Explosive Diversification: Organized Crime Adaptation to Mexico's Crackdown on Fuel Theft*

Itzel De Haro Lopez[†a] and Erik Katovich[‡b]

[a]University of Navarra

[b]University of Connecticut

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Abstract

Organized criminal groups in Mexico obtain substantial revenues through theft of refined fuel products from pipelines. We show that a military crackdown on oil pipeline theft in 2019 prompted criminal groups to diversify into gas pipeline theft, a more technologically challenging and dangerous activity. This adaptive response to enforcement increased cartel presence by 17% and homicide rates by 18% in municipalities hosting gas pipeline infrastructure. Cartel diversification into gas theft was concentrated in places neighboring oil pipelines – where spatial substitution was easiest – and driven most strongly by cartels previously specialized in oil theft. While the crackdown temporarily reduced oil pipeline thefts, it increased local fuel prices and failed to reduce homicides or cartel presence in targeted areas. Findings highlight the pitfalls of combating organized crime through crackdowns, especially in the presence of opportunities for appropriation created by energy infrastructure.

JEL codes: Q34, Q35, Q32, Q48, 017

Keywords: Hydrocarbon Theft, Energy Infrastructure, Organized Crime, Crackdowns and Enforcement, Mexico

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†Corresponding author. Navarra Center for International Development (NCID), Campus Universitario, 31009 Pamplona, Spain; ideharo@unav.es

‡University of Connecticut, 1376 Storrs Road, Storrs, CT 06269, United States; erik.katovich@uconn.edu

1 Introduction

Organized criminal groups impact the lives of tens of millions of people worldwide (Blattman et al., 2023). These groups use violence to overcome missing institutions such as enforceable property rights and dispute arbitration (Chimeli and Soares, 2017), and their presence reduces economic growth (Fenizia and Saggio, 2024) and provokes forced migration (Daniele et al., 2023). Nonetheless, cracking down on organized crime often increases violence and provokes diversification toward novel revenue sources (López Cruz and Torrens, 2023; Dell, 2015). Criminal groups frequently target extractive industries such as mining and oil and gas, where point-source rents provide opportunities for appropriation (Berman et al., 2017; Parker and Vadheim, 2017; Dube and Vargas, 2013)

In this paper, we study direct and spillover effects of the Mexican government's crackdown on thefts of refined oil products (e.g., gasoline and diesel) from pipelines in 2019. Theft of these products – referred to locally as *huachicoleo* – is dominated by powerful cartels, which generate revenues from a diversified range of criminal activities and exert substantial influence over local state actors, such as police and employees of the state-owned oil company, Pemex. In 2018, cartels stole an average of 58 thousand barrels of gasoline per day, amounting to US$3.5 billion in value and 8% of national consumption (Solis, 2018). This phenomenon is part of a broader global problem: worldwide, oil thefts exceeded 200 million barrels and US$11 billion in 2015 (May, 2017). Beyond Mexico, pipeline thefts fund armed groups and criminal organizations in Indonesia, Nigeria, Russia, and Syria (Rexer, 2023; Rexer and Hvinden, 2023; Yeeles and Akporiaye, 2016; Adishi and Hunga, 2017).

We investigate whether Mexico's crackdown on oil pipeline theft achieved its immediate aim of reducing *huachicoleo* in municipalities with oil pipelines, and whether it inadvertently led cartels to shift thefts toward less-policed gas pipelines (which carry liquid petroleum and natural gas) – with concomitant spillovers of violence and cartel presence into municipalities hosting gas pipeline infrastructure.[1] Methodologically, we combine georeferenced maps of refined oil and gas pipelines with annual municipality-level reports of pipeline thefts, cartel presence, and crime. We employ a difference-in-differences (DiD) approach in conjunction with event studies to measure changes in these outcomes before and after the 2019 crackdown in municipalities with and without refined oil or gas pipelines. Additionally, we explore the effects of the crackdown on other crimes and socioeconomic development outcomes, as well as spatial spillovers of violence

[1] This shift toward gas thefts received contemporaneous media attention (Nájar, 2019) and corresponded with a sharp increase in gas-related accidents, from an annual average of 36 between 2003-2017 to 275 in 2019 and 307 in 2020 – 63% of which involved fires or explosions (CENAPRED, 2021).

into areas neighboring municipalities where the crackdown occurred.

Results show that the government crackdown – which involved military intervention to temporarily shut down high-theft pipelines and transport fuel using tanker trucks between December 2018 and April 2019 – successfully decreased the number of illegal taps on refined oil pipelines in the short-term, reversing a trend of exponential growth in pipeline thefts since 2010. However, thefts began to rise again in 2021 and recovered to 80% of their 2018 peak by 2023. Despite reducing thefts, the crackdown did not make targeted municipalities safer: homicide rates in municipalities with oil pipelines remained unchanged and the number of active cartels *increased* by an average of 1 during the two years following the crackdown. By disrupting incumbent cartels, the crackdown may have induced entry by competing cartels into oil pipeline municipalities.

Furthermore, we document a 1,085% increase in gas pipeline thefts (+3.8 taps per municipality per year) following the crackdown. This increase is concentrated in places that neighbor or host an oil pipeline, indicating that cartels previously involved in oil theft shifted spatially toward thefts of nearby gas pipelines. We show that this shift is associated with an increase in 4 homicides per 100 thousand residents (+18%) and 0.36 active cartels (+17%) in municipalities hosting gas pipeline infrastructure, suggesting that cartels shifting toward gas theft used violence to secure pipeline territories.[2] Increased cartel activity in gas pipeline municipalities is driven most strongly by *huachicoleo*-specialized cartels, providing further evidence that substitution was driven by the crackdown's disruption of cartel revenues from oil theft.

We explore several extensions of our main findings. First, we show that the 2019 crackdown significantly reduced robberies and non-lethal violence in targeted oil-pipeline municipalities – in line with increased policing and surveillance – while increasing non-lethal violence and robberies of machinery in gas pipeline places. The crackdown also decreased kidnappings in gas pipeline municipalities, suggesting cartels may have eased off this alternative revenue source as more profitable opportunities for gas theft emerged.

Second, we exclude pipeline municipalities altogether and estimate effects of the crackdown on homicide rates in neighbors of municipalities hosting oil or gas infrastructure, relative to non-neighbors. Findings reveal large spillovers of violence into places neighboring oil pipeline municipalities (+5.8 per 100 thousand residents, a 30% increase), revealing that cartels not only substituted toward gas theft, but also shifted spatially into neighboring areas to evade the crackdown. Taking into account direct effects on violence in targeted oil pipeline municipalities and

[2]Theft of refined gas products is significantly more dangerous and technologically challenging than oil theft, often requiring coordination with cooperating Pemex employees to notify thieves when pipes will be depressurized in order to safely tap them. Consistent with this requirement, we find a significant decrease in homicides of Pemex employees in gas pipeline municipalities following the crackdown, which is indicative of cooperation.

spillover effects into gas pipeline municipalities and neighbors, we find that the crackdown increased overall levels of violence in Mexico. Back-of-the-envelope calculations suggest that direct and spillover effects of the crackdown can explain approximately 15% of all homicides recorded in Mexico in the post-2018 period.

Finally, we analyze socioeconomic development outcomes (formal employment and higher-education enrollment rates) in municipalities hosting pipeline infrastructure. We find no effects of the crackdown on formal employment in either oil or gas pipeline municipalities, which may be due to pipeline theft exerting countervailing effects on economic activity – empowering criminal groups but also subsidizing local fuel prices. Following the crackdown, we measure a downward trend in higher education enrollment rates in gas pipeline municipalities – with this effect driven entirely by municipalities near oil pipelines – as well as an increase in enrollment rates in oil pipeline municipalities that were directly targeted in the crackdown. While statistically insignificant at the 5% level, these results provide suggestive evidence that the shift in cartel activity toward gas pipeline municipalities may have recruited youths in these areas away from education.

1.1 Related Literature and Contributions

This study contributes to three strands of literature on the economics of crime: (i) the behavior and impacts of organized criminal groups, (ii) unintended consequences of enforcement and crackdowns, and (iii) crime focused on extractive industries, particularly pipeline theft.

Literature on organized criminal groups has shown that they infiltrate and loot healthy firms (Mirenda, 2022), prey on profitable farmers (De Haro Lopez, 2023), and reduce economic growth (Fenizia and Saggio, 2024). Kugler and Zenou (2005) show that combating organized crime in contexts with opportunities for rent appropriation and potential for corruption can *increase* criminal activity. Blattman et al. (2023) find that governments face trade-offs in combating organized crime because attacking criminal groups' revenue sources may lead them to prey on local residents. We build on this literature by studying criminal groups' adaptation to a major crackdown effort using rich data on cartel presence and crime. In particular, we show that the rise of gas theft is associated with reduced kidnappings, suggesting cartels may reduce looting of civilians when more lucrative revenue sources become available.[3]

Studies of law enforcement crackdowns have largely concluded that criminal groups are adaptable and resilient, and that disruptions of illicit equilibria increase violence (Magaloni et al., 2020; Herrera and Martinez-Alvarez, 2022; Jones, 2013). Parker and Vadheim (2017) show policies de-

[3]Since stolen oil and gas products are sold in local markets at a discount, these sources of cartel revenue may actually increase support for cartels among local populations.

signed to prevent trade in conflict minerals from the Democratic Republic of the Congo led warlords to substitute toward gold mining and looting of civilians. Chimeli and Soares (2017) study the prohibition of mahogany harvesting in the Brazilian Amazon and show that criminalizing this market increased violence without reducing the mahogany trade. Finally, Dell (2015) finds that crackdowns on drug trafficking in Mexico increased violence as cartels fragmented and took advantage of weakened rivals. We contribute to this literature by showing that Mexico's 2019 crackdown on oil theft failed to reduce violence or root out cartels in targeted areas, while triggering violent cartel diversification into a new and explosive activity: gas pipeline theft.

Extractive industries are especially vulnerable to criminal appropriation because they present fixed point targets and generate large rents (Dube and Vargas, 2013; Angrist and Kugler, 2008). Berman et al. (2017) show that increases in world mineral and metal prices significantly increase violence around African mines as groups fight to control resource windfalls. Our findings provide further evidence that fixed extractive infrastructures (i.e., pipelines) are vulnerable to criminal appropriation and associated violence, even far removed from active production areas.

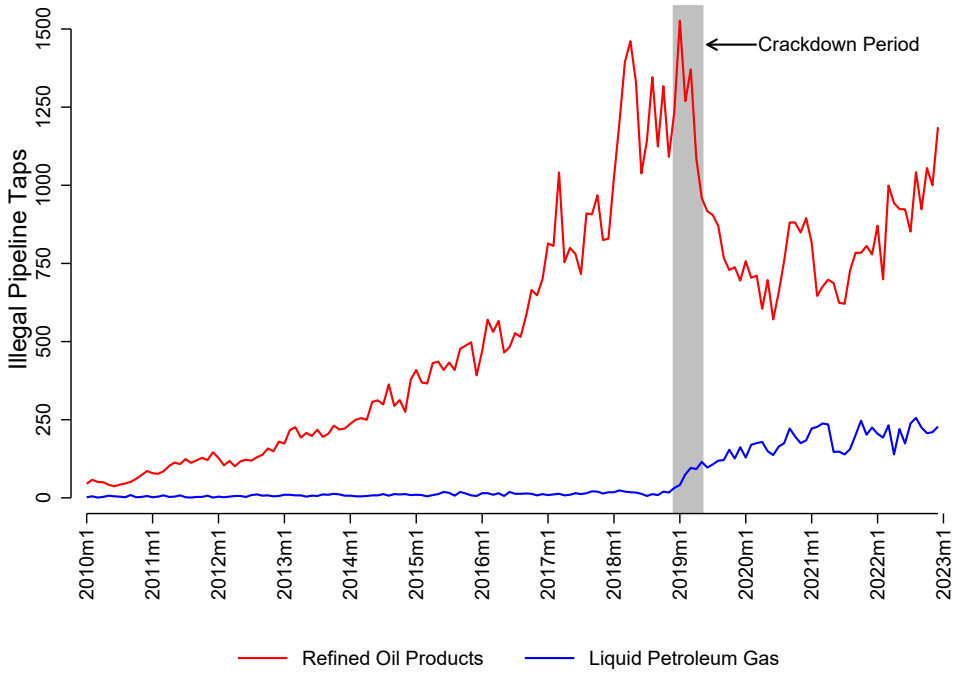
Most specifically, we build on existing studies of pipeline thefts in Mexico and Nigeria. López Cruz and Torrens (2023) document increased oil thefts and violence near oil pipelines after a government crackdown on drug trafficking in Mexico in 2007, providing evidence that cartels substituted for lost drug revenues with fuel thefts. Battiston et al. (2022) leverage the same 2007 drug trafficking crackdown to show that upstart cartels leapfrogged incumbents to engage in pipeline thefts, leading to cartel specialization and segmentation of illegal markets. Rexer (2023) finds that a policy that shifted ownership of Nigerian's oil fields to local firms reduced oil thefts, as local firms were better able to strike bargains with armed groups and leverage government connections to improve law enforcement. Finally, Rexer and Hvinden (2023) show an amnesty for armed groups in the Niger river delta decreased attacks but increased pipeline thefts, suggesting the military allowed thefts in order to reduce violence. We build on previous studies of pipeline theft in Mexico by documenting a new stage in the story of cartel diversification: from oil thefts to gas – which represents a significant increase in technical sophistication and infiltration of state agencies. More broadly, we contribute to the literature on global pipeline theft by quantifying the emergence of gas theft at scale for the first time. Growth of this lucrative and explosive market in Mexico presages threats to other gas producing regions around the world.

2 Background

2.1 Mexico's War on Drugs and the Rise of Fuel Theft

In 2006, Mexico's government launched a War on Drugs to combat drug trafficking organizations. The government employed the kingpin strategy, which involved apprehending leaders of these criminal organizations. This tactic of capturing prominent drug lords destabilized large drug cartels, leading to their fragmentation, increased competition from newly formed organizations (Calderón et al., 2015), and diversification into non-drug-related activities, such as the extortion of agricultural workers (De Haro Lopez, 2023) and theft of refined oil products from pipelines – with accompanying increases in violence (López Cruz and Torrens, 2023; Battiston et al., 2022). Reports of illegal taps on refined oil pipelines increased dramatically following the War on Drugs, peaking at 15,000 reported taps in 2018.[4] Figure 1 shows monthly reports of illegal taps on refined oil and gas products between 2010 and 2022.

Figure 1: Illegal Taps on Refined Oil and Gas Pipelines (Monthly)



Note: Data were obtained from Pemex, Mexico's state-owned petroleum company, through a freedom of information request. Refined oil products are defined as gasoline and diesel.

