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Crime Exposure and Educational Outcomes in Mexico

Violencia y desempeño académico en México

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Abstract

Driven by drug-related crimes, homicide levels in Mexico have dramatically increased since 2007. This study examines the effect of students' exposure to crime on educational outcomes in Mexico. Using school-level data, a panel of the country's elementary and secondary schools is constructed to analyze the effect of local homicides on standardized test scores and grade failure rates. The results show that a one-unit increase in the homicide rate per 10,000 inhabitants is associated with a reduction in school-level test scores between 0.0035 and 0.0142 standard deviations, this is likely being driven by effects of individual test scores and by compositional changes in the student body. Additionally, a rise in the homicide rate is also associated with an increase in the grade failure rate. It is proposed that the negative effects of crime exposure are partly due to a reduction of the number of contact hours, and students not compensating for this, by studying more outside of school. Exposure to homicides has potentially long-term consequences since it may affect educational achievement levels and future income flow.

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Resumen

Debido a un aumento en el número de delitos relacionados con el crimen organizado, los niveles de homicidios en México se incrementaron drásticamente a partir de 2007. Este artículo estudia los efectos de la exposición a altos niveles de homicidios sobre los logros educativos en México. Para ello, se construye un panel de escuelas primarias y secundarias a fin de analizar los efectos de los homicidios sobre los resultados de la prueba ENLACE y la tasa de reprobación. Los resultados muestran que un aumento en una unidad en la tasa de homicidios por cada 10,000 habitantes está asociado con una reducción en los resultados de la prueba ENLACE entre 0.0035 y 0.0042 desviaciones estándar, donde estos hallazgos son producto del efecto negativo sobre los resultados de la prueba y del cambio en la composición estudiantil dentro de las escuelas. Asimismo, incrementos en los niveles de homicidios también están asociados con un aumento en la tasa de reprobación. Los efectos negativos generados por los homicidios son, en parte, producto de una reducción en el número de horas que los alumnos asisten a la escuela.

Introduction

Driven by drug-related crimes, homicide levels in Mexico have dramatically increased in recent years. Between 2007 and 2012, approximately 121,613 homicides and 66,217 drug-related homicides were committed in the country.[1] The rise in crime and insecurity has proven costly, totalling 1.4% of Mexico's gross domestic product (GDP) in 2012 (INEGI, 2012). Since violence affects not only those directly involved in illegal activities, but also reaches a much broader segment of society, it is likely to affect important aspects of social welfare. In the short run, these include: negatively affecting school enrolment rates, the number of contact hours, academic performance and grade failure rates, among others. In the long run, it may influence educational attainment levels and income streams. This study examines the effect that students' exposure to local homicides has on educational outcomes in Mexico. The effects of crime exposure are investigated for both standardised test scores and grade failure rates.

1 Author's calculation based on the State and Municipal Database System (SIMBAD) and Policía Federal (2015).

The mechanisms linking violent crime exposure and educational outcomes operate across different channels. At the individual-level, it may affect educational achievement due to changes in behaviours or mental health. Children and adolescents exposed to different types of violence frequently display several symptoms related to post-traumatic stress disorder (PTSD), including intensified levels of stress and a lack of awareness, which have been shown to negatively affect educational outcomes (Osofsky *et al.*, 2004; Ding *et al.*, 2009). Within the household, parents exposed to high levels of crime may shift their focus to ensure the basic safety of their children, dedicating less time and energy towards improving their education (Harding, 2010).

Crime related events can also affect the school routine by causing closings and temporarily interrupting classes. Staff turnover may also increase given that managing a school in a neighbourhood with high levels of crime can be difficult as well as risky (Monteiro and Rocha, 2017). If exposure to violent crimes leads to short term interruptions of classes, students exposed to these incidents are likely to perform at a consistently lower level throughout the entire school year.

Students may also attempt to avoid attending school due to safety concerns. Based on the National Victimization and Perception of Public Safety Survey (ENVIPE), Table 1 shows that, in 2010, 7.2% of Mexico's students reported that they stopped going to school due to fear of becoming a crime victim. Moreover, this figure is positively related to the homicide rate in their county of residence.

Table 1
Due to fear of being a crime victim, did you stop going to school?

Violence by municipality	Yes	No	Observations
Homicides			
Total	7.2%	92.8%	7,237
High	8.9%	91.1%	1,006
Medium	5.8%	94.2%	2,173
Low	3.6%	96.4%	4,058
Drug-related homicides			
High	10.4%	89.6%	3,301
Medium	5.2%	94.8%	3,025
Low	2.5%	97.5%	911

Source: Author's elaboration based on ENVIPE 2011. Municipalities with high, medium and low violence levels refer to those located in the upper, medium and lower tercile, respectively, of the homicide distribution. The ENVIPE 2011 was collected during April and March 2011. Nonetheless, respondents were asked about their perceptions of crime, insecurity and violence with respect to 2010.

Several studies have examined the relationship between violence and educational outcomes in Mexico. Caudillo and Torche (2014) investigate the effect of crime exposure on grade failure among elementary school students. Based on school-level data from the Statistics 911 census, covering the 1990-2010 period, and estimating fixed effect models, the authors observe that a one-unit rise in the homicide rate per 10,000 inhabitants increases the failure rate by 0.027 percentage points. Michaelsen and Salardi (2015) quantify the effects of the rise in crime on standardised test scores in elementary schools. Using the National School Evaluation of Academic Achievement (ENLACE) test, covering the 2007-2011 period, and estimating fixed effects models, the study finds that the increase in crime observed throughout Mexico negatively affected standardised test scores in both Spanish and Mathematics. The authors attribute the decline in academic performance to acute psychological stress among students in the aftermath of local violence. Also using the ENLACE test, Márquez-Padilla *et al.* (2015) examine the 2009-2011 period and, implementing a fixed effects methodology, they did not observe an effect of the rise in violence on standardised test scores among elementary or secondary school students. Nevertheless, the authors did find that higher crime exposure leads to a reduction in enrolment rates among high school-age individuals. Finally, Brown and Velásquez (2017), using the Mexican Life Survey and a series of individual fixed effects models, analysed the impact of the increase in drug-related violence on the educational outcomes and employment behaviour of young adults. The study shows that individuals exposed to elevated levels of violence achieved less years of education and were less likely to complete compulsory schooling, possibly because of economic hardship at the household-level.

This study contributes to the literature on crime and its effect on educational outcomes in Mexico in several ways. First, the period of analysis is updated and extended, as it focuses on the years 2006 to 2012. Second, the econometric analysis controls for different school and homeschool-level programs implemented by the federal government that have been shown to strongly affect educational outcomes in Mexico, and which have been mostly ignored in literature. Third, with respect to standardised test scores, different subsamples of schools are examined. Among secondary schools, heterogeneous effects, depending on when the homicide occurred with respect to examination dates, are investigated. Fourth, regarding grade failure, the study, while including secondary schools, distinguishes between homicides and drug-related homicides and examines different subsamples of schools. Fifth, the potential endogeneity of the homicide rate is addressed by estimating instrumental-variables regression models, using the instrument first proposed by Castillo *et al.* (2014) based on the proximity of Mexico's municipalities to the U.S. border, interacted with information on cocaine seizures in Colombia. Finally, evidence is provided on the mechanisms

driving the negative relationship between crime exposure and educational outcomes, by focusing on the effects of violence on the number of contact hours and the amount of time students spend performing school related activities at home. From a public policy standpoint, the study provides evidence regarding the fact that non-educational policies, such as those concerning the country's security, affect educational outcomes.

The results show that a one-unit increase in the homicide rate per 10,000 people is associated with a decrease on school-level test scores between 0.0035 and 0.0142 standard deviations. This effect, largely in secondary schools, is stronger if the homicide occurs closer to the examination date and is more stable when using either the total number of homicides or drug-related homicides to measure crime. A rise in the homicide rate is also associated with an increase in the grade failure rate.

The study proceeds as follows. Section 2 reviews the related international literature. Section 3 discusses the motives behind recent increases in homicides and drug-related crimes in Mexico. Section 4 describes the data and presents summary statistics. Section 5 outlines the econometric methodology. Section 6 discusses the results. Section 7 tests the robustness of the results. Section 8 concludes.

