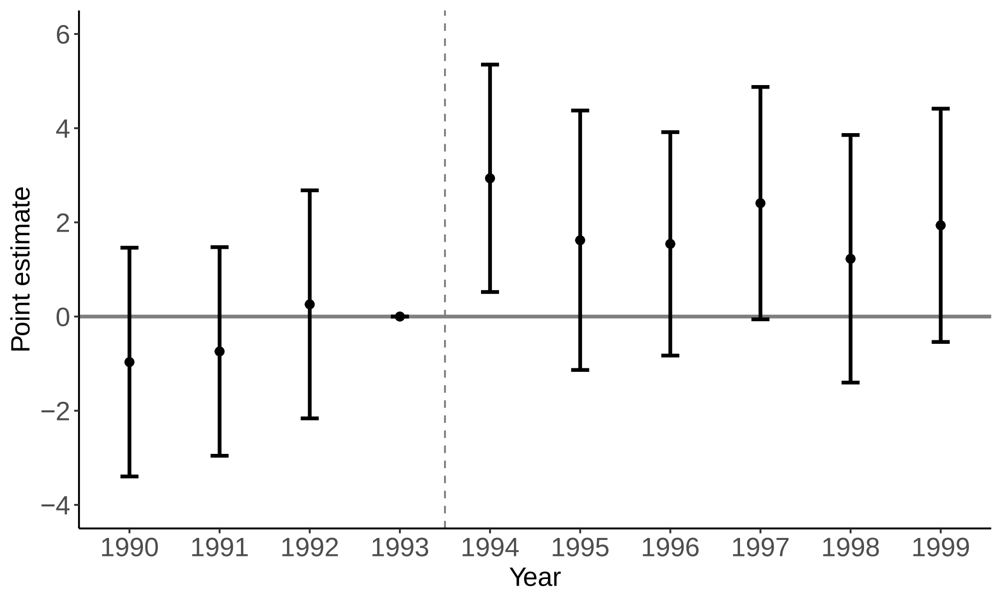
Table D.1: Spillover effects for neighbor municipalities

Dep. var.:	Drug-homicides per 100.000 inhabitants		
	(1)	(2)	(3)
Route × post NAFTA	3.189***		4.076***
	(0.675)		(0.842)
Neighbor × post NAFTA	2.308***	2.252***	2.289***
	(0.555)	(0.539)	(0.555)
Length of routes × post NAFTA		1.576***	
		(0.395)	
Number of tributaries × post NAFTA			−0.189***
			(0.055)
Municipality FE	✓	✓	✓
Time FE	✓	✓	✓
Baseline controls	✓	✓	✓
Mean homicides pre-Nafta	8.22	8.22	8.22
Observations	23,980	23,980	23,980

Notes: The table shows results from estimating equation 1. The unit of observation is a municipality. *Neighbor* is defined as a municipality that shares a side or an edge with a municipality with a predicted drug-trafficking route. *Length of route* is standardized with zero mean and unit standard deviation. The variable *Number of tributaries* counts the number of tributaries that had flown into the route upstream from a traversed municipality. Baseline controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors clustered at the municipality level in parenthesis. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.



(A) Route municipalities



(B) Neighbor municipalities

Figure D.1: Event study of spillover effects

These figures show event-study estimates based on equation 2 adding an indicator for being a neighbor of a trafficking municipality. Panel A shows the dynamic effect for municipalities that are traversed by a route; Panel B shows the dynamic effect for neighbor municipalities from the same regression. The unit of observation is a municipality. Controls include temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990. Standard errors are clustered at the municipality level. 95% confidence band shown.

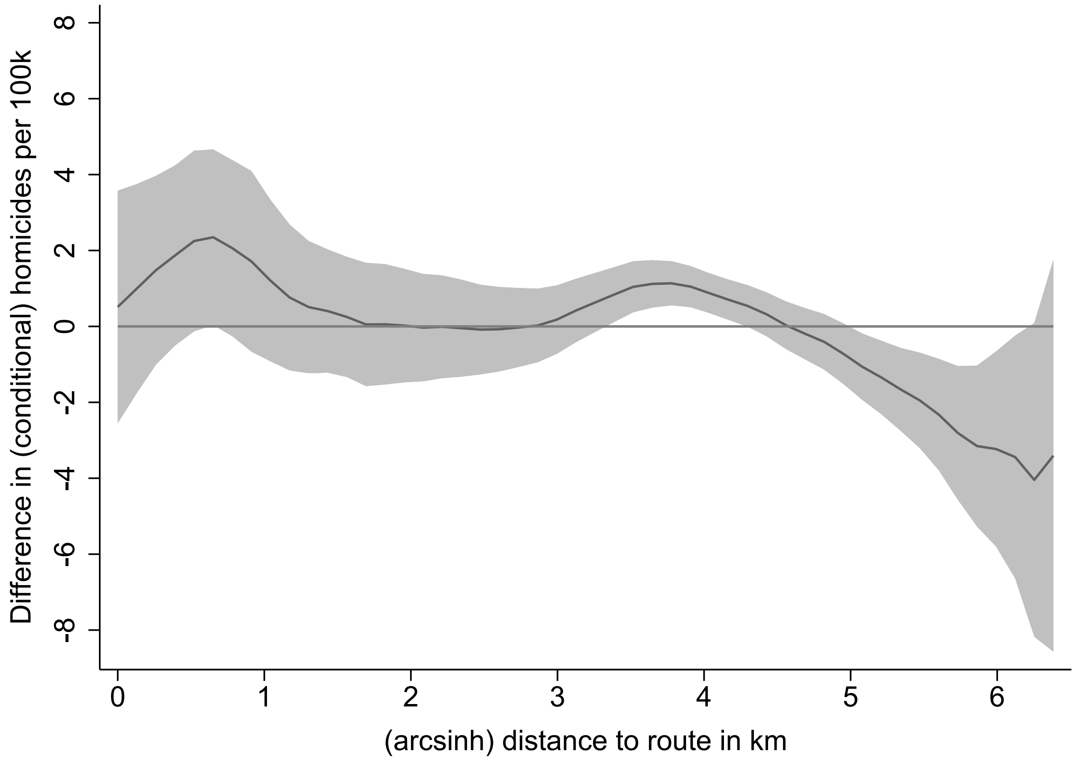


Figure D.2: The displacement of violence

This figure shows results from local polynomial regressions of the residual change in drug-related homicides of males (15–39) between the periods 1990–93 and 1994–99 on the inverse hyperbolic since (arcsinh) transformed distance in km between a municipality's centroid and the closest predicted optimal drug-trafficking route. The residual change in homicides is calculated from the difference in residual homicides drawn from regressions of homicides on the baseline control variables (temperature, precipitation, soil ph, maize suitability, optimal conditions for cannabis and opium production, distance to U.S. border, population size in 1990), separately for the periods 1990–93 and 1994–99. 95% confidence band shown.