Criminal organizations have developed effective methods to steal refined oil products (primarily gasoline and diesel) from pipelines operated by Pemex, the state-owned oil company.[5] Cartel

[4] National estimates obtained from Carranza (2018) for the period of 2003-2011 and annual taps for 2012-2022 were obtained through a Freedom of Information request to Pemex.

[5] In 2017, a nationwide energy reform allowed private investments in crude oil exploration, as well as gas and

members pay Pemex employees to share information on the pipelines' location and provide the necessary equipment and information on how to extract the fuel (Cultura Colectiva, 2019; López Cruz and Torrens, 2023). Collaborating Pemex employees also notify cartels of the best time to drill to avoid an explosion, and of the type of fuel (e.g., gasoline or diesel) passing through the pipeline. The stolen fuel is loaded into barrels or trucks and sold in local markets or along local roads. Among consumers of stolen fuel products are factories, transportation businesses, taxi drivers, and gas stations (Torres, 2017; Ralby, 2017). In 2018, Pemex reported losses of approximately US$3.5 billion due to illegal gasoline taps, which amounted to 8% of national gasoline consumption (Solis, 2018). Fuel theft also causes substantial losses in tax revenues, which Mexico's tax authority estimated at US$3.15 billion in 2021 (Tapia Cervantes, 2021).

As illustrated in Figure 1, thefts of liquid petroleum gas (LPG) from gas pipelines were almost unheard of prior to 2019. Corresponding with the crackdown on refined oil theft beginning in December 2018, illegal gas taps quickly increased by over 500%. Approximately 50,000 tons of LPG were stolen monthly in 2022 (Usla, 2022) – accounting for 7.6% of national consumption. LPG presents unique opportunities for criminal organizations since 79% of Mexican households use it for cooking and heating (INEGI, 2022). Stolen LPG is stored in small cylinders and sold to local consumers informally. Gas pipeline theft is intrinsically more dangerous than oil pipeline theft, since gas is stored under extreme temperatures and pressures and taps cannot be made while the pipeline is in use. Instead, thieves rely on tip-offs on when the pipeline will be available for tapping, or provoke accidents that require pipes to be shut down (Nájar, 2019). The rise in gas pipeline thefts is thus closely associated with a dramatic rise in gas-related accidents (mostly fires and explosions), from an average of 36 per year between 2003 and 2017 to 275 in 2019 and 307 in 2020 (Appendix Figure A1). Gas thefts are often undertaken in densely populated urban areas, putting local residents at risk. Mexico's National Center for the Prevention of Disasters reports 208 deaths and 2352 injuries from gas fires and explosions since 2003, with most occurring in recent years (CENAPRED, 2021).

2.1.1 Pipeline Thefts Respond to World Fuel Prices

Using monthly data on fuel prices from CRE, we regress the number of oil or gas pipeline thefts recorded in a municipality-month on (i) national gasoline and diesel prices, (ii) national LPG prices, and (iii) Brent Crude world oil prices, including municipality fixed effects and clustering standard errors at the municipality level. Results, reported in Appendix Table **??**, reveal a

gasoline distribution. However, Pemex continues to own and operate nearly all production and transportation infrastructure (e.g., refineries and pipelines).

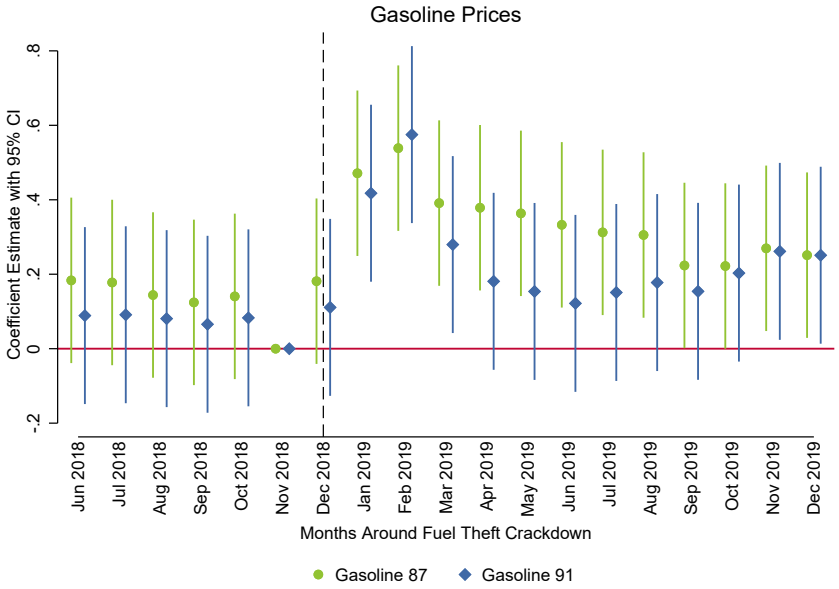
significant positive association between fuel prices and thefts. A 10% increase in exogenous world oil prices is associated with a 3.6% rise in refined oil pipeline thefts. Thefts are even more responsive to national fuel prices: a 10% increase in Mexican gasoline and diesel prices is associated with a 5% increase in fuel thefts. If efforts to crack down on pipeline theft lead to increased fuel prices, this could paradoxically encourage additional thefts.

2.2 The 2019 Crackdown on Fuel Theft

Rising levels of oil pipeline theft and associated violence reached a boiling point in 2018, corresponding with the beginning of Andrés Manuel López Obrador's term as president of Mexico. In December 2018, López Obrador declared a far-reaching crackdown on pipeline theft (Crisis Group, 2022). The Mexican government's crackdown on fuel theft involved shutting down severely affected stretches of oil pipelines that connected refineries and storage depots. Instead, fuel trucks were used to transport refined oil products across these stretches. This intervention resulted in widespread disruption of local fuel markets and fuel shortages (Specia, 2019).

In Figure 2, we use state-month level gasoline price data from Mexico's Energy Regulatory Commission to estimate an event study around the onset of the crackdown by comparing gasoline prices in targeted states versus non-targeted states. Targeted states are defined as those where the Mexican government shut down pipelines and other fuel infrastructure between late December 2018 and April 2019 to combat fuel theft (Caballero-Morales and Martínez-Flores, 2019; Carranza Garcia and Esposito, 2019). Estimates include month and state fixed effects. Results indicate a significant fuel price spike in states affected by the crackdown (peaking at a price differential of up to 0.6 Mexican pesos per liter), beginning in January 2019 and persisting for several months. Gasoline-87 prices remain higher in affected states for at least one year after the crackdown.

Figure 2: Crackdown Effects on Gasoline Prices in Affected States



Note: Figure reports coefficient estimates from the following regression specification: $Y_{st} = \delta_s + \gamma_t + \sum_{t \neq 12/18} \beta_t T_{st} + \epsilon_{st}$, where Y_{st} are nominal gasoline 87 and 91 prices in Mexican Pesos per liter, δ_s and γ_t are state and month fixed effects, respectively, and T_{st} is an indicator taking a value of 1 in states where the Mexican government shut down pipelines and other fuel infrastructure in December 2018 to combat fuel theft. These states are identified as Hidalgo, México, Jalisco, Michoacán de Ocampo, Guanajuato, Querétaro, and Aguascalientes based on reports by Caballero-Morales and Martínez-Flores (2019) and Carranza Garcia and Esposito (2019). Data on fuel prices are from CRE (2023).

The most dramatic fallout from Mexico's crackdown on fuel theft came on January 19th 2019, when a massive explosion resulting from a gasoline pipeline tap killed at least 74 people and injured hundreds more in the town of Tlahuelilpan, Hidalgo. Up to 800 people had converged on the gushing pipeline tap to collect fuel in jerrycans, in part because the crackdown had created local fuel shortages (Semple, 2019). Discussing the incident, residents explained that: "In these towns, we all have a relative or friend who is dedicated to [pipeline theft]... Here, even the mayor protects *huachicol*... Authorities here receive money from *huachicol*. It pays very well and it's an opportunity to enjoy a better life (McDonnell and Linthicum, 2019)." The high costs and substantial disruptions involved in the 2019 crackdown made it unsustainable in the long-term, leading to a winding down of crackdown efforts in April 2019. Since the crackdown did not resolve underlying security challenges, institutional weaknesses, and local incentives driving pipeline theft, illegal taps on refined oil pipelines began to grow again from 2021 onward (Crisis Group, 2022).

3 Data

Our sample consists of 2,471 municipalities tracked annually between 2015-2022. In this section, we describe each of our data sources.

3.1 Energy Infrastructure

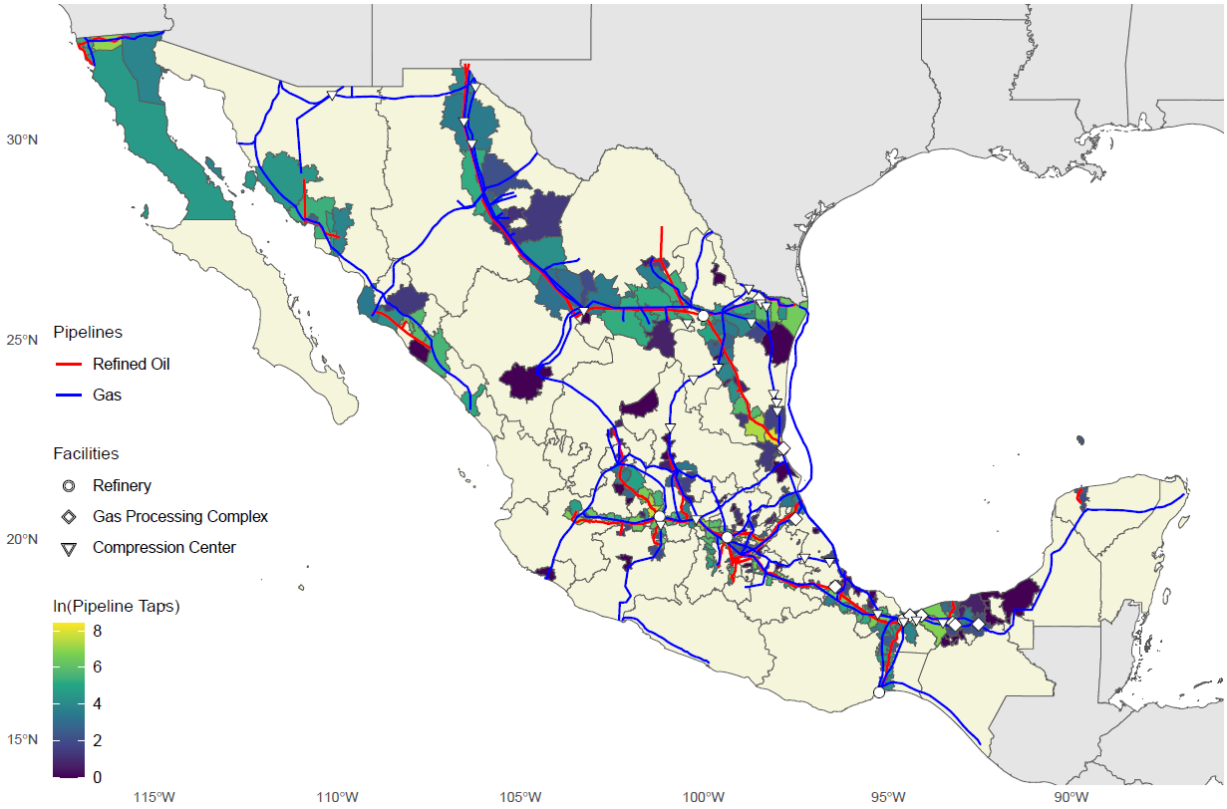
We obtained georeferenced information on Mexico's energy infrastructure from the National Commission of Hydrocarbons (Comisión Nacional de Hidrocarburos, CNH) (CNH, 2019). The data include precise locations of oil refineries, gas processing complexes, and gas compression centers, as well as pipelines used in the transportation of crude and refined oil and gas products, as of 2019. Among oil pipelines, we focus on those designated as carrying gasoline and diesel – the products targeted by fuel thieves – and exclude pipelines that exclusively carry other products, such as crude oil, fuel oil (a heavy fuel used by industry), and jet fuel.

Mexico's gas distribution infrastructure includes government-owned pipelines (the "SISTRAGAS" system) as well as privately owned pipelines. In our main specifications, we do not differentiate between the two. We exclude importation pipelines from our analysis, as these are located outside the Mexican territory. Figure 3 maps Mexico's refined oil and gas pipelines, as well as the locations of refineries, gas processing complexes, and gas compression centers.

3.2 Illegal Taps on Fuel and Gas Pipelines

Data on reports of illegal gasoline and liquid petroleum gas siphoning were obtained through a Freedom of Information Act request to Pemex. The data obtained include the number of illegal taps reported each month in each Mexican municipality between 2010 to 2022. Taps on refined fuel and gas products are reported separately. We overlay cumulative oil and gas pipeline taps reported in each municipality between 2010-2022 in Figure 3. The resulting map reveals substantial spatial variation in the intensity of thefts across different stretches of pipeline.

Figure 3: Mexico: Refined Oil and Gas Processing and Transportation Infrastructure



Note: Geo-referenced data on pipelines and other energy infrastructure are from the National Commission of Hydrocarbons (CNH, 2019); data on pipeline taps were obtained from Pemex through freedom of information requests. Areas in beige reported no illegal pipeline taps between 2010-2022.

3.3 Crime Reports

We use data on homicides from the National Department of Health Information (Sistema Nacional de Información en Salud; SINAIS). This database includes individual-level information on the cause of death, location of death, and type of weapon used (in the case of homicides). It also reports the sex, occupation, marital status, and insurance affiliation of the deceased.[6]

Using municipal data on population from the National Institute of Statistics and Geography (INEGI), we calculate homicide rates per 100,000 people for males, females, potentially cartel-related individuals, Pemex employees, and military personnel. Potential cartel-related homicides are defined as deaths of males between the ages of 15 and 40 who were killed by firearms (De Haro Lopez, 2023). We use this definition because men between these ages are the most vulnerable to criminal violence, and because possession of firearms is illegal in Mexico (Calderón

[6]We prefer this database to police report data from the Ministry of Public Security (SSP) since it provides more details on the victim, including insurance affiliation, which we use to identify murders of Pemex employees and military personnel. It also does not suffer from under-reporting of homicides – as police reports might – since it is based on death certificates rather than police investigations.

et al., 2015; Herrera and Martinez-Alvarez, 2022). According to Mineo (2022), 70% of all guns recovered at crime scenes in Mexico can be traced back to drug cartel organizations. As a measure of deaths from combat between the military and cartels, we identify homicides of individuals whose insurance affiliation was with SEDENA, Mexico's Defense Ministry. Since military family members can also have this affiliation, we limit this definition to homicides of working-age SEDENA-affiliates (18-60 years old) killed by firearms. Similarly, we identify homicides of Pemex employees as deaths of working age Pemex-affiliates by firearms.