1. Literature review

Within the international literature that examines the impact of crime exposure on educational outcomes, a series of articles have focused on the effects of school-level violence (Grogger, 1997; Abouk and Adams, 2013; Poutvaara and Ropponen, 2018). These studies tend to observe that bringing weapons to school, fights between students and school shootings are associated with lower enrolment rates, a reduction in attendance and graduation rates and lower scores in national standardised tests. Another area of the literature has focused on the effects of widespread conflict. Armed conflict has been shown to have strong long-term effects on elementary school completion rates in Timor-Leste (Justino *et al.*, 2014), to affect human capital accumulation in Guatemala (Chamarbagwala and Morán, 2011) and Perú (León, 2012), and to decrease women's enrolment rates and mandatory schooling completion rates in Tajikistan (Shemyakina, 2011), among others. Lastly, a series of studies have examined the effects of violent crimes and illegal activities. Focusing on Colombia, Gerardino (2014) observes that teenage males are less likely to be enrolled in secondary school relative to girls when male-biased violence is high. Monteiro and Rocha (2017) analyse the impact of armed struggles between drug gangs in Rio de Janeiro related to student achievement and show that the negative effects of violence increase with its intensity, duration, and proximity to the examination dates.

2. Crime and drug-related violence in Mexico

The increase in crime and drug-related violence observed in Mexico in the late 2000s was a result of a long-term political and economic process, where the relationship between government authorities and drug trafficking organizations (DTOs) was radically altered in 2006.

After coming into power, President Felipe Calderón made the fight against organised crime groups, commonly referred to as the "war on drugs", the centrepiece of his administration by sending troops to the state of Michoacán in December 2006. The crackdown was mostly unanticipated, due to the fact that the election campaigns made little mention of security issues in Mexico (Dell, 2015). The "war on drugs" was largely based on the non-selective arrest of criminal leaders, which led to the fragmentation of DTOs and the emergence of violent conflicts between criminal organisations. Without their heads, a power vacuum emerged in many DTOs. Aspiring leaders who worked as part of the enforcement arms of the DTOs resorted to the use of higher levels of violence to try to gain control of the fragmented markets, which resulted in a significant increase in the number of homicides (O'Neil, 2009; Guerrero-Gutiérrez, 2011). The rise in violence resulted not only in an increase in the homicide rate, but also in homicides becoming more visible, where DTOs slayed civilians and public officials and commonly claimed responsibility for beheadings (Duran-Martínez, 2015).

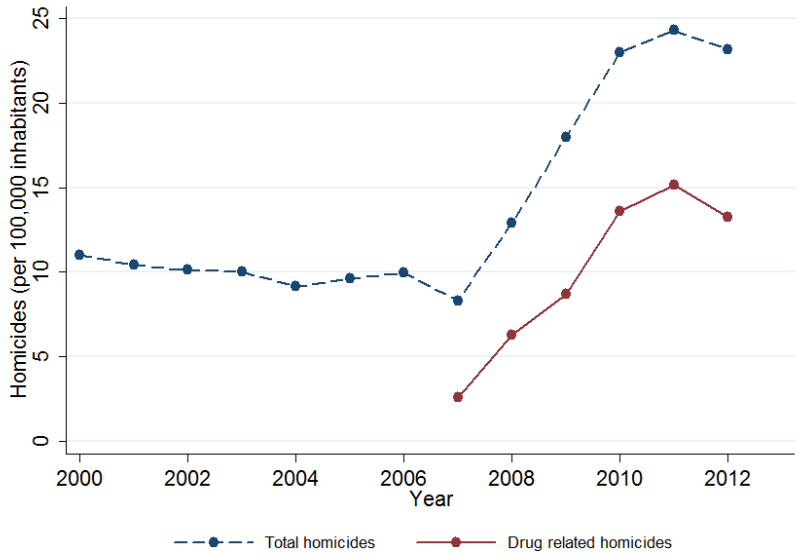
Figure 1 shows that in 2000, the homicide rate in Mexico per 100,000 inhabitants stood at 11.0. Beginning in 2008, the homicide rate grew significantly, reaching 24.3 in 2011. This increase was largely driven by an escalation in drug-related homicides, where the trend in the homicide rate is similar to the one observed for drug-related homicides.[2]

Since the approach taken by President Calderón was to go after all DTOs, this resulted in an amplified and geographically dispersed conflict (Guerrero-Gutiérrez, 2011). Figure 2 shows the geographic distribution and intensity of the homicide rate per 100,000 inhabitants by municipality from 2006 to 2012. While initially concentrated in a few states, homicides became more spatially diverse. Furthermore, a large part of drug-related homicides take place in areas close to drug trafficking routes and in border cities such as Ciudad Juárez or Tijuana, since the most lucrative part of the drug trafficking business chain happens at U.S.-Mexico border crossing points (Rios, 2014:

2 The homicide rate per 100,000 inhabitants is the measure most commonly used in the literature, where this unit of measurement is used in Figure 1, 2 and A.1. Nonetheless, when presenting descriptive statistics and performing the empirical analysis, the homicide rate per 10,000 inhabitants is used instead, so that the estimated coefficients are larger and easier to interpret.

201). It is estimated that in 2008, there was either a major DTO or a local drug gang operating in 68.0% of Mexico's municipalities (Dell, 2015).

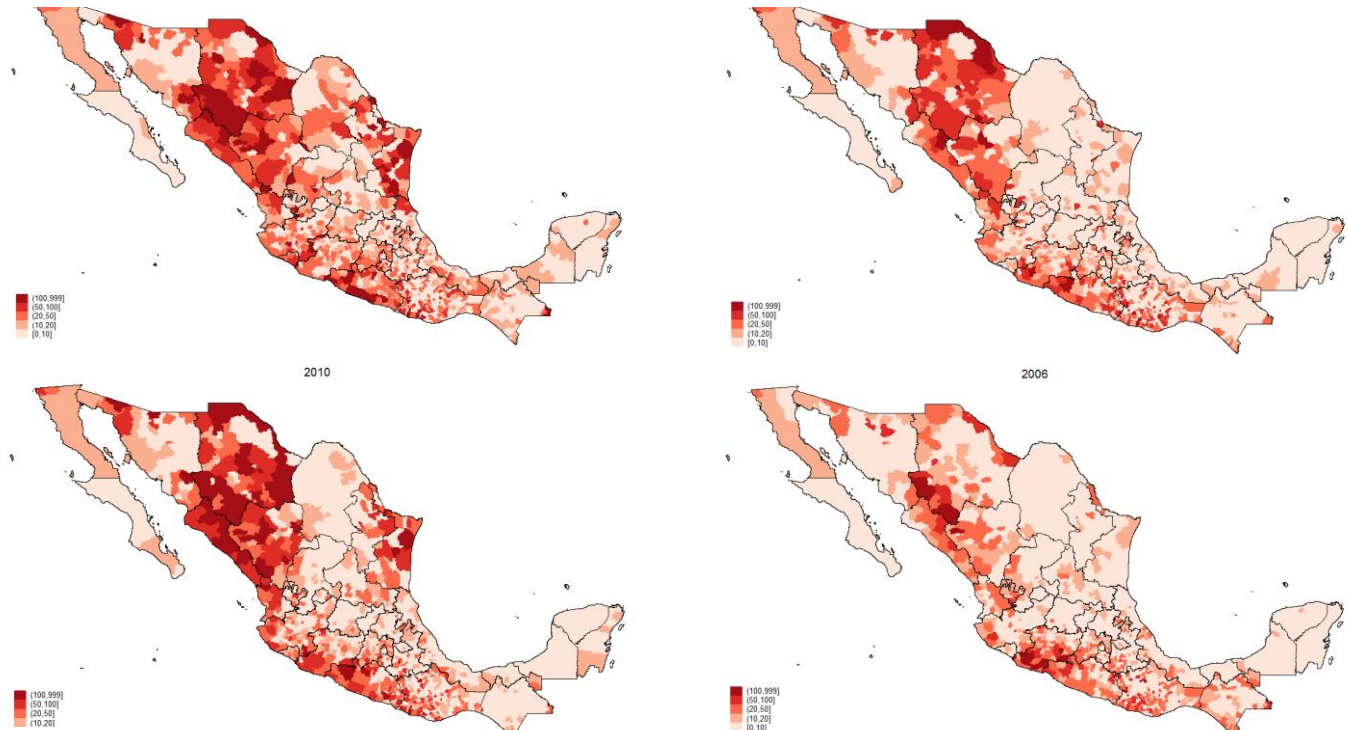
Figure 1
Homicides per 100,000 inhabitants in Mexico, 2000-2012



Source: Author's elaboration based on SIMBAD and Policía Federal (2015).