Data on other crimes were obtained from the Ministry of Public Security (SSP). This database includes monthly reports of all crimes reported to the police in each municipality. We identify robberies, kidnappings, threats and extortion, and non-lethal physical violence. Table A1 reports summary statistics for municipalities with a gas or refined oil pipeline, as well as non-pipeline municipalities. As shown in the table, municipalities hosting a pipeline present higher homicide and crime rates than the rest of the country. The only exceptions to this are kidnappings, threats, and extortion, which suggests that criminal groups may focus more on looting of civilians when opportunities for rent appropriation from pipelines are not available.

3.4 Cartel Presence

The Mapping Criminal Organization project (MCO) provides a municipality-year panel dataset on the presence of criminal organizations in Mexico. The project employs a web-crawling technique to identify news articles related to criminal cartels on Google and Google News. Using the number of times a cartel is mentioned in news articles, the database determines whether a cartel is present in a particular municipality. The database contains information on the presence of 75 different criminal organizations in Mexico at the municipal level from 1990 to 2021. As shown in Table A1, cartel presence is much higher in municipalities hosting pipeline infrastructure, averaging 3.74 active cartels versus 1.39 cartels per municipality in non-pipeline municipalities.

3.5 Socioeconomic Development Indicators

To measure socioeconomic consequences of cartel presence and the fuel theft crackdown, we draw data on higher education enrollment rates at the municipality-year level from the National Association of Universities and Higher Education Institutions (Asociación Nacional de Universidades e Instituciones de Educación Superior – ANUIES) for the years 2017-2021. We draw data on formal employment rates at the municipality-year level from the Telephone Survey of Occupation and Employment (Encuesta Telefónica de Ocupación y Empleo – ETOE) for 2015-2022.

Table 1: Summary Statistics in Municipalities with Gas or Refined Oil Pipelines

	Gas or Refined Oil			Rest of Country		
	Mean	SD	Obs.	Mean	SD	Obs.
Reports of illegal taps						
Gas	1.57	15.30	5,320	0.04	1.69	14,464
Refined petroleum	13.57	54.22	5,320	0.37	5.87	14,464
Homicide rates						
All	26.04	40.73	5,296	19.56	38.40	14,352
Male	23.06	37.36	5,296	17.33	34.81	14,352
Female	2.74	5.20	5,296	2.14	8.76	14,352
Cartel related	11.32	23.17	5,296	7.57	20.09	14,352
Pemex employee	0.05	0.53	5,296	0.00	0.13	14,352
Military	0.09	1.62	5,296	0.04	0.91	14,352
Number of cartels						
All cartels	3.74	5.94	4,655	1.39	3.27	12,656
Huachicol specialized	2.08	2.51	4,655	0.83	1.64	12,656
Non-huachicol specialized	1.66	3.84	4,655	0.57	1.87	12,656
Robberies						
All	375.64	389.08	5,296	141.15	224.91	14,352
Home & business	91.43	116.39	5,296	32.15	64.55	14,352
Highway & street	157.90	213.62	5,296	52.35	104.45	14,352
Machinery	1.94	6.75	5,296	1.00	5.83	14,352
Other	112.42	130.96	5,296	48.64	91.64	14,352
Other crimes						
Kidnapings	1.23	3.59	5,296	0.62	3.41	14,352
Threats & extortion	68.83	81.75	5,296	42.82	72.46	14,352
Non-lethal violence	137.73	125.58	5,296	80.01	106.83	14,352

Note: This table presents means, standard deviations (SD), and number of observations for relevant variables. Homicide, robbery, and crime rates are expressed as the number of cases per 100,000 people. Huachicol (fuel theft) specialized cartels refer to the nine criminal organizations identified as having high participation in fuel theft. Non-lethal violence consists of injuries and other crimes that threaten life. Cartel data are only available up to 2021. The number of illegal taps reported in non-pipeline municipalities is non-zero because taps can occur at processing centers and other infrastructure sites as well as pipelines, though this happens much less often

4 Empirical Strategy

We implement a pre/post difference-in-differences (DiD) approach to estimate effects of the government's crackdown on fuel theft on homicide rates, cartel presence, and other outcomes in municipalities with refined oil or gas pipelines. Specifically, we compare municipalities with (i)

refined oil pipelines or (ii) gas pipelines to those without pipelines, before and after the 2019 crackdown. Our main specification is as follows:

$$Y_{it} = \alpha_i + \tau_t + \delta(P_i^G \times Post_{t\geq 2019}) + \gamma(P_i^O \times Post_{t\geq 2019}) + e_{it} \tag{1}$$

where Y_{it} is an outcome of interest in municipality i and year t. P_i^G and P_i^O are two binary variables indicating the presence of pipelines carrying gas and refined oil products, respectively. $Post_{t\geq 2019}$ indicates the period before and after the military crackdown on fuel theft in 2019. Finally, we control for time-invariant municipality characteristics and temporal shocks using municipality (α_i) and year-fixed effects (τ_t).

Our primary parameter of interest in this specification is δ, which reflects change in the outcome in municipalities with a gas pipeline after the crackdown. If criminal organizations diversified into gas pipeline theft after the crackdown, we expect to observe an increase in homicide rates and cartel presence in municipalities with a gas pipeline ($\hat{\delta} > 0$). A secondary parameter of interest is γ, which measures the effect of the crackdown on outcomes in places with oil pipelines. For outcomes such as homicide rates and cartel presence, negative values of γ would suggest the crackdown was effective at reducing crime in directly targeted oil-pipeline municipalities. In our preferred specification, we normalize homicide and crime rates to number of incidents per 100,000 municipal inhabitants to account for large differences in population size between municipalities.[7] We also estimate event studies to assess dynamic effects of the crackdown:

$$Y_{it} = \alpha_i + \tau_t + \sum_{y\neq 2018} \delta_y \, P_i^G \times I(t = y) + \sum_{y\neq 2018} \gamma_y \, P_i^O \times I(t = y) + v_{it} \tag{2}$$

In this specification, coefficients δ_y and γ_y capture the impact of the military crackdown y years before or after 2019 on outcome Y_{it} in municipalities that host gas and refined oil pipelines, respectively. Pre-crackdown year 2018 is omitted as a baseline reference. Besides revealing dynamic evolution in outcomes across years, event studies also allow evaluation of the identifying parallel pre-trends assumption that underlies DiD strategies.

Prior to these strategies, we estimate a slightly modified specification to measure the effects of the crackdown on the number of illegal oil and gas thefts reported by Pemex. Since these outcomes are almost always zero in non-pipeline municipalities, we estimate event studies separately for

[7] We focus on homicides as our primary outcome of interest since other types of crime are often under-reported. According to Mexico's National Survey of Victimization and Perceptions of Public Security (ENVIPE), over 90% of crimes in the country are not reported by civilians or filed by the police, largely due to intimidation by organized criminal groups.

the sub-sample of municipalities hosting (i) refined oil pipelines or (ii) gas, as follows:

$$Y_{it}^{f} = \alpha_i + \tau_t + \sum_{y \neq 2018} \beta_y^f \, P_i^f \times I(t = y) + w_{it} \tag{3}$$

In this specification, Y_{it}^{f} is the number of illegal taps reported in municipality i and year t for fuel type $f = \{\text{gas}, \text{refined oil}\}$, P_i^f is a binary variable indicating the presence of a pipeline carrying fuel f, and α_i and τ_t are municipality and year fixed effects to control for time-invariant municipality characteristics and time shocks. In all specifications, standard errors are clustered at the municipality level.

There are several potential threats to identification in our empirical strategy. First, reverse causality could occur if direct treatment (i.e., directly experiencing the military crackdown due to the presence of oil pipelines) was caused by trends in outcomes of interest during pre-treatment periods. As shown in Section 5 below, this is indeed the case for oil pipeline municipalities: increasing rates of oil pipeline thefts, homicides, and cartel presence led the government to focus its military crackdown on those areas. While oil pipeline municipalities were thus *endogenously* treated and exhibit strong pre-trends, gas pipeline municipalities were *exogenously* treated by spillovers from a crackdown focused elsewhere. In light of this distinction, we interpret results for oil pipeline municipalities as descriptive, and results for gas pipeline municipalities as causal. A second threat to identification could come from violations of the stable unit treatment value assumption (SUTVA) if spillovers from treated groups contaminate the control group (i.e., non-pipeline municipalities). We quantify spatial spillovers explicitly in Section 6, and estimate a "spillover-free" robustness check in Section 7 that excludes control municipalities sharing a border with places hosting oil or gas pipelines and find similar results. Finally, our estimates could suffer from omitted variable bias if treatment and control municipalities differ in ways that systematically affect pre- and post-treatment trends. In our preferred specifications, we include municipality and year fixed effects to reduce these concerns. In Section 7, we estimate a robustness check that limits the sample to treated and control municipalities that exactly matched on binned baseline characteristics, ensuring the two groups are comparable on observables, and find that results are strongly robust.

5 Results

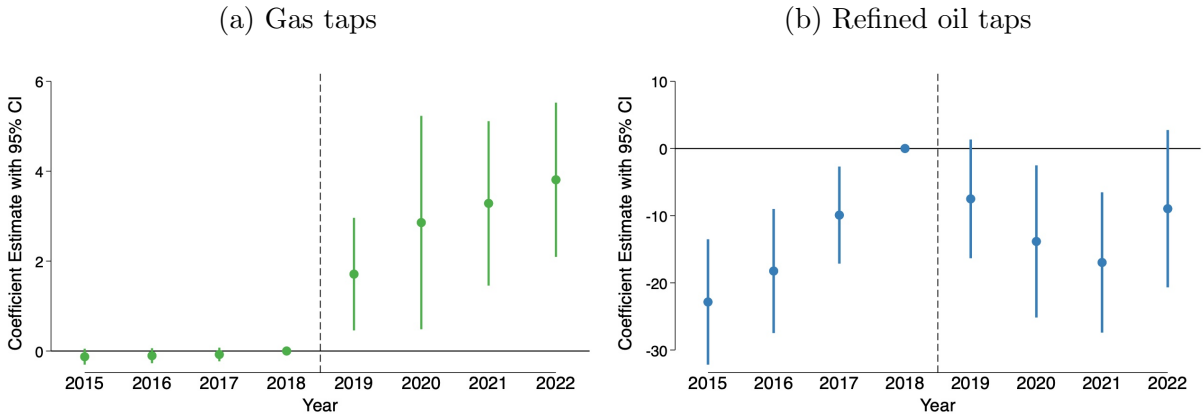
This section presents our main empirical results. We first show estimates of the crackdown's impact on the number of illegal taps reported on gas or refined oil pipelines. Next we show

effects on homicide rates in municipalities with gas or refined oil pipelines relative to non-pipeline municipalities. Finally, we show effects of the crackdown on cartel presence and other crimes.

5.1 Refined Oil and Gas Theft

Figure 4 reports estimated effects of the fuel theft crackdown on (a) illegal taps on gas pipelines and (b) illegal taps on refined oil pipelines. As shown in Panel a, there was effectively no trend in gas pipeline thefts prior to the 2019 crackdown, after which gas thefts increase significantly, rising by an average of 1.7 thefts per municipality-year in 2019 and by 3.8 thefts per municipality-year by 2022. As shown in Panel b, illegal taps on refined oil pipelines were trending sharply upwards in years preceding the military crackdown, which is precisely what triggered the crackdown in the first place. The strong pre-trend in this panel is thus to be expected. The 2019 crackdown temporarily reversed this upward trend, significantly reducing oil thefts for several years, before they began trending back toward previous levels in 2022.

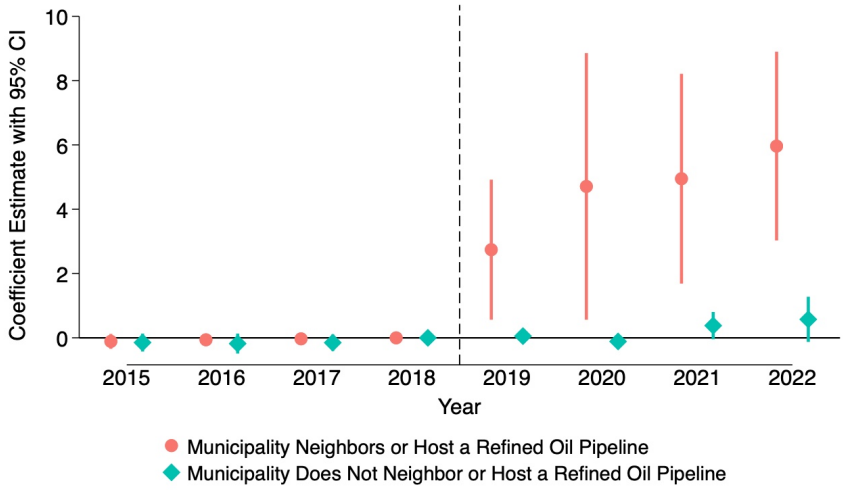
Figure 4: Effects of the Fuel Theft Crackdown on Illegal Pipeline Taps



Note: Figure reports coefficient estimates and 95% confidence intervals for (a) number of illegal taps reported on gas pipelines, and (b) number of illegal taps reported on refined oil (gas and diesel) pipelines, estimated using Equation 3. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

We next decompose gas thefts into those occurring near and far from places with oil pipelines. Results, reported in Figure 5, indicate that effectively all of the post-crackdown increase in gas pipeline thefts occurred in municipalities that neighbor or host a refined oil pipeline, confirming the importance of geographic proximity in enabling substitution between these distinct but technologically related criminal activities.

Figure 5: Crackdown Effects on Gas Thefts Near/Far from Oil Pipelines



Note: Figure reports coefficient estimates and 95% confidence intervals for the number of illegal gas taps (liquid petroleum gas or natural gas) reported in municipalities hosting gas pipelines, decomposed into two groups: (i) municipalities that neighbor or host a refined oil pipeline as well as a gas pipeline, and (ii) municipalities that do not neighbor or host a refined oil pipeline. Specification includes municipality and year fixed effects, and standard errors are clustered at the municipality level.

5.2 Homicides

Table 2 shows results from estimation of Equation 1 on homicide rates for different demographic groups. Column (1) shows the effect of the 2019 crackdown on overall homicides. We find that the intervention increased the homicide rate in municipalities with a gas pipeline by 4.1 per 100,000 inhabitants, representing an 18% increase over a baseline mean of 21.3. In oil pipeline municipalities, we find a positive but statistically insignificant effect on homicides, suggesting that the crackdown failed to reduce violence in these directly-targeted areas.

Columns (2)-(6) show crackdown effects across different demographic groups: male, female, Pemex employees, potentially cartel-related individuals, and military personnel. Estimates indicate that the post-crackdown rise in homicide rates in gas pipeline municipalities was driven by male and cartel-related homicides. We estimate an 18.5% increase in homicides among males and a 24.8% increase among cartel-related individuals. These increases may be the result of criminal groups fighting over territorial control of gas pipelines. We find no statistically significant effects of the crackdown on homicide rates among females, Pemex employees, or military members.

Figure 6 reports event study results from estimation of Equation 2 for the overall homicide rate. Panel (a) of this figure confirms pre/post estimates of the crackdown impact on homicides in municipalities with gas pipelines. The crackdown significantly increased homicides by 2.1 homicides per 100,000 residents in the year following the intervention, and by 4.8 additional

Table 2: Crackdown Effects on Homicides in Municipalities with Gas and Refined Oil Pipelines

	All	Male	Female	Pemex	Cartel	Military
	(1)	(2)	(3)	(4)	(5)	(6)
Gas pipeline × Post 2019	4.054***	3.491**	0.355	-0.007	2.125**	0.036
	(1.540)	(1.423)	(0.231)	(0.011)	(0.886)	(0.059)
Refined oil pipeline × Post 2019	4.222	3.796	0.253	-0.018	1.408	0.054
	(2.658)	(2.437)	(0.308)	(0.024)	(1.575)	(0.107)
Observations	19648	19648	19648	19648	19648	19648
Adj. R-squared	0.356	0.355	0.076	0.175	0.325	0.041
Mean dep. var.	21.31	18.87	2.30	0.02	8.58	0.05

Notes: This table reports coefficient estimates and standard errors from Equation 1. Dependent variables are measured as number of homicides per 100,000 inhabitants. Homicides of Pemex employees are estimated based on homicides of individuals of working age (18-60 years old) insured through Pemex. Potential cartel-related homicides are classified as males aged 18-40 killed by a firearm. Homicides of military personnel are estimated based on individuals insured through SEDENA, ages 18-60, and killed by a firearm. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

homicides in 2021. Moreover, we find no statistically significant effects or trends in homicide rates among gas pipeline municipalities prior to 2019, supporting the identifying parallel pre-trends assumption. Event study estimates of homicide rates disaggregated by demographic group are reported in Appendix Figure A2. Disaggregated results confirm that the significant post-crackdown increase in homicide rates in gas pipeline municipalities was driven by homicides of men. Since men are much more likely to be involved in organized crime and violence, this provides further evidence that violent conflict over control of gas pipelines was the underlying driver of the observed increase in homicides.

Panel (b) illustrates dynamic effects of the crackdown on municipalities hosting refined oil pipelines. As with oil thefts, there is an upward trend in homicide rates prior to the 2019, which is part of the reason the military crackdown focused on these areas. Though estimates are statistically insignificant, they suggest the crackdown halted the upward trend in homicide rates in oil pipeline municipalities, but failed to substantially reduce violence in these places.

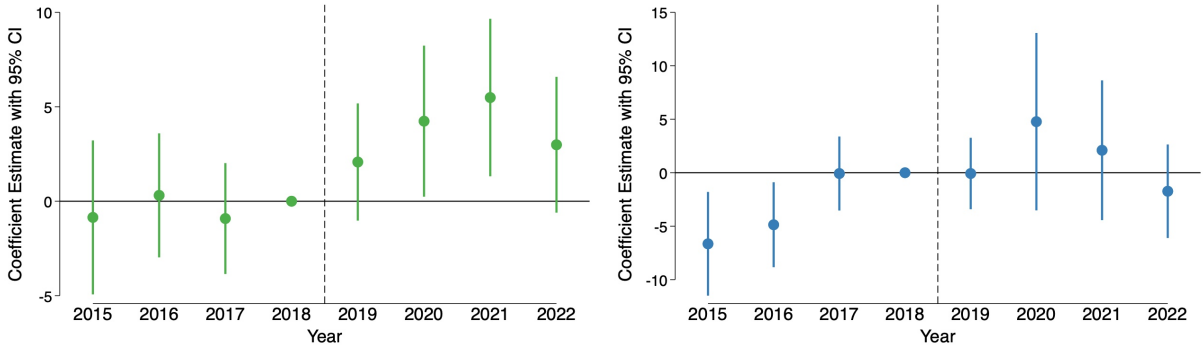
5.3 Cartel Presence

Table 3 shows estimated crackdown effects on cartel presence. Columns (1)-(3) report effects on the number of cartels (intensive margin), while Columns (4)-(6) report effects on a binary variable equal to one if at least one cartel is present in a municipality (extensive margin).

Following the military crackdown in 2019, the number of cartels operating in municipalities

Figure 6: Dynamic Crackdown Effects on Homicide Rates

(a) Gas Pipeline Municipalities (b) Refined Oil Pipeline Municipalities



Note: Figure reports coefficient estimates and 95% confidence intervals for homicide rates per 100,000 residents in (a) municipalities hosting gas pipelines and (b) municipalities hosting refined oil pipelines, relative to non-pipeline municipalities, estimated using Equation 2. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

with a gas pipeline increased, on average, by 17% (corresponding to an increase of 0.36 cartels). Similarly, Panel (a) of Figure 7 confirms that the average number of cartels in gas pipeline municipalities was mostly stable in years preceding 2019, and then exhibited statistically significant growth after the crackdown. In 2019, there were 0.31 additional cartels in these areas relative to pre-crackdown 2018 levels. By 2021, there were 0.44 additional cartels. As shown in Panel (b), municipalities with refined oil pipelines also experienced increased cartel activity for two years following the crackdown, followed by a reduction in average cartel presence in 2021. Strong upward pre-trends in cartel activity in municipalities with refined oil pipelines was, along with thefts and homicides, an endogenous driver of the 2019 crackdown in these places.

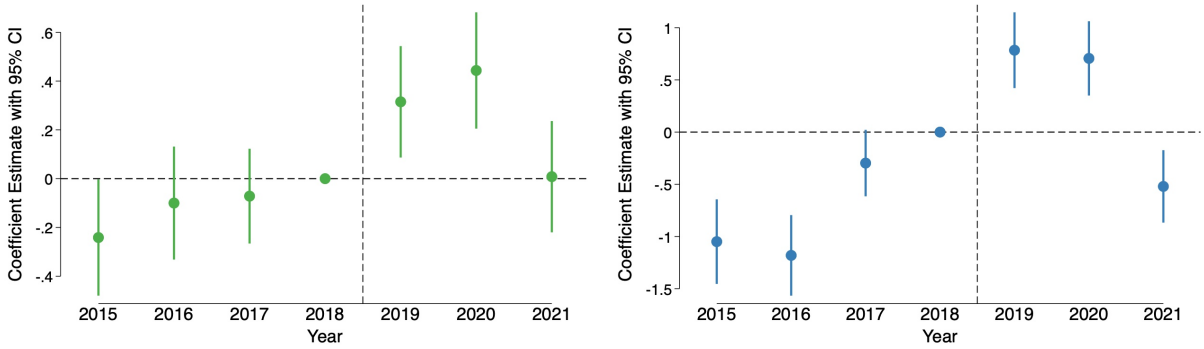
Table 3: Crackdown Effects on Cartel Presence

	Number of Cartels			Cartel Presence (1/0)		
	All	Huachicol Specialized	Non-Huachicol Specialized	All	Huachicol Specialized	Non-Huachicol Specialized
	(1)	(2)	(3)	(4)	(5)	(6)
Gas pipeline × Post 2019	0.360***	0.230***	0.130**	0.0339**	0.0420***	0.0355**
	(0.090)	(0.048)	(0.060)	(0.015)	(0.015)	(0.016)
Refined oil pipeline × Post 2019	0.957***	0.282***	0.675***	-0.00678	-0.00735	0.0491**
	(0.154)	(0.071)	(0.118)	(0.018)	(0.018)	(0.021)
Observations	17311	17311	17311	17311	17311	17311
Adj. R-squared	0.884	0.819	0.867	0.642	0.640	0.606
Mean dep. var.	2.024	1.164	0.860	0.408	0.384	0.252

Note: This table reports coefficient estimates and standard errors from estimation of Equation 1. In Column (1) the dependent variable measures total active cartels; in column (2) the dependent variable measures fuel theft-specialized cartels, and in column (3) the dependent variable measures non-fuel theft specialized cartels, where fuel-theft specialized cartels are identified from Etellekt Consultores (2016), Langner (2017), Castillo (2021), and González (2020). Columns (4)-(6) report results for analogous binary categories to assess the extensive margin of cartel presence. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 7: Dynamic Crackdown Effects on Cartel Presence

(a) Gas Pipeline Municipalities (b) Refined Oil Pipeline Municipalities



Note: Figure reports coefficient estimates and 95% confidence intervals for the number of active cartels in (a) municipalities hosting gas pipelines and (b) municipalities hosting refined oil pipelines, relative to non-pipeline municipalities, estimated using Equation 2. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

Drawing on media coverage and a research report, we identify nine cartels that are most prominently involved in fuel theft (Etellekt Consultores, 2016; Langner, 2017; Castillo, 2021; González, 2020).[8] Seven of these groups are large, well-established cartels responsible for 95% of all illegal fuel taps in 2016 (Etellekt Consultores, 2016), while the remaining two are smaller, local organizations also specialized in fuel theft (Castillo, 2021; González, 2020). Column (2) of Table 3 reports estimated crackdown effects on the number of these fuel theft-specialized cartels operating in gas pipeline municipalities. Results indicate that the crackdown increased the number of fuel theft-specialized cartels in gas pipeline areas by 19.8%, corresponding to an average of 0.23 more cartels of this type. Column (3) reports corresponding estimates for cartels that are not known to specialize in fuel theft. The effect of the crackdown was notably smaller among non-specialized cartels, suggesting cartels with previously accumulated experience in oil pipeline thefts were more likely to substitute toward gas pipeline theft. Similar patterns hold in columns (5) and (6), which report effects on binary indicators of cartel presence. Individual results for each of the nine fuel theft cartels are reported in Appendix Table A2).

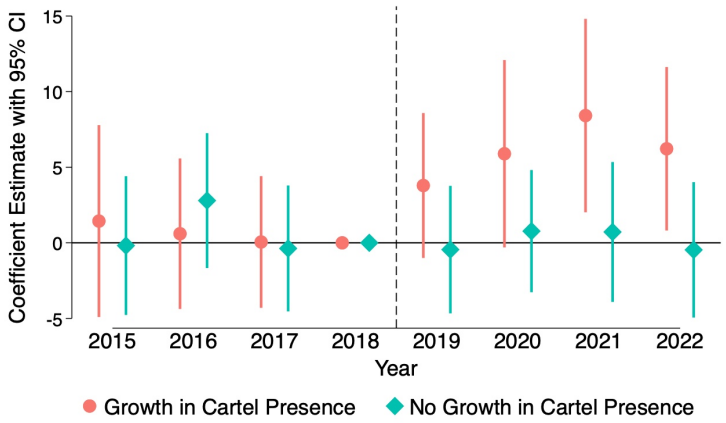
In Appendix Figure A4, we report analogous event study estimates that decompose crackdown effects on cartel presence between fuel theft-specialized and non-specialized cartels. Results indicate that, prior to 2019, trends in the presence of both types of cartels were parallel between (treated) gas pipeline municipalities and (control) non-pipeline municipalities. After the military crackdown, cartel presence in gas pipeline municipalities increased significantly among both

[8]The nine cartels identified as *huachicoleros* are the Cartel Jalisco Nueva Generación (CJNG), Los Zetas, the Gulf Cartel, the Sinaloa Cartel, the Beltrán Leyva Organization, La Familia Michoacana, Los Caballeros Templarios, the Cartel de Santa Rosa de Lima (CSRL), and La Unión León. The last two began as smaller criminal groups and gained power through gasoline theft.

specialized and non-specialized cartels, but point estimates are larger among specialized cartels, suggesting these groups moved more aggressively and/or were more successful in expanding their presence in gas pipeline areas.

Finally, Figure 8 reports effects of the crackdown on homicide rates, decomposed into (i) places where cartel presence increased following the crackdown and (ii) places where cartel presence remained unchanged. Results show that the post-crackdown increase in homicides in gas pipeline municipalities was clearly driven by places where new cartels entered, suggesting that cartel competition for new pipeline territories drove the increase in violence.

Figure 8: Gas Pipeline Municipalities: Correspondence between Growth in Cartel Activity and Homicide Rates



Note: Figure reports coefficient estimates and 95% confidence intervals for estimation of Equation 2 with two treatment indicators, defined as (i) municipalities with gas pipelines where the number of active cartels grew by at least one after the beginning of the crackdown, and (ii) municipalities with gas pipelines that did not experience post-crackdown cartel growth. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

5.4 Other Crimes

Table 4 shows estimated effects of the military crackdown on other criminal rates: robberies, kidnappings, threats, extortion, and non-lethal crimes (injuries and other crimes that threaten life). In gas pipeline municipalities, robberies and threats and extortion do not change in a statistically detectable way after the crackdown, but reported non-lethal violence increases by an average of 6.1 incidents per 100,000 residents, corresponding to a 6.4% increase following the crackdown. Interestingly, results show a decrease in kidnappings of 0.28 cases per 100,000 residents, corresponding to a 36.5% decline relative to the 2018 mean.[9]

[9]Self-reported data on other crimes should be interpreted with caution, considering that people may be less inclined to report crimes in places where organized criminal groups are active. Thus, reporting rates could differ between pre and post-crackdown periods, as the rate of cartel presence increased. This reporting issue is not a concern for homicide data, which are collected from death certificates.

Table 4: Crackdown Effects on Other Crimes

	Robberies	Kidnap	Threats & Extortion	Non-lethal Violence
	(1)	(2)	(3)	(4)
Gas pipeline × Post 2019	0.722	-0.287*	3.281	6.105**
	(8.472)	(0.151)	(2.869)	(3.021)
Refined oil pipeline × Post 2019	-49.28***	-0.345	0.228	-14.09***
	(12.926)	(0.244)	(3.999)	(4.249)
Observations	19648	19648	19648	19648
Adj. R-squared	0.838	0.119	0.526	0.736
Mean dep. var.	204.4	0.786	49.83	95.57

Note: Table reports coefficient estimates and standard errors from estimation of Equation 1. Dependent variables are measured as number of crimes per 100,000 inhabitants. Non-lethal violence consists of injuries and other crimes that threaten life. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

For municipalities hosting refined oil pipelines, results show that robberies and non-lethal violence decreased by 24.1% (49.28 fewer robberies per 100,000 residents) and 14.7% (14.09 fewer injuries per 100,000 residents), respectively. These results may be attributable to increased military and police presence from the crackdown. To verify this, we further decompose the robberies outcome by type of robbery: those targeting homes and businesses, highways and streets, machinery, and other (Table 5). In oil pipeline municipalities, the crackdown reduced the incidence of thefts on highways and streets by 27.7%, but had no significant effect on robbery rates focused on homes and business. These results suggest the post-crackdown reduction in robberies was likely driven by increased military surveillance on roads. Finally, results show that the crackdown increased thefts of machinery by 83% in gas pipeline municipalities – potentially reflecting increased thefts of equipment used for gas pipeline tapping.