In addition to the increase in homicides, a rise in the number of illegal activities targeting the general population was also observed. When the leaders of DTOs were neutralised, criminal organisations often lost the ability to operate their international drug trafficking routes effectively. Thus, the remaining members frequently turned against civilians to exploit economic resources through criminal acts (Robles *et al.*, 2015). These included kidnappings, extortions, assault and car-thefts, among others.

Figure 2
Homicides per 100,000 inhabitants by Municipality



Source: Author's elaboration based on SIMBAD.

Other changes also occurred around the time President Calderón took office, which affected the illegal drug market and homicide rates in Mexico. In 2006, the Colombian government redefined its anti-drug strategy changing from a policy that emphasised attacking coca crops, to one that focused on the confiscation of drug shipments and the destruction of cocaine processing labs. This resulted in an increase in the amount of cocaine seized in Colombia, Mexico's main cocaine supplier. This created a scarcity of cocaine and increased drug-related violence in Mexico (Castillo *et al.*, 2014). Finally, a factor that also contributed to the increase in crime was the expiration of the U.S. Federal Assault Weapons Ban in 2004. Dube *et al*. (2013) observes that this made semiautomatic weapons more accessible to DTOs in Mexican states along the U.S. border. Thus, the Mexican municipalities located near border states encountered differential increases in homicides and gun-related homicides after 2004.

The rise in violence proved costly to the Mexican economy, as it deterred economic growth (Enamorado *et al.*, 2014) and negatively affected labour-force-participation rates and increased the proportion of unemployed workers (Robles *et al.*, 2015).

3. Data and descriptive statistics

3.1 Data

This study uses annual data from 2006 to 2012. Educational outcomes are measured at the school level and homicide rates at the municipal level. There are 59,673 and 22,932 elementary and middle schools, respectively, in the sample, each observed for six periods. The schools are located across 1,697 municipalities, which represent approximately 69.1% of México's 2,456 municipalities in 2010.

Academic performance is measured using the scores obtained in the ENLACE standardised test. ENLACE evaluates students' abilities in the subjects of Spanish and Mathematics. Beginning in 2008, it also included a third subject which changes on a rotating basis. The test was initially implemented with the purpose of providing information on how to better structure and improve course outlines, and to help identify the skills and training needed by teachers. While elementary school in Mexico covers grades 1 through 6, ENLACE is taken by students in grades 3 through 6, and by middle school students in grades 7 through 9.[3] The test is measured on a scale ranging from 200 to 800, with a mean of 500. ENLACE scores in

3 From 2008 onwards, twelfth grade students also started taking the ENLACE test. Nevertheless, due to the data unavailability, these students were not included in the study.

Spanish and Mathematics are available by grade and subject. However, in the empirical analysis, they are used at the school level by averaging the scores obtained in each subject across different grades. An advantage of ENLACE is that it allows for a single and direct comparison between all evaluated students and schools. School level figures on ENLACE scores were obtained from the Ministry of Public Education (SEP).

Information on grade failure rates was taken from the Statistics 911 school census. The dataset includes information on students, teachers, school characteristics and other elements of the educational system from all the elementary and middle schools in Mexico.[4]

Statistics on the number of homicides at the municipal level were obtained from SIMBAD. Homicides per 10,000 inhabitants were constructed using population data from the 2005 Population Count and the 2010 Population Census. For year with unavailable information on population figures, the data was extrapolated assuming a constant yearly population growth-rate. Data on drug-related homicides was taken from Policía Federal (2015) and only includes information from December 1, 2006 onwards. While the homicide rate—like other crime related variables— is potentially subject to measurement error, as argued by Caudillo and Torche (2014: 90), it is the most noticeable type of violent crime and provides a more reliable measurement than other types of crimes (Sampson, Raudenbush and Earls, 1997).

To identify the effect of crime exposure on educational outcomes, a series of school, municipal, and state-level controls are introduced. Data on narcotics related charges at the municipal-level and the unemployment rate and GDP per capita at the state-level was taken from SIMBAD. Data on school characteristics such as the number of students, groups, and the student-teacher ratio, among others, was obtained from Statistics 911. Information on whether the school participates in the Quality School Program (PEC), Full-Time School Program (PETC) or the Safe School Program (PES) was taken from SEP.[5] Data on the *Seguro Popular* coverage rate was obtained from the National Commission of Social Protection in Health. Information regarding

4 In the Statistics 911 school census, students are classified as having failed a grade when, during the current academic year, they fail between 1 and 5 subjects.

5 The PETC extends the school day from four or five hours to between six and eight hours per day. The PEC allows each school to design an education improvement plan which includes teacher training and additional course materials, among others. The PES grants economic and technical resources to schools which may be used on training, course materials or equipment related to school safety.

the *Prospera* coverage rate was taken from the National Coordination of Prospera Social Inclusion Program.[6]

3.2 Descriptive statistics

Table 2 displays the means and standard deviations of selected variables. Regarding the variables of interest, every year ENLACE scores in Mathematics are higher than those in Spanish. With respect to grade failure rates, they gradually decreased each year during the period of analysis.

Among school-level controls, on one hand, the average number of students per school decreased between 2006 and 2012, dropping from 192.9 to 188.1, respectively. On the other hand, the number of groups per school remained relatively constant at around 7.9. The fact that the number of groups is highly correlated with the number of classrooms used signals that classrooms are generally not shared among different groups. Focusing on the different school-level programs, the coverage rate of both the PETC and PES increased each year between 2006 and 2012. Specifically, while the coverage of the PETC was 0.4% in 2009, by 2012 this figure had increased to 2.2%. Furthermore, the PES which started in 2007 increased its coverage rate from 1.1% in its initial year to 35.0% in 2012. The PEC followed a less predictable pattern, where its coverage rate varied between 22.4% and 30.5%.

Turning our attention to municipal-level characteristics, the number of homicides per 10,000 inhabitants more than doubled during the period of analysis. While this figure stood at 0.9 in 2006, it escalated to 2.1 in 2011 and 2012. The increase in the total homicide rate was driven by a rise in drug-related homicides, which stood at 0.2 in 2007 and reached 1.5 in 2011. While not as pronounced, there was also an increase in the number of narcotics related charges per 10,000 inhabitants, which rose from 1.2 in 2006 to 1.7 in 2011. Regarding different social assistance programs, the expansion of

6 Seguro Popular is a free-of-charge publicly provided health insurance program for uninsured households. Prospera is a poverty reduction cash-transfer program where households receive transfers conditional on sending their children to school and visiting health clinics.