Table 5: Crackdown Effects on Robberies (Disaggregated)

	Home & Business	Highway & Street	Machinery	Other
	(1)	(2)	(3)	(4)
Gas pipeline × Post 2019	-1.429	1.026	1.046***	2.201
	(2.878)	(4.714)	(0.283)	(3.408)
Refined oil pipeline × Post 2019	-6.933	-22.45***	-0.521	-18.22***
	(4.913)	(7.569)	(0.366)	(5.017)
Observations	19648	19648	19648	19648
Adj. R-squared	0.752	0.792	0.146	0.740
Mean dep. var.	48.13	80.80	1.255	65.83

Note: Table reports coefficient estimates and standard errors from estimation of Equation 1. Dependent variables are measured as number of robberies of specific types per 100,000 inhabitants. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Empirical Extensions

In this section, we explore spatial spillovers of the crackdown, additional heterogeneity analyses, and crackdown effects on socioeconomic development outcomes.

6.1 Spatial Spillovers to Neighbors

Besides diversifying into gas pipeline theft, cartels affected by the 2019 crackdown may have shifted spatially into neighboring municipalities to avoid military operations around oil pipelines. To test this possibility, we redefine treated municipalities to be those that (i) neighbor a municipality hosting a refined oil pipeline or (ii) neighbor a municipality hosting a gas pipeline. We exclude all municipalities that host pipelines, leaving non-neighbor, non-pipeline municipalities as controls. DiD results on homicides based on this specification are reported in Table 6.

Estimates show no effect of the crackdown on homicide rates in municipalities neighboring municipalities with gas pipelines. This is to be expected, since gas pipeline municipalities did not experience the military crackdown directly, and criminal groups operating in these areas were therefore not displaced. In contrast, we find large spillovers of violence into municipalities neighboring places with refined oil pipelines, with homicides increasing by 5.8 per 100 thousand residents, or 30%, in these places. Increased homicides are driven by homicides of men and potentially cartel-related cases. This suggests that our main estimates for refined oil municipalities may underestimate the true impact of the military crackdown on homicide rates, making our estimates conservative. Given that some municipalities neighbor both gas and refined oil pipeline

municipalities, the presence of spatial spillovers could still bias our overall estimates by contaminating the non-pipeline control group. To verify this, we estimate a robustness check wherein we exclude direct pipeline neighbors from the control group. Results, reported in the Appendix Tables A3, A4 and A5, are very similar to results from our preferred specification.

Table 6: Crackdown Effects on Homicides in Neighboring, Non-Pipeline Municipalities

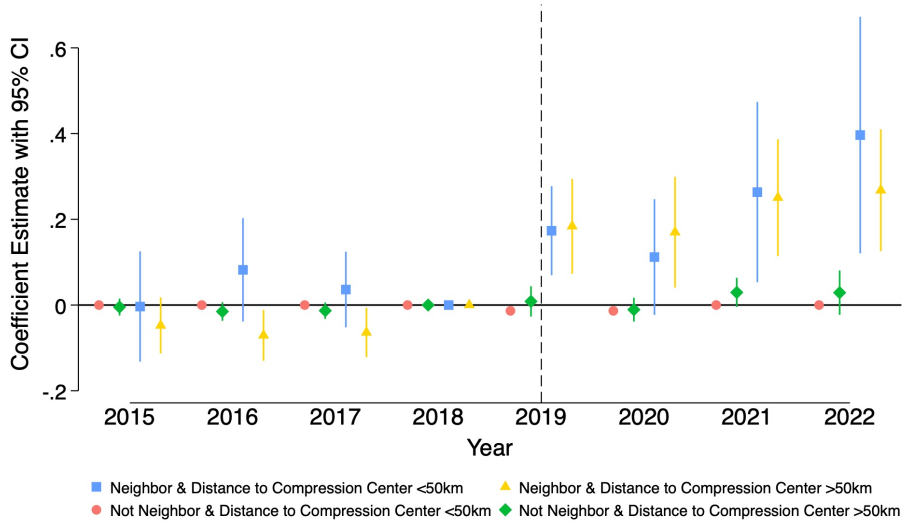
	All	Male	Female	Pemex	Cartel	Military
	(1)	(2)	(3)	(4)	(5)	(6)
Neighbor with gas pipeline × Post 2019	-1.303	-1.593	0.267	-0.00678	-0.621	0.00803
	(1.773)	(1.647)	(0.323)	(0.007)	(0.886)	(0.027)
Neighbor with refined oil pipeline × Post 2019	5.806**	5.631***	-0.0226	0.00294	2.091*	0.0819
	(2.369)	(2.125)	(0.449)	(0.007)	(1.190)	(0.068)
Observations	14352	14352	14352	14352	14352	14352
Adj. R-squared	0.327	0.331	0.0567	0.100	0.294	0.00214
Mean dep. var.	19.56	17.33	2.141	0.00461	7.570	0.0372

Notes: Table reports coefficient estimates and standard errors measuring spillovers of the 2019 crackdown onto homicide rates in municipalities neighboring municipalities that host refined oil or gas pipelines. The sample is restricted to municipalities with no refined oil or gas pipelines. The specification thus compares outcomes between non-pipeline neighbors (treated) and non-pipeline non-neighbors (controls). Dependent variables are measured as homicides per 100,000 inhabitants. Homicides of Pemex employees are estimated based on homicides of individuals of working age (18-60 years old) insured through Pemex. Potential cartel-related homicides are males aged 18-40, killed by a firearm. Homicides of military personnel are estimated based on individuals insured through SEDENA, ages 18-60, and killed by a firearm. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6.2 Distance to a Gas Compression Center

Based on media reporting that gas pipeline theft is easier in places where gas pressure is higher (Nájar, 2019), we compute the distance between each municipality centroid and the nearest gas compression center (facilities that maintain gas pressure along pipelines). We then re-estimate event studies of gas pipeline thefts around the 2019 crackdown for places near (<50km) and far (>50km) from a compression center. We estimate a four-way specification to explore the joint effects of neighboring an oil pipeline (where spatial substitution from oil theft to gas theft is easier) and neighboring a compression center. Results, reported in Figure 9, indicate that post-crackdown increases in illegal gas taps are driven by proximity to oil pipelines, with no significant difference in effects based on proximity to a compression center.

Figure 9: Heterogeneity in Gas Pipeline Thefts, by Neighboring/Not-Neighboring an Oil Pipeline and Near/Far from a Gas Compression Center



Note: Figure reports coefficient estimates and 95% confidence intervals for an event study specification with municipality and year fixed effects and four treatment interactions: neighbor/non-neighbor × near/far from a gas compression center. Near/far is defined using a 50km radius cutoff. Neighbors are defined as municipalities that are adjacent to or that themselves contain an oil pipeline. Standard errors are clustered at the municipality-level.

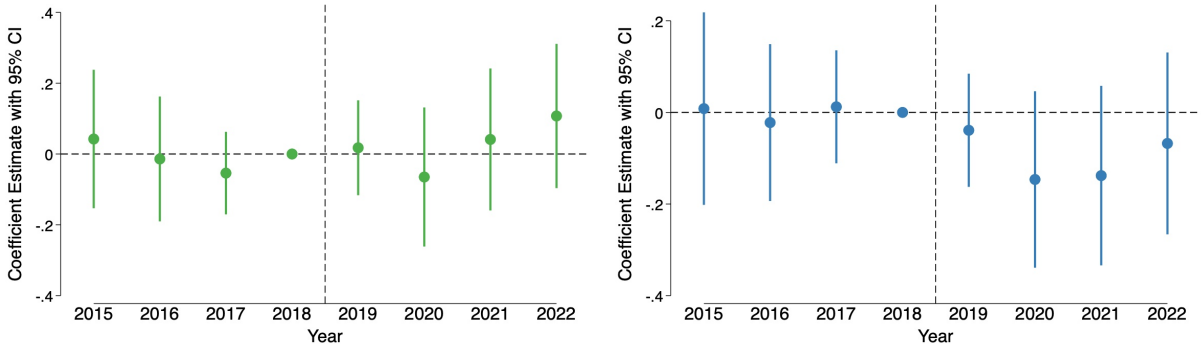
6.3 Socioeconomic Development Outcomes

Finally, we explore effects of the 2019 fuel theft crackdown on socioeconomic development indicators: the share of the population with formal employment (a measure of economic development) and the share of the population enrolled in higher education (a proxy for availability of illicit alternatives to studying). While strong cartel presence and pipeline theft may harm economic activity and draw students away from school, pipeline theft also subsidizes local fuel prices and brings money into communities, potentially boosting economic activity.

We estimate event studies around the crackdown to assess these dynamics. Results, reported in Figures 10 and 11, indicate that the crackdown had no statistically significant effect on formal employment or higher-education enrollment at the 5% level, with the exception of a significant positive coefficient estimate for higher-education enrollment in oil pipeline municipalities in 2021. Based on weakly significant estimates, there is suggestive evidence the crackdown was associated with a downward trend in formal employment in municipalities with oil pipelines, as well as a downward trend in higher-education enrollment in gas pipeline municipalities. This latter decline was concentrated in municipalities neighboring oil pipelines, where cartel activity increased the most (see Appendix Figure A5). These findings suggest that proliferation of cartels into gas pipeline municipalities may have drawn youths out of education and into cartel involvement.

Figure 10: Crackdown Effects on the Share of Population with Formal Employment

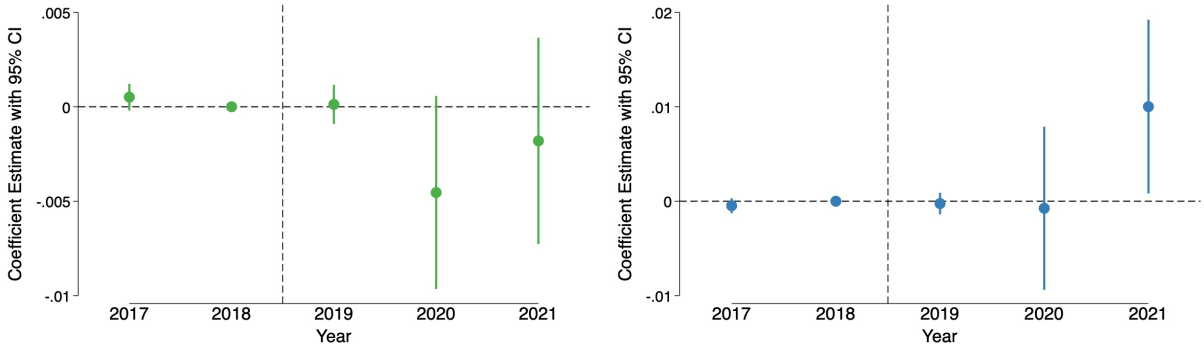
(a) Gas Pipeline Municipalities (b) Oil Pipeline Municipalities



Note: Figure reports coefficient estimates and 95% confidence intervals for the share of the population (out of 1) holding formal employment in (a) municipalities hosting gas pipelines and (b) municipalities hosting refined oil pipelines, relative to non-pipeline municipalities, estimated using Equation 2. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

Figure 11: Crackdown Effects on the Share of Population Enrolled in Higher Education

(a) Gas Pipeline Municipalities (b) Oil Pipeline Municipalities



Note: Figure reports coefficient estimates and 95% confidence intervals for the share of the population (out of 1) enrolled in higher education in (a) municipalities hosting gas pipelines and (b) municipalities hosting refined oil pipelines, relative to non-pipeline municipalities, estimated using Equation 2. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

7 Robustness Checks

In this section, we implement a variety of alternative specifications to assess the robustness of our main results. First, we re-estimate DiD and event study specifications using log-transformed outcomes, which are less influenced by extreme values. Log-transforming outcomes introduces difficulties in the presence of heteroskedasticity and large proportions of zero-value outcomes, as is our case (Manning and Mullahy, 2001; Silva and Tenreyro, 2006). In DiD models, this can result in level and log-transformed specifications yielding coefficient estimates with different signs (McConnell, 2024). Log-transformed results reported in Appendix Tables A6 and A7 are very similar to our preferred estimates. For other crime outcomes, we find evidence of sign-switching

(Appendix Table A8).

Second, we address concerns that municipalities with pipeline infrastructure may have been chosen to host this infrastructure for endogenous reasons and may exhibit systematically different trends. To do so, we implement a Coarsened Exact Matching (CEM) procedure (Iacus et al. (2012)) to restrict the sample of treated municipalities (those with pipelines) and control municipalities to those that match on pre-treatment characteristics, thus ensuring that treated and control municipalities are comparable places. We match municipalities exactly on state and quintiles of pre-treatment (2015-2018) homicide rates, number of active cartels, formal employment share, population, and income level. Results, reported in Appendix Figure Appendix Figure A6, are strongly robust to this restriction.

Third, we estimate a "spillover free" specification to ensure that spillovers of the crackdown into neighboring places do not bias our main estimates. To do so, we exclude all non-pipeline control municipalities that border places with refined oil or gas pipelines, leaving only non-pipeline, non-neighbor places as controls. Results, presented in Tables A3, A4, and A5, show that our main estimates for homicides, cartel presence, and other crimes are robust to this restriction.

Finally, a potential concern regarding the precision of our results is that we lack precise information on specific locations targeted in the 2019 military crackdown on fuel theft. We designate all municipalities with refined oil pipelines as directly treated in the crackdown, while in reality only a subset of these were directly targeted. Unfortunately, detailed information on exact municipalities where crackdown operations took place is classified. Through several Freedom of Information requests to Mexico's Ministry of Defense and other institutions, we were able to obtain records of which municipalities received deployments of military personnel to combat pipeline thefts in 2022 and 2023, which is several years after the crackdown. While we thus lack time-varying or contemporaneous data on exact crackdown locations, we use the data on 2022-2023 military presence as a proxy. Using these data, we re-estimate specifications incorporating an interaction term indicating whether military personnel were deployed in a municipality in 2022 or 2023. Results are reported in Appendix Tables A9, A10 and A11. Our main coefficients of interest are strongly robust to inclusion of this interaction term. However, coefficients on the interaction term itself are insignificant, indicating that military operations reported in 2022-2023 are not useful proxies for areas targeted in 2019.

8 Conclusions

Organized criminal groups impose significant costs on communities where they operate, including reduced economic growth and violence (Fenizia and Saggio, 2024; Daniele et al., 2023). However, criminal groups can also deliver benefits that appeal to local residents (Blattman et al., 2023), including cheap black market fuels obtained through pipeline thefts. Broader consequences of pipeline theft include enrichment and empowerment of criminal organizations (May, 2017) and loss of government revenues that could otherwise be spent on much-needed public goods provision (Solis, 2018).