Table 2
Descriptive statistics

	2006	2007	2009	2010	2011	2012
School characteristics						
ENLACE scores: Spanish	487.4	492.7	502.7	508.4	515.4	522.8
	(57.8)	(61.3)	(57.7)	(61.2)	(65.5)	(70.4)
ENLACE scores: Mathematics	491.6	497.6	506.4	516.4	529.6	554.4
	(57.5)	(61.4)	(61.9)	(65.6)	(70.2)	(77.4)
Grade failure rate (%)	3.2	3.0	2.8	2.5	2.3	1.8
	(4.3)	(4.2)	(4.1)	(4.0)	(3.9)	(3.5)
Number of students	192.9	193.2	192.2	190.8	189.3	188.1
	(195.0)	(195.3)	(194.4)	(193.1)	(192.0)	(191.3)
Number of groups	7.9	7.9	8.0	8.0	7.9	7.9
	(4.4)	(4.4)	(4.4)	(4.4)	(4.4)	(4.4)
Teachers per 100 students	4.0	4.0	4.0	4.1	4.1	4.1
	(3.0)	(3.0)	(3.2)	(3.4)	(3.4)	(3.3)
Number of classrooms used	7.9	7.9	8.0	8.0	8.0	8.0
	(6.1)	(6.0)	(6.4)	(5.8)	(5.9)	(5.7)
Principal is also a teacher (%)	41.6	41.6	41.2	40.7	40.4	40.6
	(49.3)	(49.3)	(49.2)	(49.1)	(49.1)	(49.1)
PEC (%)	24.7	25.1	22.4	24.3	30.5	26.7
	(43.1)	(43.4)	(41.7)	(42.9)	(46.0)	(44.2)
PETC (%)	0.0	0.0	0.4	0.8	0.9	2.2
	(0.0)	(0.0)	(6.6)	(8.9)	(9.3)	(14.6)
PES (%)	0.0	1.1	14.9	25.8	31.1	35.0
	(0.0)	(10.3)	(35.6)	(43.8)	(46.3)	(47.7)
Municipal characteristics						
Homicides per 10,000 inh.	0.9	0.8	1.6	2.0	2.1	2.1
	(1.1)	(1.0)	(3.0)	(3.8)	(3.4)	(3.4)
Drug homicides per 10,000 inh.	0.0	0.2	0.8	1.3	1.5	1.3
	(0.0)	(1.0)	(2.4)	(4.0)	(3.6)	(2.8)
Narcotics sentences per 10,000 inh.	1.2	1.2	1.0	1.6	1.7	1.5
	(2.1)	(1.8)	(1.7)	(2.7)	(3.2)	(2.9)

Seguro Popular coverage (%)	21.6	28.2	36.8	48.3	55.2	55.9
	(19.8)	(21.1)	(21.3)	(22.9)	(22.8)	(22.5)
Prospera coverage (%)	33.4	32.3	30.9	32.5	32.1	31.8
	(28.5)	(27.6)	(25.5)	(25.8)	(25.6)	(25.6)
State characteristics						
Unemployment rate (%)	3.6	4.0	5.3	5.6	5.5	5.2
	(1.1)	(1.5)	(1.8)	(1.8)	(1.5)	(1.6)
GDP per capita/1000	108.1	109.2	102.1	105.5	107.7	110.1
	(111.0)	(103.1)	(86.3)	(82.3)	(79.6)	(78.5)
Observations	82,619	82,619	82,619	82,619	82,619	82,619

Source: Author's elaboration based on ENLACE, Statistics 911 and SIMBAD. GDP per capita is in 2010 pesos. Standard errors are shown in parenthesis.

Seguro Popular is seen within the period analysed. In 2006, 21.6% of the population were enrolled in *Seguro Popular*. By 2012, this figure stood at 55.9%. On the contrary, the coverage rate of *Prospera* remained stable, between 30.9% and 33.4%, as its main enrolment surge occurred before 2006. With respect to state-level characteristics, the unemployment rate fluctuated between 3.6% in 2006 and 5.6% in 2010, while GDP per capita reached its lowest point in 2009, when it dropped to 102,100 pesos per year. The reduction in GDP per capita was driven by the global economic crisis, when in 2009 Mexico's GDP contracted by 4.7% (World Bank, 2014).

4. Methodology

To estimate the effect of crime exposure on standardised test scores and grade failure rates, the variation in homicide rates within a municipality and time is used. This is done by estimating a fixed effects (FE) model specified in the following manner:

$$y_{imt} = \gamma Crime_{mt} + X_{imt}\beta + W_{mt}\delta + Z_{st}\lambda + \alpha_i + \mu_t + \epsilon_{imt} \quad (1)$$

where y_{imt} denotes either the ENLACE score obtained in Spanish or Mathematics or the grade failure rate observed in school i in municipality m in year t; $Crime_{mt}$ represents the homicide rate per 10,000 inhabitants, constructed using the total number of homicides registered in the municipality where the school is located during the 12 months prior to the ENLACE test being taken; X_{imt} denotes a vector of school-level characteristics that may affect ENLACE test scores or grade failure rates;

W_{mt} and Z_{st} represent vectors of municipal- and state-level variables, respectively; α_i denotes school fixed effects that capture time-invariant characteristics which may affect the educational outcomes of interest; μ_t represents a time period dummy which helps control for national trends in homicide rates; and ϵ_{imt} is a random error term assumed to be uncorrelated with $Crime_{mt}$, X_{imt}, W_{mt} and Z_{st}.[7]

In addition to the homicide rate at the municipal level, the model includes school-level characteristics as covariates such as the following: number of students, number of groups, number of teachers per 100 students, number of classrooms used, and dummy variables denoting whether the principal is also a teacher and whether the school participates in the PEC, PETC or PES. Municipal and state-level covariates include the number of narcotics related charges per 10,000 inhabitants, the *Seguro Popular* and *Prospera* coverage rates at the municipal-level, and the state unemployment rate and GDP per capita. Introducing information on narcotics related charges helps control for municipal-level law enforcement capabilities or institutional characteristics. Eq. (1) is estimated separately for elementary and middle schools, and for ENLACE scores in Spanish and Mathematics and grade failure rates. Standard errors are clustered by municipality to account for possible correlation among schools.

Lastly, given that the study is performed using school-level data, a disadvantage of the empirical analysis is that it is not possible to disentangle the effects of homicides on individual-level-test scores from changes in school-level-test scores caused by compositional changes in the student body.

5. Results

5.1 Homicides and academic performance

Table 3 presents the effects of homicides on ENLACE scores in Spanish and Mathematics for elementary and middle school students. Columns (1) and (2) show that among elementary school students, a one-unit increase in the homicide rate per 10,000 inhabitants is associated with lower scores in Spanish and Mathematics exams between 0.0035 and 0.0039 standard deviations. Both effects are statistically significant at the 5.0% level. Regarding middle school students, columns (3) and (4) show that the effect of homicides is negative and significant at the 1.0% level. Specifically, a one-unit increase in the homicide rate per 10,000 inhabitants is associated with

7 When focusing on grade failure rates, y_{imt} represents a continuous variable between 0 and 100 that captures the proportion of students that failed the grade during the current academic year.

lower scores in Spanish and Mathematics ENLACE exams 0.0089 and 0.0142 standard deviations, respectively.[8]

Table 3
FE estimations of the effect of local homicide rates on test scores

Variable	(1)	(2)	(3)	(4)
	ENLACE scores: Elementary		*ENLACE scores: Secondary*	
	Spanish	*Math*	*Spanish*	*Math*
Homicides per 10,000 inhabitants	-0.0035**	-0.0039**	-0.0089***	-0.0142***
	(0.0018)	(0.0019)	(0.0029)	(0.0032)
Number of students/100	0.036***	0.043***	0.093***	0.058***
	(0.008)	(0.008)	(0.011)	(0.011)
Number of groups	-0.014***	-0.014***	-0.003	0.005
	(0.003)	(0.003)	(0.005)	(0.005)
Teachers per 100 students	1.570***	1.950***	0.580***	0.628***
	(0.202)	(0.224)	(0.133)	(0.138)
Number of classrooms used	0.017***	0.016***	0.005*	0.007***
	(0.002)	(0.003)	(0.003)	(0.003)
Principal is also a teacher	-0.009	0.003	-0.047***	-0.051***
	(0.007)	(0.008)	(0.013)	(0.014)
PEC	0.015***	0.015***	0.022***	0.024***
	(0.005)	(0.006)	(0.008)	(0.008)
PETC	0.126***	0.124***	0.233***	0.256**
	(0.025)	(0.025)	(0.081)	(0.101)
PES	-0.011	-0.012	-0.056***	-0.011
	(0.013)	(0.013)	(0.020)	(0.023)
School fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Municipal-level controls	Yes	Yes	Yes	Yes
State-level controls	Yes	Yes	Yes	Yes
R-squared	0.218	0.270	0.082	0.169
Observations	358,038	358,052	137,592	137,592

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on ENLACE, Statistics 911 and SIMBAD. Dependent variable is the standardised ENLACE test score at the school-level. Standard errors are clustered at the municipal-level.

8 The sample used in the study is a balanced panel based on schools that are observed for all six periods, i.e. from 2006 to 2012 and have no missing values in any of the variables. An analysis based on an unbalanced panel of schools provides very similar results. These results are available upon request.

Moreover, it is observed that in all cases an increase in the number of students at the school and in the number of classrooms used is associated with a rise in standardised test scores. On the contrary, an increase in the number of groups at the school decreases the ENLACE scores in elementary schools but is not significant for middle schools. A rise in the number of teachers per 100 students is positively associated with an increment in standardised test scores, where this variable is significant at the 1.0% for both elementary and middle schools. This implies that students improve their academic performance when the student-teacher ratio decreases. With respect to the school's principal also being a teacher, under this scenario middle school students tend to perform worse in both Spanish and Mathematics, whereas for elementary schools there is no effect. The fact that the principal is also a teacher may be signalling that there is a shortage of teachers in the school. Focusing on the different federal programs, in all four columns the PEC and PETC are associated with an increase in ENLACE scores. Finally, the PES is associated with a decrease in standardised test scores, although this variable is generally not significant.

Table 4 presents how the effects of homicides vary depending on their timing and how close they occur to the date the ENLACE test was taken. In general, the effects of an increase in the homicide rate grow stronger if they occur closer to the examination date. For elementary schools, whereas a rise in the homicides registered during the entire academic year is associated with a decrease in Spanish test scores of 0.0043 standard deviations, an increase in the homicides committed during the week prior to the test being taken decreases average scores by 0.0214 standard deviations. A similar relationship is observed for scores in Mathematics, where a rise in the number of homicides committed the week before the exam is associated with a decrease on average scores of 0.0325 standard deviations, compared to 0.0048 for homicides committed during the entire academic year. Among middle schools, the relationship between Spanish scores and the timing of the homicides remains stable over the different time periods. Conversely, the effect of an increase in the homicide rate on Mathematics scores stands at 0.0155 standard deviations for homicides committed during the entire academic year and rises to 0.0203 for homicides registered during the 3 months prior to the ENLACE test. On one hand, the larger impact of homicides as they occur closer to the examination date may be indicating that the emotional and psychological effects of being exposed to a violent crime gradually decrease over time. On the other hand, it could also be signalling that classes missed closer to the examination date have a stronger effect on test performance than classes that were cancelled earlier in the academic year.

Table 4
FE estimations of the effect of local homicide rates on test scores
Different effects by time

Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
	Academic Year	6 months	3 months	Week
	Elementary school			
ENLACE scores: Spanish	-0.0043**	-0.0049*	-0.0042	-0.0214*
	(0.0021)	(0.0028)	(0.0038)	(0.0119)
ENLACE scores: Math	-0.0048**	-0.0057*	-0.0066	-0.0325***
	(0.0022)	(0.0032)	(0.0043)	(0.0125)
	Secondary school			
ENLACE scores: Spanish	-0.0098***	-0.0094**	-0.0121**	-0.0097
	(0.0033)	(0.0042)	(0.0054)	(0.0137)
ENLACE scores: Math	-0.0155***	-0.0158***	-0.0203***	-0.0186
	(0.0037)	(0.0045)	(0.0061)	(0.0189)
School-level controls	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Municipal-level controls	Yes	Yes	Yes	Yes
State-level controls	Yes	Yes	Yes	Yes

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on ENLACE, Statistics 911 and SIMBAD. Dependent variable is the standardised ENLACE test score at the school-level. Coefficients correspond to the total number of homicides per 10,000 inhabitants registered during the: (1) current academic year, (2) previous 6 months, (3) previous 3 months, and (4) previous week. School-level controls are the same as those included in Table 3. Standard errors are clustered at the municipal-level.

In elementary schools, the largest effects on test scores can be attributed to homicides that occurred during the week prior to the examination date. And in middle schools the largest effects are homicides that occurred during the 3 months prior to the exam. In middle schools, the non-effect of homicides that occurred during the week before the exam is partly a result of the coefficients' larger standard errors. Nonetheless, this also reflects that the

factors through which violence affects elementary and middle school students are different.[9]

To examine if there are heterogeneous effects, Table 5 focuses on different subsamples, where separate regressions were estimated for the different groups of schools. It can be seen that for both elementary and middle schools, the negative effect of a rise in the homicide rate is strongest among those based in a locality with high marginality levels or in highly deprived areas.[10] Moreover, the decrease in ENLACE scores generated by an increase in the homicide rate is larger in schools located in rural areas compared to those registered in urban localities, where for the latter there is generally no significant effect.[11] Additionally, the effects of an increase in the homicide rate tend to be greater among schools teaching in the morning session compared to those that teach in the afternoon session. Among elementary schools, an increase in the homicide rate negatively affects test scores in public schools; while among private schools, a rise in the homicide rate increases ENLACE scores in both subjects, although the coefficient is only significant for Spanish. This result may be signalling that pupils studying in private schools, due to their generally privileged socioeconomic status, are being compensated in some manner (for example, by being given private tutoring) to minimise the adverse effects of being exposed to homicides or to keep them away from the perceived dangers brought by an increase in the levels of violent crime. On the other hand, due to hesitation driven by economic constraints or because some parents may not perceive their children to be aware of the situation or to be at risk due to their young age, it may be that students attending public schools are not being compensated in the same way. Nonetheless, academic performance in indigenous schools appears to be greatly affected by increases in violent crime levels, where a one-unit rise in the homicide rate per 10,000 inhabitants is associated with a reduction in Spanish and Mathematics ENLACE scores of 0.0264 and 0.0236 standard deviations, respectively. These effects are statistically significant at the 1.0% level.

9 This is further examined in Section 7, where Table 9 shows that upon an increase in the homicide rate, relative to middle and elementary school students, who reduce to a greater extent the number of hours they spend at school and reduce to a lesser degree the number of hours they spend performing school related activities at home.

10 The locality's degree of marginality is measured using the National Population Council's (CONAPO) marginality index, which is a multidimensional indicator that measures the intensity of the deprivations suffered by the population in different dimensions including education, housing, population distribution and income. The higher the marginality level, more severe is the socioeconomic deficits faced by its population.

11 A locality is considered rural (urban) if it has less (more) than 2,500 inhabitants.

Table 5
FE estimations of the effect of local homicide rates on test scores
Subsamples

Sample	(1)	(2)	(3)	(4)
	ENLACE scores: Elementary		*ENLACE scores: Secondary*	
	Spanish	*Math*	*Spanish*	*Math*
A. Main	-0.0035**	-0.0039**	-0.0089***	-0.0142***
	(0.0018)	(0.0019)	(0.0029)	(0.0032)
B. Marginality level				
High	-0.0087**	-0.0065	-0.0183***	-0.0196**
	(0.0041)	(0.0041)	(0.0059)	(0.0088)
Medium	-0.0037	-0.0027	0.0033	-0.0036
	(0.0037)	(0.0042)	(0.0052)	(0.0058)
Low	0.0004	0.0005	0.0072***	0.0018
	(0.0011)	(0.0012)	(0.0022)	(0.0017)
C. Locality size				
Urban	-0.0015	-0.0019	0.0024	-0.0031*
	(0.0015)	(0.0016)	(0.0019)	(0.0017)
Rural	-0.0057**	-0.0041	-0.0161***	-0.0191***
	(0.0027)	(0.0029)	(0.0037)	(0.0049)
D. Session				
Morning	-0.0040**	-0.0043**	-0.0103***	-0.0151***
	(0.0019)	(0.0019)	(0.0029)	(0.0034)
Afternoon	-0.0013	-0.0017	0.0127***	0.0052
	(0.0017)	(0.0020)	(0.0041)	(0.0034)
E. School type				
Public	-0.0032*	-0.0032*	0.0086***	0.0041**
	(0.0018)	(0.0019)	(0.0023)	(0.0021)
Private	0.0062**	0.0044	0.0143**	0.0130***
	(0.0028)	(0.0032)	(0.0060)	(0.0049)
Indigenous	-0.0264***	0.0236***	---	---
	(0.0066)	(0.0071)		
Telesecundaria	---	---	-0.0178***	-0.0220***
			(0.0037)	(0.0048)