Using rich data on crime and cartel presence combined with detailed maps of Mexico's pipeline infrastructure, we document that the Mexican government's heavy-handed military crackdown on oil pipeline theft in 2019 did succeed in temporarily reducing oil thefts, but failed to root out violence or cartel presence in targeted areas. Furthermore, it encouraged criminal organizations – especially those with prior experience in oil theft – to diversify into thefts from nearby gas pipelines. Theft of highly-pressurized gas products is a much more technologically advanced operation than oil theft, requiring deeper collaboration by corrupt pipeline operators and frequently resulting in fires and explosions. Cartels' shift into gas theft required them to expand geographically and compete over gas pipeline territories, leading to significant increases in cartel presence (+17%) in these areas. In turn, competition over pipelines unleashed violence, with homicide rates in gas pipeline municipalities growing by 18% after the crackdown. Cartels also responded to the fuel theft crackdown by expanding their reach into neighboring, non-pipeline municipalities, leading to a 30% increase in homicide rates in these places. Overall we calculate that the 2019 military crackdown on fuel theft *increased* net rates of violence in Mexico, accounting for approximately 15% of all homicides recorded in the country between 2019 and 2022.

These findings have implications for the design of policies focused on combating organized crime and pipeline theft. First, the military's approach of shutting down high-theft pipelines and re-routing fuel shipments through tanker trucks led to spikes in local fuel prices. These crackdown-driven price spikes may have further incentivized pipeline thefts and eroded local support for enforcement efforts. Furthermore, pipeline shutdowns and truck convoys were a temporary solution that did not address root issues such as poor monitoring of pipeline corridors, infiltration and corruption of pipeline operators, and lack of local economic opportunities besides fuel theft (Crisis Group, 2022). As a result, pipeline theft rates rapidly bounced back after the crackdown ended.

By increasing the risks of oil pipeline theft but leaving gas pipelines unguarded, the crackdown

changed the cost-benefit calculus of gas pipeline theft, prompting cartels to overcome fixed costs of entry (e.g., acquiring new equipment, co-opting new operators) into this more advanced and dangerous activity. Evidently, operation and protection of pipelines must be consistent and professionalized across all pipeline modalities to avoid infiltration, deter pipeline taps, and rapidly detect and repair taps where they occur. Ultimately, governments must maintain state control over areas hosting energy infrastructure and promote formal economic opportunities for residents such that criminal groups struggle to take hold. This may involve channeling oil and gas revenues toward communities hosting pipeline infrastructure to create shared incentives for protection and maintenance of pipelines.

References

Adishi, E. and Hunga, M. O. (2017). Oil theft, illegal bunkering and pipeline vandalism: It's impact on Nigeria economy, 2015–2016. *International Journal of Economics and Business Management*, 3(2):47–65.

Angrist, J. D. and Kugler, A. D. (2008). Rural windfall or a new resource curse? Coca, income, and civil conflict in Colombia. *The Review of Economics and Statistics*, 90(2):191–215.

Battiston, G., Daniele, G., Le Moglie, M., and Pinotti, P. (2022). Fueling organized crime: The Mexican War on Drugs and oil thefts.

Berman, N., Couttenier, M., Rohner, D., and Thoenig, M. (2017). This mine is mine! how minerals fuel conflicts in africa. *American Economic Review*, 107(6):1564–1610.

Blattman, C., Duncan, G., Lessing, B., and Tobón, S. (2023). Gang rule: Understanding and countering criminal governance. *NBER Working Paper Series*, (28458).

Caballero-Morales, S. and Martínez-Flores, J. (2019). A facility allocation-location approach to analyze the capability of the state-owned mexican petroleum company to respond to the closure of pipelines. *Paternina-Arboleda, C., Voß, S. (eds) Computational Logistics. ICCL 2019. Lecture Notes in Computer Science*, 11756.

Calderón, G., Robles, G., Díaz-Cayeros, A., and Magaloni, B. (2015). The beheading of criminal organizations and the dynamics of violence in Mexico. *Journal of Conflict Resolution*, 59(8):1455–1485.

Carranza Garcia, F. and Esposito, A. (2019). Mexico offensive against fuel theft leaves motorists stranded. *Reuters*.

Castillo, G. (2021). La Unión León, nuevo factor que aumenta la violencia en Guanajuato. *La Jornada*. Available at https://www.jornada.com.mx/notas/2021/01/17/politica/la-union-leon-nuevo-factor-que-aumenta-la-violencia-en-guanajuato/ (Accessed on June 27, 2024).

CENAPRED (2021). Analis de acidentes con gas lp. Centro Nacional de Prevencion de Desastres.

Chimeli, A. B. and Soares, R. R. (2017). The use of violence in illegal markets: Evidence from mahogany trade in the Brazilian Amazon. *American Economic Journal: Applied Economics*, 9(4):30–57.

CNH (2019). Mapa Interactivo de Hidrocarburos. Available at https://mapa.hidrocarburos.gob.mx/.

CRE (2023). Precios promedio de combustibles. Comisión Reguladora de Energía.

Crisis Group (2022). Keeping oil from the fire: Tackling mexico's fuel theft racket. *Crisis Group*.

Cultura Colectiva (2019). Los ingenieros de Pemex nos dan todo: así trabaja un huachicolero. https://culturacolectiva.com/especiales/los-ingenieros-de-pemex-nos-dan-todo-asi-trabaja-un-huachicolero.

Daniele, G., Le Moglie, M., and Masera, F. (2023). Pains, guns and moves: The effect of the u.s. opioid epidemic on mexican migration. *Journal of Development Economics*, 160:102983.

De Haro Lopez, I. (2023). Avocados: Mexico's green gold. the U.S. opioid crisis and its impact on Mexico's drug cartel violence. Working Paper. Available at SSRN: https://ssrn.com/abstract=4366356.

Dell, M. (2015). Trafficking networks and the mexican drug war. *American Economic Review*, 105(6):1738–79.

Dube, O. and Vargas, J. F. (2013). Commodity price shocks and civil conflict: Evidence from Colombia. *The Review of Economic Studies*, 80(4):1384–1421.

Etellekt Consultores (2016). Situación actual y perspectivas sobre el robo de hidrocarburos en México 2016. Available at http://www.etellekt.com/reporte/etellekt_robo_de_combustibles_2016.html.

Fenizia, A. and Saggio, R. (2024). Organized crime and economic growth: Evidence from municipalities infiltrated by the mafia. *American Economic Review (forthcoming)*.

González, M. (2020). El robo de combustibles en México: cómo es la peligrosa práctica que desangra a Pemex y al país (y cuál ha sido la respuesta de AMLO). *BBC News Mundo*. Available at https://www.bbc.com/mundo/noticias-america-latina-53174707 (Accessed on June 27, 2024).

Herrera, J. S. and Martinez-Alvarez, C. B. (2022). Diversifying violence: Mining, export-agriculture, and criminal governance in Mexico. *World Development*, 151:105769.

Iacus, S. M., King, G., and Porro, G. (2012). Causal inference without balance checking: Coarsened exact matching. *Political Analysis*, 20(1):1–24.

INEGI (2022). Censo nacional de gobierno federal 2022. *INEGI*.

Jones, N. (2013). The unintended consequences of kingpin strategies: Kidnap rates and the Arellano-Felix Organization. *Trends in Organized Crime*, 16(2):156–176.

Kugler, Maurice, V. T. and Zenou, Y. (2005). Organized crime, corruption and punishment. *Journal of Public Economics*, 89:1639– 1663.

Langner, A. (2017). Cárteles controlan 95% de tomas clandestinas. *El Economista*. Available at: https://www.eleconomista.com.mx/politica/Carteles-controlan-95-de-tomas-clandestinas-20170516-0050.html (Accessed on June 27, 2024).

López Cruz, I. and Torrens, G. (2023). Hidden drivers of violence diffusion: Evidence from illegal oil siphoning in Mexico. *Journal of Economic Behavior & Organization*, 206:26–70.

Magaloni, B., Robles, G., Matanock, A. M., Diaz-Cayeros, A., and Romero, V. (2020). Living in fear: the dynamics of extortion in Mexico's drug war. *Comparative Political Studies*, 53(7):1124–1174.

Manning, W. G. and Mullahy, J. (2001). Estimating log models: to transform or not to transform? *Journal of health economics*, 20(4):461–494.

May, C. (2017). Transnational crime and the developing world. *Global Financial Integrity*.

McConnell, B. (2024). Bias in difference-in-difference models with log-transformed dependent variables. *Working Paper*. Available at http://brendonmcconnell.github.io/pdf/logDD.pdf.

McDonnell, P. and Linthicum, K. (2019). Mexico's president vows to 'eradicate' gas theft amid the horror of pipeline explosion. *Los Angeles Times*. Accessed on Jan. 31st, 2024; URL: https://www.latimes.com/world/la-fg-mexico-pipeline-fire-20190119-story.html.

Mineo, L. (2022). Stopping toxic flow of gun traffic from U.S. to Mexico. Available at https://news.harvard.edu/gazette/story/2022/02/stopping-toxic-flow-of-gun-traffic-from-u-s-to-mexico/.

Mirenda, Literio, M. S. R. L. (2022). The economic effects of mafia: Firm level evidence. *American Economic Review*, 112(8):2748–2773.

Nájar, A. (2019). Pemex: "gaschicol"', el nuevo y productivo negocio de los carteles en México. *BBC News Mundo - Mexico*.

Parker, D. P. and Vadheim, B. (2017). Resource cursed or policy cursed? US regulation of conflict minerals and violence in the Congo. *Journal of the Association of Environmental and Resource Economists*, 4(1):1–49.

Ralby, I. (2017). Downstream oil theft: global modalities, trends, and remedies. www.jstor.org/stable/resrep03694. Accessed on September 13, 2019.

Rexer, J. (2023). Corruption as a local advantage: Evidence from the indigenization of nigerian oil. *American Economic Review (forthcoming)*.

Rexer, J. and Hvinden, E. (2023). Violence and black markets: Evidence from the Niger Delta conflict. *CEPR Discussion Paper*.

Semple, K. (2019). Mexico's fuel thieves become more violent as government clamps down. *The New York Times*. Available at: https://www.nytimes.com/2019/01/21/world/americas/mexico-pipeline-disaster-gas-crisis.html.

Silva, J. S. and Tenreyro, S. (2006). The log of gravity. *The Review of Economics and statistics*, 88(4):641–658.

Solis, J. (2018). Pemex reconoce más pérdidas por robo de combustible durante 2018. *Forbes Mexico*.

Specia, M. (2019). Long lines and guarded fuel: Mexico's gas crisis, explained. *New York Times*.

Tapia Cervantes, P. (2021). Mercado ilegal de combustibles deja una pérdida de 64 mil mdp al fisco: Sat. *Forbes Mexico*.

Torres, E. (2017). Los empresarios admiten que compran gasolina a huachicoleros. *Expansion*. Accessed on May 5, 2023.

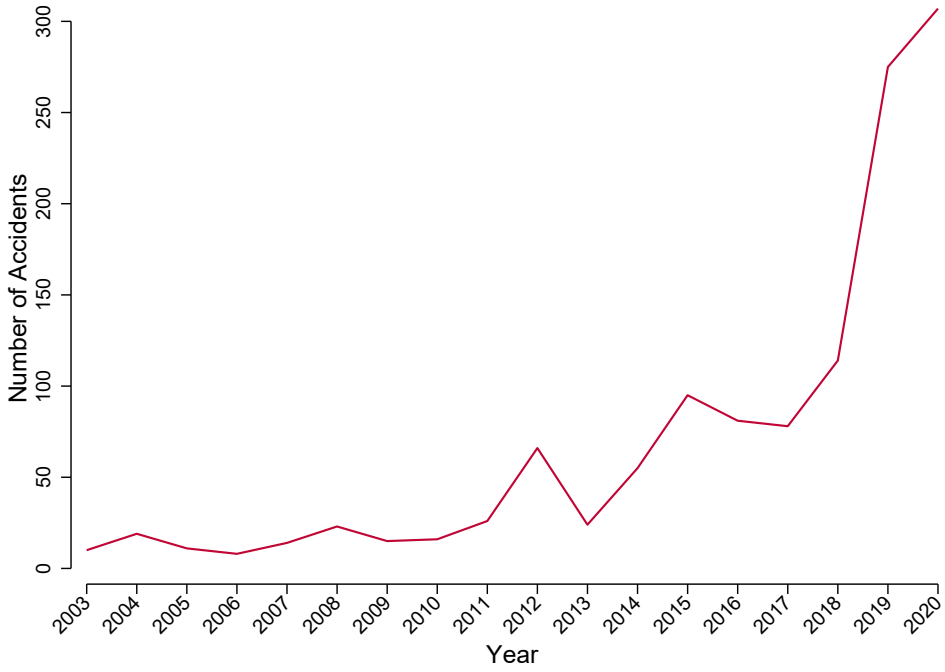
Usla, H. (2022). Huachigas: se roban 50 mil toneladas mensuales de gas LP en México. *El Financiero*. Available at: https://www.elfinanciero.com.mx/economia/2022/11/30/huachigas-se-roban-50-mil-toneladas-mensuales-de-gas-lp-en-mexico/ (Accessed: April 29, 2023).

Yeeles, A. and Akporiaye, A. (2016). Risk and resilience in the nigerian oil sector: The economic effects of pipeline sabotage and theft. *Energy Policy*, 88:187–196.