F. Lagged homicide rate				
t-1	-0.0034*	-0.0033	-0.0109***	-0.0177***
	(0.0019)	(0.0021)	(0.0031)	(0.0038)
t-2	-0.0013	-0.0004	-0.0063**	-0.0139***
	(0.0018)	(0.0019)	(0.0032)	(0.0048)
G. Cumulative effects				
Last 2 years	-0.0019*	-0.0020*	-0.055***	-0.0088***
	(0.0010)	(0.0011)	(0.0016)	(0.0019)
Last 3 years	-0.0014	-0.0013	-0.0044***	-0.0075***
	(0.0008)	(0.0009)	(0.0014)	(0.0017)
School-level controls	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Municipal-level controls	Yes	Yes	Yes	Yes
State-level controls	Yes	Yes	Yes	Yes

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on ENLACE, Statistics 911 and SIMBAD. Dependent variable is the standardised ENLACE test score at the school-level. Coefficients correspond to the number of homicides per 10,000 inhabitants. School-level controls are the same as those included in Table 3. Standard errors are clustered at the municipal-level.

Among middle schools, the estimated coefficients of the effect of a rise in homicides on test scores are positive for public and private schools but are negative for *telesecundarias*, which are distance learning middle schools that provide classes mainly through television broadcasts in rural or difficult to access areas in Mexico. On one hand, the positive effect for public and private middle schools may arise because an increase in violence is likely to lead some students to drop out of school and enter the labour force to help support their families through the negative economic consequences of a more violent context. Hence, this may be a result of changes in the composition of students within schools. This is also consistent with the positive estimate for afternoon middle schools, which tend to focus on students who often work and therefore might be less attached to school. On the other hand, the negative effect for *telesecundarias* may be driven by the fact that, like indigenous schools, they tend to be in small communities in isolated areas with prevalent poverty rates and low levels of schooling. It may be that in these communities there are higher levels of kinship or affinity among its residents, where the effects of an increase in the homicide rate are more

widely felt among its inhabitants compared to schools located in larger or more densely populated areas. Furthermore, due to a lack of economic resources or geographical isolation, there may not be any type of compensating mechanisms in place for pupils attending *telesecundarias*.

The lagged effects of an increase in homicides are small for elementary schools and completely disappear after two years. Lagged effects are strong for middle schools, where these only become non-significant after three years.[12] Lastly, the cumulative effects of the homicides that occurred during the two and three years prior to the exam date are more noticeable in middle schools than in elementary schools, and are strongly significant.[13]

5.2 Homicides and grade failure

As Table 6 shows, a one-unit increase in the homicide rate per 10,000 inhabitants is associated with a rise in the grade failure rate of 0.028 percentage points for elementary schools and 0.027 percentage points for secondary schools, where both effects are significant at the 1.0% level.

Column (1) shows that for elementary schools, the effect of homicides is only significant for schools located in areas with low marginality levels. Nevertheless, although not significant, the estimated coefficient is the largest for schools situated in high marginality areas. Concerning the locality size, the effect of a rise in violent crime is significant at the 1.0% level in schools located in both urban and rural localities, where the effect of an increment in homicides is stronger among schools located in rural settings. With respect to whether classes are taught in the morning or afternoon session, the effect of a rise in homicides is slightly larger for schools that teach in the afternoon. Regarding the school type, the effect of crime exposure is stronger in public schools compared to private schools. In indigenous schools an increase in the homicide rate is associated with a decrease in the grade failure rate. On the contrary, a rise in the lagged homicide rate is related with an increase in the grade failure rates for up to two periods.

12 Regressions with lagged effects incorporate homicide data at the municipal-level from previous periods, i.e. from 2003, 2004 and 2005, since this information is available from 1990 onwards. Therefore, no observations are dropped and the full sample of schools covering the period from 2006 to 2012 is included in these regressions.

13 Cumulative homicide rates for two and three years are constructed by adding the homicide rates per 10,000 inhabitants registered during the last two and three years, respectively.

Table 6
FE estimations of the effect of local homicide rates on grade failure rates

Sample	(1)	(2)
	Elementary	*Secondary*
A. Main	0.0282***	0.0268***
	(0.0070)	(0.0082)
B. Marginality level		
High	0.0151	0.0545***
	(0.0140)	(0.0209)
Medium	-0.0016	0.0041
	(0.0151)	(0.0252)
Low	0.0129**	0.0196**
	(0.0058)	(0.0093)
C. Locality size		
Urban	0.0172***	0.0220**
	(0.0066)	(0.0104)
Rural	0.0276***	0.0403***
	(0.0086)	(0.0132)
D. Session		
Morning	0.0273***	0.0269***
	(0.0073)	(0.0085)
Afternoon	0.0309***	0.0258
	(0.0096)	(0.0164)
E. School type		
Public	0.0293***	0.0168**
	(0.0073)	(0.0072)
Private	0.0137*	0.0279
	(0.0075)	(0.0246)
Indigenous	-0.0576	---
	(0.0522)	
Telesecundaria	---	0.0447***
		(0.0151)
F. Lagged homicide rate		
t-1	0.0357***	0.0277***
	(0.0074)	(0.0083)
t-2	0.0362***	0.0306***
	(0.0083)	(0.0075)
G. Cumulative effects		
Last 2 years	0.0173***	0.0151***
	(0.0039)	(0.0044)
Last 3 years	0.0159***	0.0138***
	(0.0034)	(0.0035)

School-level controls	Yes	Yes
School fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Municipal-level controls	Yes	Yes
State-level controls	Yes	Yes

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on ENLACE, Statistics 911 and SIMBAD. Dependent variable is the grade failure rate at the school-level. Coefficients correspond to the total number of homicides per 10,000 inhabitants. School-level controls are the same as those included in Table 3. Standard errors are clustered at the municipal-level.

Focusing on middle schools, it can be seen in column (2) that the effect of a rise in homicides on grade failure rates is larger in schools based in localities with high marginality levels. Once again, the negative effect of violent crime is stronger in rural areas compared to urban settings. Further, the effect of an increase in homicides on grade failure rates is stronger for middle schools that teach in the morning session. While there is no significant effect for private schools, a rise in crime does increase the grade failure rate for public schools and *telesecundarias* or distance learning middle schools, where this effect is significant at the 1.0% level. One- and two-year lagged values of the homicide rate significantly affect current grade failure rates. Finally, cumulative effects of the homicides that occurred during the last two and three years show that a one-unit rise in the homicide rate per 10,000 inhabitants is associated with an increase in the grade failure rate that ranges from 0.0138 to 0.0173 percentage points, where these effects are statistically significant at the 1.0% level.[14]

6. Robustness checks and mechanisms

6.1 Drug-related homicides and instrumental variable estimations

Since the increase in homicide levels was driven by a rise in drug-related homicides, this section examines their effect on educational outcomes. Obtained from Policía Federal (2015), data on drug-related homicides is available at the municipal-level on an annual basis starting in 2006.