Appendix

A1 Tables and Figures

Figure A1: Gas-Related Accidents



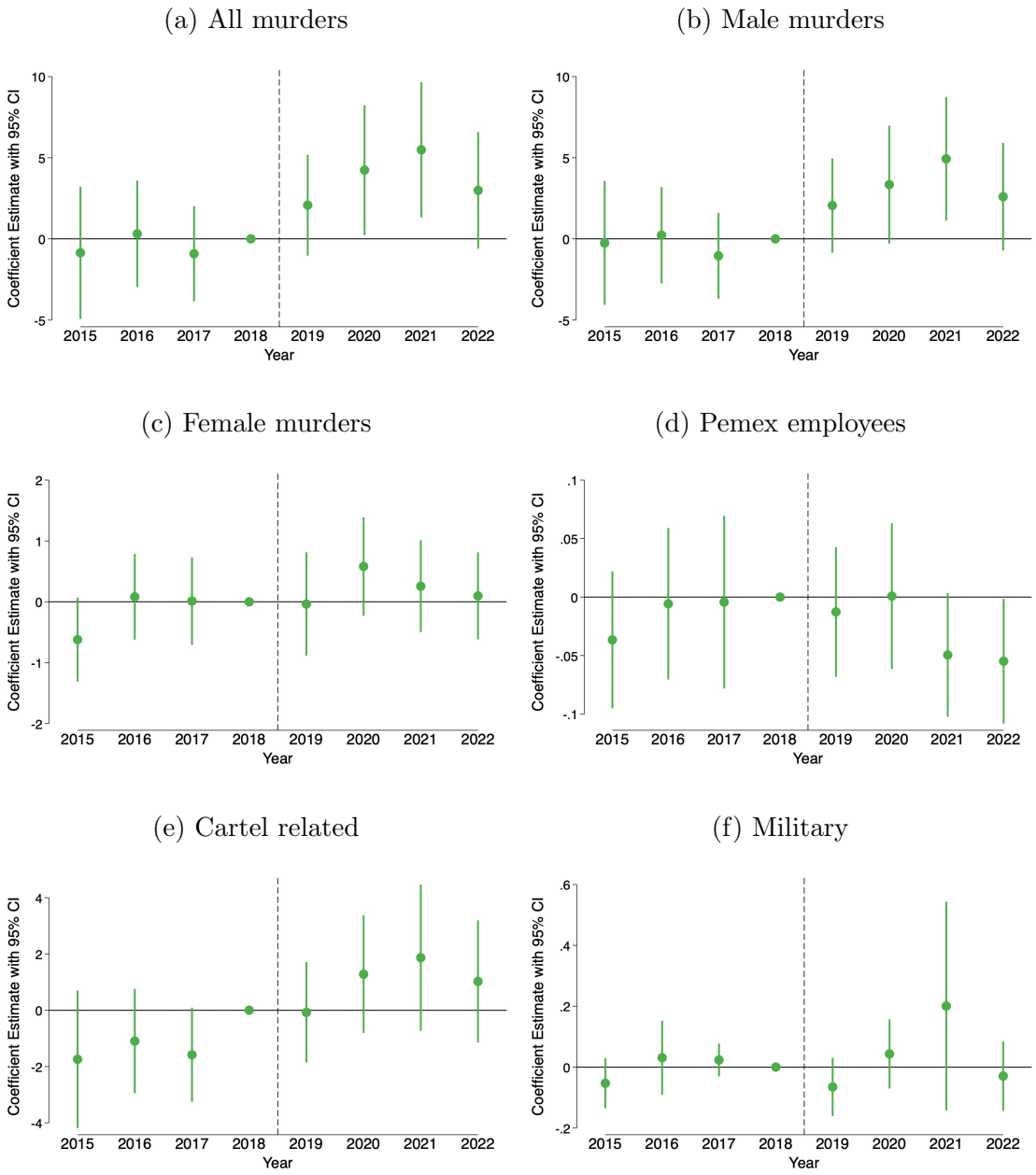
Note: Data are drawn from Mexico's National Center for Disaster Prevention (CENAPRED, 2021). Gas related accidents include fires, explosions, and other accidents.

Table A1: Sensitivity of Gas and Refined Oil Thefts to Fuel Prices

		Dependent Variable	
		Illegal Oil Taps	Illegal Gas Taps
		(1)	(2)
(a) Mexican Gasoline & Diesel Price	*Coef.*	0.520***	0.107***
	St. Err.	(0.072)	(0.025)
(b) Mexican LPG Price	*Coef.*	0.132**	0.022
	St. Err.	(0.058)	(0.027)
(c) Brent World Oil Price	*Coef.*	0.378***	0.069***
	St. Err.	(0.052)	(0.019)

Note: Table presents coefficient estimates and standard errors in parentheses from the regression of (column 1) number of illegal taps on refined oil pipelines or (column 2) number of illegal taps on gas pipelines reported in a particular municipality-month on municipality fixed effects and monthly prices series for (panel a) the country-level mean gasoline and diesel retail price, (panel b) the country-level mean liquid petroleum gas (LPG) retail price, and (panel c) the Brent Crude world oil price, which moves exogenously to local events in Mexico. Standard errors are clustered at the municipality-level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure A2: Crackdown Effects on Homicides in Municipalities with Gas Pipelines (Disaggregated)



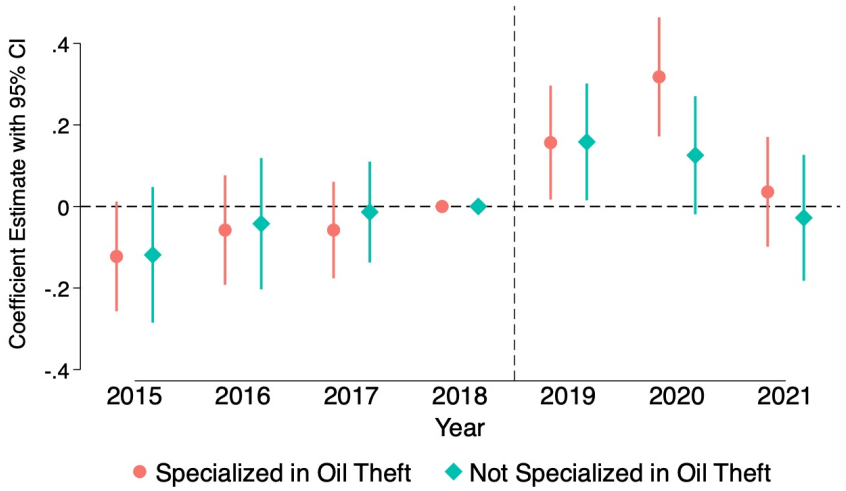
Note: Figure reports coefficient estimates and 95% confidence intervals for homicide rates per 100,000 residents among (a) all residents, (b) males, (c) females, (d) Pemex employees, (e) likely cartel-related murders, and (f) military personnel, estimated using Equation 2. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

Table A2: Crackdown Effects on Cartel Presence in Municipalities with Refined Oil and Gas Pipelines (Disaggregated by Cartel)

	CJNG	Zetas	Golfo	Sinaloa	BLO	Fam. Mich.	Templarios	Juarez	CSRL	Union Leon
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Gas pipeline × Post 2019	0.0609***	0.0164	0.0341***	0.0495***	0.00940	0.00957	0.00431	0.0148*	0.0302**	0.000972
	(0.016)	(0.013)	(0.013)	(0.013)	(0.009)	(0.010)	(0.009)	(0.008)	(0.012)	(0.003)
Refined Oil pipeline × Post 2019	-0.00888	0.000793	0.0546***	0.00126	0.0500***	0.0206	0.0260	0.00420	0.116***	0.0167***
	(0.019)	(0.018)	(0.020)	(0.018)	(0.015)	(0.018)	(0.017)	(0.014)	(0.020)	(0.006)
Observations	17311	17311	17311	17311	17311	17311	17311	17311	17311	17311
Adj. R-squared	0.624	0.550	0.540	0.566	0.596	0.571	0.556	0.536	0.470	0.439
Mean dep. var.	0.273	0.178	0.124	0.172	0.101	0.108	0.0941	0.0532	0.0577	0.00335

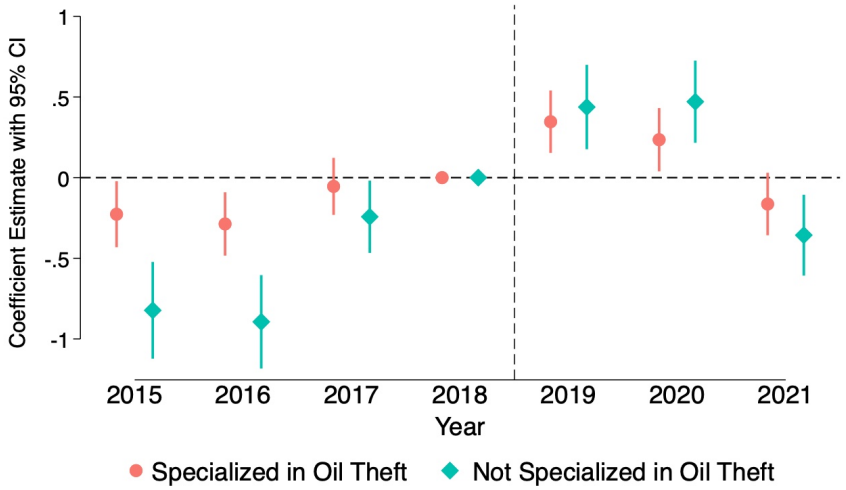
Note: This table reports coefficient estimates and standard errors from estimation of Equation 1. The dependent variables are dichotomous variables equal to one if the respective cartel is present in a municipality in a year. CJNG stands for Cartel Jalisco Nueva Generación, BLO for Bentrál Leyva Organization, Fam. Mich. for La Familia Michoacana, and CSRL for Cartel Santa Rosa de Lima. Clustered standard errors at the municipality level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure A3: Crackdown Effects on Cartel Presence in Gas Pipeline Municipalities, by Cartel Type



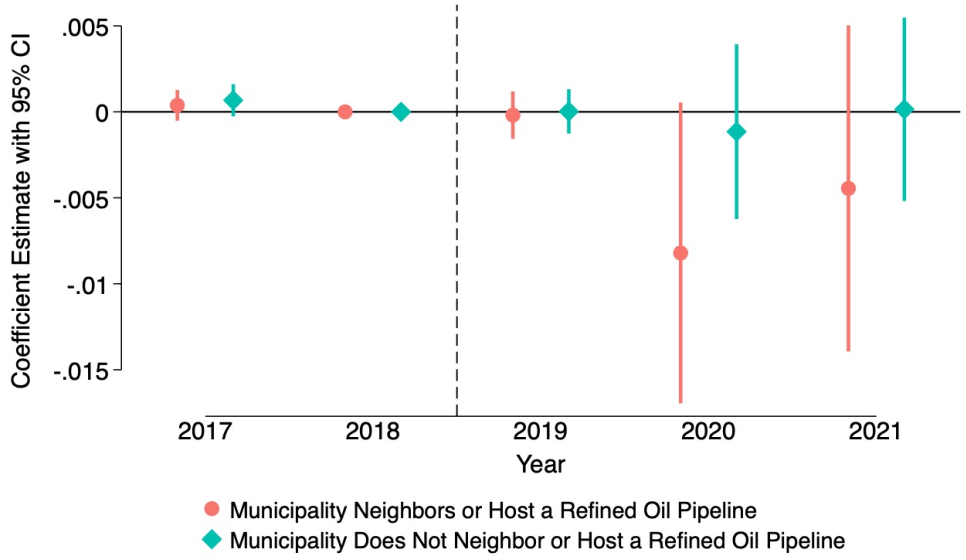
Note: Figure presents coefficient estimates and 95% confidence intervals from estimation of Equation 2, with outcomes disaggregated into the number of active cartels specialized in oil theft and other cartels. Treatment is defined as being a municipality with a GAS pipeline. Standard errors are clustered at the municipality-level. Fuel-theft-specialized cartels are identified from media and reports (Etellekt Consultores, 2016; Langner, 2017; Castillo, 2021; González, 2020).

Figure A4: Crackdown Effects on Cartel Presence in Oil Pipeline Municipalities, by Cartel Type



Note: Figure presents coefficient estimates and 95% confidence intervals from estimation of Equation 2, with outcomes disaggregated into the number of active cartels specialized in oil theft and other cartels. Treatment is defined as being a municipality with an OIL pipeline. Standard errors are clustered at the municipality-level. Fuel-theft-specialized cartels are identified from media and reports (Etellekt Consultores, 2016; Langner, 2017; Castillo, 2021; González, 2020).

Figure A5: Crackdown Effects on Enrollment in Higher Education in Gas Pipelines Municipalities, Decomposed by Neighboring/Not-Neighboring an Oil Pipeline



Note: Figure reports coefficient estimates and 95% confidence intervals for the share of the population (out of 1) enrolled in higher education in municipalities hosting gas pipelines, relative to non-pipeline municipalities, estimated using Equation 2. Treatment is decomposed into places that neighbor or host a refined oil pipeline and places that do not. Specification includes municipality and year fixed effects. Standard errors are clustered at the municipality level.

Table A3: No-Neighbors Analysis: Crackdown Effects on Homicides

	All	Male	Female	Pemex	Cartel	Military
	(1)	(2)	(3)	(4)	(5)	(6)
Gas pipeline × Post 2019	4.329***	3.756***	0.341	-0.007	2.192**	0.045
	(1.555)	(1.439)	(0.234)	(0.011)	(0.895)	(0.059)
Refined oil pipeline × Post 2019	4.359	3.928	0.246	-0.018	1.442	0.058
	(2.663)	(2.442)	(0.309)	(0.025)	(1.578)	(0.107)
Observations	18088	18088	18088	18088	18088	18088
Adj. R-squared	0.365	0.360	0.077	0.177	0.321	0.050
Mean dep. var.	21.29	18.88	2.27	0.02	8.59	0.05

Note: This table reports coefficient estimates and standard errors from Equation 1. This specification drops all non-pipeline municipalities that are adjacent to a municipality with a refined oil or gas pipeline to avoid bias introduced by potential spillovers into these control units. Dependent variables are measured as number of homicides per 100,000 inhabitants. Homicides of Pemex employees are estimated based on homicides of individuals of working age (18-60 years old) insured through Pemex. Potential cartel-related homicides are classified as males aged 18-40 killed by a firearm. Homicides of military personnel are estimated based on individuals insured through SEDENA, ages 18-60, and killed by a firearm. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A4: No-Neighbors Analysis: Crackdown Effects on Cartel Presence

	Number of Cartels			Cartel Presence (1/0)		
	All	Huachicol Specialized	Non-Huachicol Specialized	All	Huachicol Specialized	Non-Huachicol Specialized
	(1)	(2)	(3)	(4)	(5)	(6)
Gas pipeline × Post 2019	0.405***	0.258***	0.147**	0.0412***	0.0497***	0.0425***
	(0.091)	(0.048)	(0.060)	(0.015)	(0.015)	(0.016)
Refined oil pipeline × Post 2019	0.988***	0.300***	0.687***	-0.00287	-0.00327	0.0531**
	(0.155)	(0.071)	(0.119)	(0.018)	(0.018)	(0.021)
Observations	15827	15827	15827	15827	15827	15827
Adj. R-squared	0.888	0.825	0.872	0.646	0.644	0.618
Mean dep. var.	2.057	1.166	0.890	0.405	0.380	0.252

Note: This table reports coefficient estimates and standard errors from Equation 1. This specification drops all non-pipeline municipalities that are adjacent to a municipality with a refined oil or gas pipeline to avoid bias introduced by potential spillovers into these control units. In Column (1) the dependent variable measures total active cartels; in column (2) the dependent variable measures fuel theft-specialized cartels, and in column (3) the dependent variable measures non-fuel theft specialized cartels, where fuel-theft specialized cartels are identified from Etellekt Consultores (2016), Langner (2017), Castillo (2021), and González (2020). Columns (4)-(6) report results for analogous binary categories to assess the extensive margin of cartel presence. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: No-Neighbor Analysis: Crackdown Effects on Other Crimes