This section also addresses the challenges of identification that arise when attempting to estimate the effect that crime exposure has on educational outcomes. First, regardless of the inclusion of a wide range of schools,

14 In certain cases, in the fixed effects models, excluding controls related to school- and household-level programs significantly alters the magnitude of the homicide rate coefficients. For example, when examining Spanish scores in middle schools, omitting these controls decreases the coefficient associated with the homicide rate from -0.0089 to -0.0137. Furthermore, when analyzing the grade failure rates in elementary schools, it is noticed that the exclusion of these covariates results in an increase of the homicide rate coefficient from 0.0282 to 0.0368.

municipal and state level controls, unobserved variables may jointly determine educational outcomes and variations in the homicide rate. Factors such as institutions may generate a downward bias on the coefficient if municipalities with weak institutions offer lower quality schooling and have poorer educational outcomes, while also being exposed to larger increases in crimes levels due to less effective police and judicial services (Basu and Pearlman, 2017). Second, the potential reverse causality between educational outcomes and violent crime levels cannot be disregarded. Whereas an increase in the homicide rate is likely to negatively affect academic performance and grade failure rates, it is plausible to assume that violent crime levels are higher where educational outcomes are worse. This is likely to arise because DTOs may more easily employ adolescents who study at badly-performing schools (Michaelsen and Salardi, 2015). Lastly, while measurement error in homicide variables is not generally considered a serious problem compared to other types of crime, evidence suggests that this could be a problematic issue for the case of Mexico. According to official government data, between 2006 and 2013 an estimated 1,273 bodies were found in different clandestine graveyards throughout the country (PGR, 2014). Moreover, it is probable that there many other illegal graveyards that have not yet been discovered and never will be. Measurement error in the homicide rate biases the coefficient towards zero. That is, it leads to attenuation bias by overestimating or estimating a negative coefficient to be more positive. Considering all these factors, the potential direction of the bias is uncertain.

To address the potential endogeneity issues, this study follows a similar strategy to the one put forward by Castillo *et al.* (2014). Specifically, an instrumental variable (IV) model is estimated using the interaction of a municipality's proximity to the U.S. border with the percentage of cocaine seized in Colombia as a source of exogenous variation. Castillo *et al.* (2014) states that when the Colombia government seizes large quantities of cocaine, its price rises due to a reduction in supply. This increases the market value of cocaine, even more so in localities close to the U.S. border. Mexican municipalities that are close to the border have a comparative advantage due to their strategic geographic location since the U.S. is the final market. It is assumed that it will be these municipalities that see the highest increase in homicide levels because the control of these places is more valuable to the DTOs (Robles *et al.*, 2015).[15]

15 Information on cocaine seizures in Colombia was obtained from UNODC (2014). Figure A.1 presents the relationship between homicide levels in Mexico and the proportion of cocaine seized in Colombia. The exclusion restriction is upheld if the change in the proportion of total cocaine production seized in Colombia together with the municipality's proximity to the U.S. border only affects homicide levels.

However, the instrument presents a couple of limitations. First, according to Castillo *et al.* (2014) the large reduction in Colombian cocaine supply accounts for up to 25.0% of the increase of violence in northern Mexico, where this figure drops to 15.7% for Puebla, a municipality that has an approximate national mean distance from the U.S. border of 760 kilometres. Hence, the instrument has a stronger relationship to violence in northern municipalities than in the rest of the country. Second, the instrument proposed by Castillo *et al.* (2014) is related to drug-trafficking violence and therefore does not consider the channels through which violence in Mexico affected civilians.

Table 7 presents the first stage results of the IV estimations. In all cases, the coefficient on the interaction of the municipality's proximity to the U.S. border and the percentage of cocaine seized in Colombia is positive. This relationship is the expected sign, since it is assumed that if a municipality is closer to the U.S. its homicide rate will be higher. It is also expected that if the percentage of cocaine seized increases, more homicides will occur. Furthermore, the interaction term is a strong predictor of the homicide rate at the municipal level, where the coefficient, at 1%, is significant in all models. The value of the F statistic is above ten, which is commonly used in literature, and above the Stock-Yogo critical values at the 10.0% significance level.

FE and IV estimations of the effects of drug-related homicides on educational outcomes are presented in Table 8. Results for the effects of total homicides during the last calendar year have a directly comparable measurement of the two violent crime variables. Table 8 shows in columns (1) and (3) that among elementary school students, concerning ENLACE scores in Spanish and Mathematics, the decrease generated by a rise in total homicides is larger than the one generated by an increase in drug-related homicides. For grade failure the same pattern is observed, where the effect of drug homicides is smaller relative to that of total homicides. Among middle school students, FE results suggest that ENLACE scores do not decrease when drug-related homicides rise. Nonetheless, grade failure rates increase when drug homicide rise, where this coefficient is significant at the 1.0% level. With respect to the IV estimations presented in columns (2) and (4), when instruments are employed for the homicide variables, using the interaction of a municipality's proximity to the U.S. border with the percentage of cocaine seized in Colombia, the effect is again negative and significant. For middle school students, the relationship between a rise in drug-related homicides and a decrease in ENLACE scores in Spanish and Mathematics is now significant at the 1.0% level. The larger size of homicides and drug homicides coefficients when using IV models suggest that the FE estimations may be downwardly biased.

Table 7
First stage results of FE-IV estimation. Dependent variable: local homicide rate

Variable	(1)	(2)	(3)	(4)
	Homicides		*Drug-related homicides*	
	Elementary	*Secondary*	*Elementary*	*Secondary*
(Proximity to U.S.)×(% Colombian cocaine seized)	0.0091***	0.0074***	0.0089***	0.0070***
	(0.0019)	(0.0015)	(0.0015)	(0.0011)
Number of students/100	-0.326**	-0.022	-0.240***	-0.065
	(0.131)	(0.039)	(0.084)	(0.055)
Number of groups	-0.012	-0.047**	-0.004	-0.025
	(0.014)	(0.019)	(0.014)	(0.017)
All grades	-0.086	0.225**	-0.143**	-0.014
	(0.054)	(0.091)	(0.063)	(0.152)
Number of classrooms used	-0.010	-0.003	-0.004	0.008
	(0.013)	(0.011)	(0.012)	(0.008)
Principal is also a teacher	-0.031	-0.040	0.046*	0.027
	(0.027)	(0.032)	(0.027)	(0.038)
Student/Teacher ratio	0.147	0.371	0.268	0.831**
	(0.775)	(0.388)	(0.922)	(0.413)
PEC	0.072	0.044	0.066	0.070**
	(0.057)	(0.033)	(0.044)	(0.034)
PETC	-0.212**	-0.292*	-0.191	-0.335*
	(0.102)	(0.163)	(0.128)	(0.193)
PES	0.423**	0.262***	0.161	0.034
	(0.169)	(0.094)	(0.131)	(0.076)
School fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Municipal-level controls	Yes	Yes	Yes	Yes
State-level controls	Yes	Yes	Yes	Yes
R-squared	0.185	0.157	0.133	0.103
F-test on instrument	21.74	25.47	37.37	38.50
Observations	358,038	137,592	358,038	137,592

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on ENLACE, Statistics 911, SIMBAD and Policía Federal (2015). Standard errors are clustered at the municipal-level. The F statistic is the Kleibergen-Paap rk Wald F statistic, which is robust to the presence of clustering in the data.

Table 8
FE and IV estimations of the effect of local homicide rates on test scores and grade failure rates

	(1)	(2)	(3)	(4)
Dependent variable	*Homicides*		*Drug-related homicides*	
	FE	*IV*	*FE*	*IV*
	Elementary			
ENLACE: Spanish	-0.0035**	-0.0470***	-0.0021**	-0.0483***
	(0.0016)	(0.0164)	(0.0010)	(0.0143)
ENLACE: Math	-0.0039**	-0.0584***	-0.0021*	-0.0601***
	(0.0018)	(0.0186)	(0.0011)	(0.0159)
Grade failure/100	0.0282***	0.3612***	0.0190***	0.3711***
	(0.0070)	(0.0888)	(0.0053)	(0.0779)
	Secondary			
ENLACE: Spanish	-0.0089***	-0.1552***	-0.0005	-0.1631***
	(0.0029)	(0.0420)	(0.0015)	(0.0401)
ENLACE: Math	-0.0142***	-0.1471***	-0.0017	-0.1540***
	(0.0032)	(0.0409)	(0.0019)	(0.0383)
Grade failure/100	0.0268***	0.1782***	0.0199***	0.1883***
	(0.0082)	(0.0477)	(0.0055)	(0.0446)
School-level controls	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Municipal-level controls	Yes	Yes	Yes	Yes
State-level controls	Yes	Yes	Yes	Yes

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on ENLACE, Statistics 911, SIMBAD and Policía Federal (2015). Dependent variable is the standardised ENLACE test score at the school level or the grade failure rate at the school-level. Coefficients in columns (1) and (3) correspond to the total number of homicides and drug-related homicides per 10,000 inhabitants in a FE model. Coefficients in columns (2) and (4) correspond to the total number of homicides and drug-trade related homicides per 10,000 inhabitants in a FE-IV model. School-level controls are the same as those included in Table 3. Standard errors are clustered at the municipal-level.