	Robberies	Kidnap	Threats & Extortion	Non-lethal Violence
	(1)	(2)	(3)	(4)
Gas pipeline × Post 2019	17.52	-0.118	8.635	17.36***
	(23.979)	(0.102)	(7.210)	(6.454)
Refined oil pipeline × Post 2019	-246.1***	-0.741***	48.33***	-24.60*
	(54.375)	(0.226)	(15.402)	(13.689)
Observations	18088	18088	18088	18088
Adj. R-squared	0.939	0.593	0.888	0.955
Mean dep. var.	291.9	0.480	44.72	86.38

Note: This table reports coefficient estimates and standard errors from Equation 1. This specification drops all non-pipeline municipalities that are adjacent to a municipality with a refined oil or gas pipeline to avoid bias introduced by potential spillovers into these control units. Columns (1)-(4) report the number of crimes of specific types reported per 100,000 residents. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Log-Transformed Estimates: Crackdown Effects on Homicides

	All	Male	Female	Pemex	Cartel	Military
	(1)	(2)	(3)	(4)	(5)	(6)
Gas pipeline × Post 2019	0.099**	0.079*	0.060*	-0.002	0.125***	-0.002
	(0.047)	(0.048)	(0.033)	(0.004)	(0.047)	(0.008)
Refined oil pipeline × Post 2019	0.021	0.015	0.027	-0.002	-0.044	0.007
	(0.057)	(0.058)	(0.043)	(0.007)	(0.063)	(0.012)
Observations	19648	19648	19648	19648	19648	19648
Adj. R-squared	0.507	0.506	0.285	0.252	0.478	0.054
Mean dep. var.	1.96	1.84	0.54	0.01	1.11	0.01

Note: This table reports coefficient estimates and standard errors from Equation 1. All outcomes are normalized to homicide rates per 100,000 residents and then log-transformed. Homicides of Pemex employees are estimated based on homicides of individuals of working age (18-60 years old) insured through Pemex. Potential cartel-related homicides are classified as males aged 18-40 killed by a firearm. Homicides of military personnel are estimated based on individuals insured through SEDENA, ages 18-60, and killed by a firearm. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A7: Log-Transformed Estimates: Crackdown Effects on Cartel Presence

	Log(Number of Cartels)		
	All	Huachicol Specialized	Non-Huachicol Specialized
	(1)	(2)	(3)
Gas pipeline × Post 2019	0.0876***	0.0802***	0.0462***
	(0.020)	(0.017)	(0.017)
Refined oil pipeline × Post 2019	0.0978***	0.0506**	0.128***
	(0.027)	(0.024)	(0.025)
Observations	17311	17311	17311
Adj. R-squared	0.821	0.781	0.793
Mean dep. var.	0.613	0.486	0.312

Note: This table reports coefficient estimates and standard errors from Equation 1. All dependent variables are log-transformed. In Column (1) the dependent variable measures total active cartels; in column (2) the dependent variable measures fuel theft-specialized cartels, and in column (3) the dependent variable measures non-fuel theft specialized cartels, where fuel-theft specialized cartels are identified from Etellekt Consultores (2016), Langner (2017), Castillo (2021), and González (2020). Columns (4)-(6) report results for analogous binary categories to assess the extensive margin of cartel presence. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A8: Log-Transformed Estimates: Crackdown Effect on Other Crimes

	Robberies	Kidnap	Threats & Extortion	Non-lethal Violence
	(1)	(2)	(3)	(4)
Gas pipeline × Post 2019	-0.282***	-0.0496*	-0.243***	-0.324***
	(0.050)	(0.026)	(0.061)	(0.053)
Refined oil pipeline × Post 2019	-0.269***	-0.0880**	-0.352***	-0.381***
	(0.055)	(0.038)	(0.074)	(0.061)
Observations	19648	19648	19648	19648
Adj. R-squared	0.713	0.267	0.561	0.613
Mean dep. var.	3.923	0.230	2.602	3.422

Note: This table reports coefficient estimates and standard errors from Equation 1. All dependent variables are computed as the number of crimes of specific type per 100,000 residents and then log-transformed. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A9: Military Presence Analysis: Crackdown Effects on Homicides

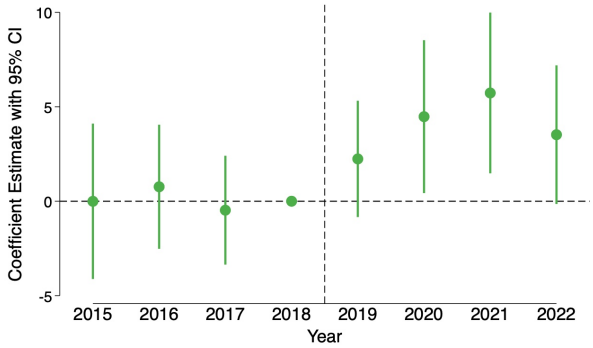
	All	Male	Female	Pemex	Cartel	Military
	(1)	(2)	(3)	(4)	(5)	(6)
Gas pipeline × Post 2019	2.863*	2.383*	0.279	-0.003	1.432	0.017
	(1.546)	(1.432)	(0.241)	(0.010)	(0.883)	(0.060)
Refined oil pipeline × Post 2019	4.190	3.771	0.360	-0.027	1.061	-0.035
	(2.609)	(2.317)	(0.419)	(0.028)	(1.461)	(0.057)
Gas pipeline × Post 2019 × Military Presence	7.299	6.344	0.890	-0.000	4.253	0.114
	(5.740)	(5.183)	(0.698)	(0.066)	(3.219)	(0.194)
Refined oil pipeline × Post 2019 × Military Presence	-9.135	-8.904	-0.681	0.100	-3.880	0.240
	(6.745)	(6.097)	(0.815)	(0.088)	(3.843)	(0.221)
Post 2019 × Military Presence	4.688	5.160	-0.213	-0.091	1.971	-0.125
	(4.879)	(4.334)	(0.658)	(0.059)	(2.559)	(0.141)
Observations	19648.000	19648.000	19648.000	19648.000	19648.000	19648.000
Adj. R-squared	0.356	0.356	0.076	0.176	0.325	0.041
Mean dep. var.	21.306	18.872	2.301	0.017	8.581	0.051

Table reports coefficient estimates and standard errors from estimation of a DiD specification that interacts treatment indicators for whether a municipality hosts a gas or refined oil pipeline with an indicator for whether that municipality experienced military presence related to pipeline theft in 2022-2023. Dependent variables are measured as number of homicides per 100,000 inhabitants. Homicides of Pemex employees are estimated based on homicides of individuals of working age (18-60 years old) insured through Pemex. Potential cartel-related homicides are classified as males aged 18-40 killed by a firearm. Homicides of military personnel are estimated based on individuals insured through SEDENA, ages 18-60, and killed by a firearm. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

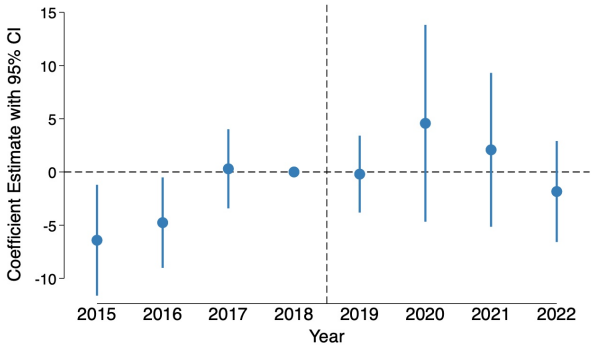
Figure A6: Event Studies with Matched Sub-sample

A. Homicides

(a) Gas Pipeline Municipalities

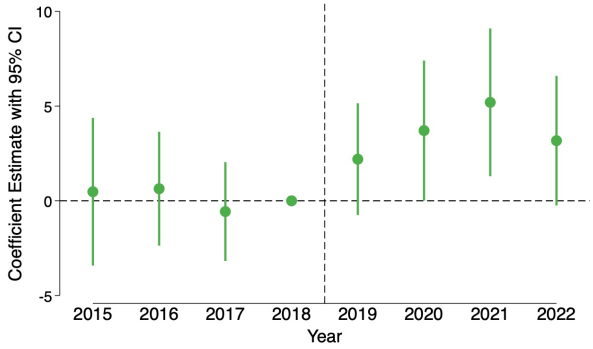


(b) Oil Pipeline Municipalities

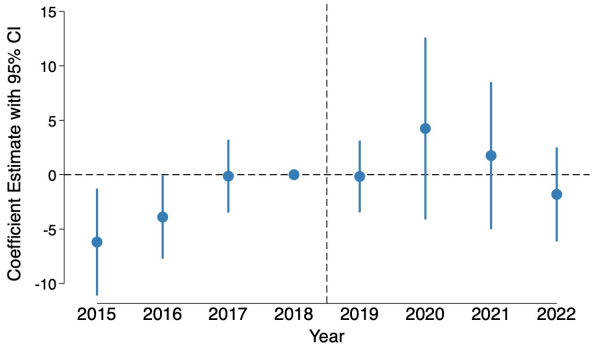


B. Male Homicides

(c) Gas Pipeline Municipalities

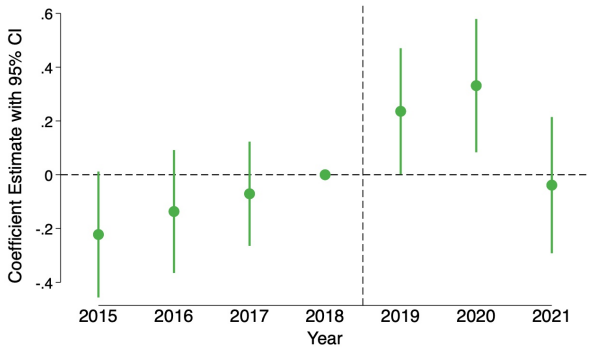


(d) Oil Pipeline Municipalities

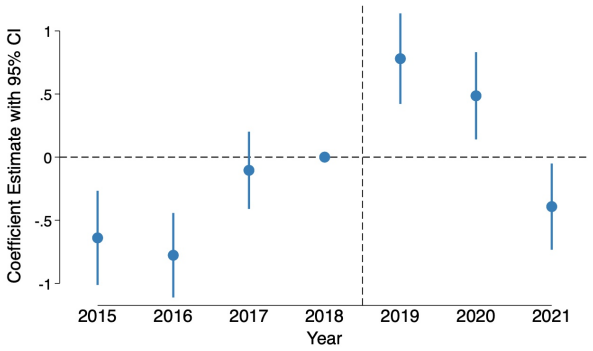


C. Number of Cartels

(e) Gas Pipeline Municipalities



(f) Oil Pipeline Municipalities



Note: Event studies are estimated analogously to Equation 2, including year and municipality fixed effects and clustering standard errors at the municipality level. Panel A show results on all homicides, Panel B presents results for homicides of males, and Panel C show results on the number of cartels. Outcomes in Panels A and B are defined as total homicides per 100,000 residents. Outcomes in Panel C are defined as the number of active cartels in a municipality. Sample is restricted to treated municipalities (i.e., municipalities that contain a refined oil or gas pipeline) and control municipalities that exactly match on state and quintiles of pre-treatment (2015-2018) homicide rates per 100,000 residents, number of active cartels, formal employment share of the population, income level, and population. Matching weights from the Coarsened Exact Matching (CEM) procedure are included in event study regressions.

Table A10: Military Presence Analysis: Crackdown Effects on Cartel Presence

	Number of Cartels			Cartel Presence (1/0)		
	All	Huachicol Specialized	Non-Huachicol Specialized	All	Huachicol Specialized	Non-Huachicol Specialized
	(1)	(2)	(3)	(4)	(5)	(6)
Gas pipeline × Post 2019	0.382***	0.258***	0.124**	0.0343**	0.0461***	0.0310*
	(0.095)	(0.051)	(0.062)	(0.015)	(0.016)	(0.017)
Refined oil pipeline × Post 2019	1.108***	0.341***	0.767***	-0.00434	0.00250	0.0347
	(0.223)	(0.095)	(0.175)	(0.023)	(0.023)	(0.028)
Gas pipeline × Post 2019 × Military Presence	-0.101	-0.193	0.0924	-0.00963	-0.0310	0.00570
	(0.355)	(0.208)	(0.259)	(0.054)	(0.053)	(0.062)
Refined oil pipeline × Post 2019 × Military Presence	-0.457	-0.0580	-0.399	-0.0136	-0.0164	0.00879
	(0.373)	(0.182)	(0.281)	(0.060)	(0.058)	(0.062)
Post 2019 × Military Presence	0.191	0.0580	0.133	0.0165	0.0166	0.0240
	(0.321)	(0.192)	(0.221)	(0.052)	(0.053)	(0.065)
Observations	17311	17311	17311	17311	17311	17311
Adj. R-squared	0.884	0.819	0.867	0.642	0.640	0.606
Mean dep. var.	2.024	1.164	0.860	0.408	0.384	0.252

Table reports coefficient estimates and standard errors from estimation of a DiD specification that interacts treatment indicators for whether a municipality hosts a gas or refined oil pipeline with an indicator for whether that municipality experienced military presence related to pipeline theft in 2022-2023. In Column (1) the dependent variable measures total active cartels; in column (2) the dependent variable measures fuel theft-specialized cartels, and in column (3) the dependent variable measures non-fuel theft specialized cartels, where fuel-theft specialized cartels are identified from Etellekt Consultores (2016), Langner (2017), Castillo (2021), and González (2020). Columns (4)-(6) report results for analogous binary categories to assess the extensive margin of cartel presence. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A11: Military Presence Analysis: Crackdown Effects on Other Crimes

	Robberies	Kidnap	Threats & Extortion	Non-lethal violence
	(1)	(2)	(3)	(4)
Gas pipeline × Post 2019	-5.553	-0.328**	2.039	3.996
	(9.020)	(0.155)	(2.985)	(3.234)
Refined oil pipeline × Post 2019	-47.68***	-0.148	3.454	-12.26**
	(18.355)	(0.285)	(5.326)	(5.750)
Gas pipeline × Post 2019 × Military Presence	23.47	0.897	9.419	19.96
	(38.452)	(0.678)	(9.599)	(12.204)
Refined oil pipeline × Post 2019 × Military Presence	-68.93*	-0.601	-22.02*	-18.16*
	(40.631)	(0.535)	(11.393)	(10.845)
Post 2019 × Military Presence	55.34	-0.549	8.956	-0.00703
	(37.324)	(0.520)	(8.521)	(12.034)
Observations	19648	19648	19648	19648
Adj. R-squared	0.838	0.119	0.526	0.737
Mean dep. var.	204.4	0.786	49.83	95.57

Note: Table reports coefficient estimates and standard errors from estimation of a DiD specification that interacts treatment indicators for whether a municipality hosts a gas or refined oil pipeline with an indicator for whether that municipality experienced military presence related to pipeline theft in 2022-2023. Dependent variables are measured as number of crimes per 100,000 inhabitants. Non-lethal violence consists of injuries and other crimes that threaten life. Municipality and year-fixed effects are included in all specifications. Standard errors clustered at the municipality-level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$