6.2 Mechanisms

It is hypothesised that exposure to violent crime affects academic performance and grade failure rates partly because it leads to a reduction in contact hours. To examine this, data from the National Time-Use Survey (ENUT) from 2002, 2009 and 2014 is used. Table 9 explores the relationship between attending school, the number of contact hours, engaging in school related work at home, the number of hours doing schoolwork at home, and homicide rates. The analysis is performed for individuals in: a) elementary or middle school age (6 to 18 years); b) elementary school age (6 to 12 years); and c) lower middle school age (13 to 16 years). Estimation results for both OLS and IV models are presented.

Row A column (1) shows that homicide rates are not associated with the decision to attend school. Nonetheless, it can be seen in column (2) that for both the OLS and IV models, higher homicide rates are indeed related with a fewer number of hours spent at school, where these effects are significant at the 5.0% level. Because of fewer contact hours, families could compensate for this by spending more time performing school related activities at home. Column (3) shows that the homicide rate is not associated with whether children and adolescents perform schoolwork at home. However, it can be seen in column (4) that higher homicide rates are negatively associated with the number of hours students spend performing school related activities at home. The coefficients in both the OLS and IV models are statistically significant. Thus, families do not compensate for fewer contact hours by making their children study more outside of the classroom. On the contrary, these two mechanisms appear to reinforce one another. When the analysis is focused exclusively on either the elementary or the middle school age population, rows B and C also show a similar relationship.

Table 9
OLS and IV estimations of the effect of state homicide rates on school attendance, contact hours and schoolwork

Model	(1)	(2)	(3)	(4)
	Attending school (Yes = 1, 0 =No)	*Hours at school*	*Schoolwork at home (Yes = 1, 0 = No)*	*Hours doing schoolwork at home*
Age: 6 to 18 years				
OLS	0.0015	-0.1679**	0.0018	-0.1509***
	(0.0024)	(0.0711)	(0.0027)	(0.0405)
IV	-0.0088	-0.6961*	-0.0146	-0.5118**
	(0.0123)	(0.3586)	(0.0133)	(0.2194)
Observations	18,589	11,612	17,818	18,395
Age: 6 to 12 years				
OLS	.0063	-0.2174**	0.0040	-0.0635*
	(0.0052)	(0.1042)	(0.0032)	(0.0374)
IV	-0.0089	-0.7072	-0.0087	-0.2255**
	(0.0153)	(0.5822)	(0.0141)	(0.1112)
Observations	5,255	2,080	5,236	5,918
Age: 13 to 16 years				
OLS	0.0030	-0.1596**	0.0027	-0.1757***
	(0.0020)	(0.0700)	(0.0024)	(0.0529)
IV	0.0002	-0.7947*	-0.0151	-0.5970*
	(0.0107)	(0.4344)	(0.0147)	(0.3071)
Observations	8,905	7,189	8,604	8,502

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on ENUT 2002, 2009 and 2014. Dependent variable is indicated below the column number. Coefficients correspond to the total number of homicides per 10,000 inhabitants at the state-level. Regressions include as controls age, age squared and gender of the respondent, number of persons in the household, an indicator of quality of the walls in the household and time and size of locality dummies. Standard errors are clustered at the state-level.

Table 10
FE estimations of the effect of local homicide rates on teacher and student mobility and school and teacher characteristics

Variable	(1)	(2)	(3)	(4)
	Log (no. of teachers at school)	*Log (no. of students at school)*	*Student-teacher Ratio*	*% of teachers, with graduate studies*
A. Main	-0.0021***	-.00032***	-0.0183*	-0.0245
	(0.0004)	(0.0006)	(0.0106)	(0.0152)
B. Educational level				
Elementary	-0.0022***	-0.0035***	-0.0233*	-0.0004
	(0.0004)	(0.0006)	(0.0129)	(0.0172)
Secondary	-0.0007	-0.0018***	-0.0207	-0.0958***
	(0.0007)	(0.0006)	(0.0157)	(0.0318)
C. Marginality Level				
High	-0.0011	-0.0028***	-0.0131	-0.041
	(0.0009)	(0.0010)	(0.0227)	(0.0276)
Medium	-0.0022***	-0.0034***	0.0171	-0.0359
	(0.0008)	(0.0010)	(0.0244)	(0.0395)
Low	-0.0018***	-0.0032***	-0.0309***	-0.0153
	(0.0004)	(0.0007)	(0.0108)	(0.0184)
D. Locality Size				
Urban	-0.0022***	-0.0038***	-0.0339***	-0.0304
	(0.0004)	(0.0006)	(0.0095)	(0.0194)
Rural	-0.0012**	-0.0019***	0.0182	-0.0405*
	(0.0005)	(0.0006)	(0.0135)	(0.0221)
E. Session				
Morning	-0.0016***	-0.0023***	-0.0059	-0.0256*
	(0.0003)	(0.0004)	(0.0093)	(0.0155)
Afternoon	-0.0032***	-0.0058***	-0.0670***	-0.0341
	(0.0007)	(0.0011)	(0.0170)	(0.0247)
F. School Type				
Public	-0.0019***	-0.0033***	-0.0229*	0.0035
	(0.0003)	(0.0006)	(0.0127)	(0.0181)
Private	-0.0034***	-0.0057***	-0.0325	-0.0746*
	(0.0010)	(0.0014)	(0.0221)	(0.0415)

School-level controls	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Municipal-level controls	Yes	Yes	Yes	Yes
State-level controls	Yes	Yes	Yes	Yes

Note: * p<0.10; ** p<0.05; *** p<0.01. Source: Author's elaboration based on Statistics 911 and SIMBAD. Dependent variable is indicated below the column number. Coefficients correspond to the total number of homicides per 10,000 inhabitants. School-level controls are the same as those included in Table 3. Standard errors are clustered at the municipal-level.

High levels of violent crime in a municipality are also likely to affect the characteristics of the schools located within their limits. Table 10 explores the relationship between homicides, teacher and student mobility and teachers' education levels. Row A presents results based on all elementary and middle schools. It can be seen in column (1) that an increase in the homicide rate is associated with a decrease in the number of teachers per school. Moreover, column (2) shows that a rise in homicide levels is also associated with a reduction in the number of students enrolled per school. The estimated coefficients are statistically significant at the 1.0% level and suggest that crime exposure affects both teacher and student composition. Column (3) presents the effects of the homicide rate on the student-teacher ratio, where an increase in the homicide rate is associated with a reduction in the number of students per teacher. This may be partly a result of the higher mobility that students have in changing schools relative to teachers. Column (4) shows that the relationship between homicides and the percentage of teachers with graduate studies, interpreted here as a broad measure of teacher quality, is not statistically significant. Row B separates elementary schools and lower middle schools. Among elementary schools, an increase in the homicide rate is associated with a statistically significant reduction in the number of teachers, students and the student-teacher ratio. Among lower middle schools, it is associated with a drop in the number of students and in the number of teachers with graduate studies.

Focusing on different subgroups of schools, an increase in the homicide rate is always statistically associated with a decrease in the number of teachers in all the different groups of schools, except in those located in high marginality areas. A similar relationship is observed for students, where a rise in the homicide rate is always associated with a decrease in the number of teachers, where these coefficients are statistically significant at the 1.0% level.

Moreover, by locality size, the reduction in the number of students is almost double in urban schools relative to rural schools. This may be reflecting differences in the supply of schools and hence the number of options available to parents depending on the size of the locality of residence. By school type, a rise in the homicide rate has a larger effect in private schools relative to public schools, which may be signalling the higher income capacity of parents to move their children to a different school. Additionally, when the homicide rate increases the student-teacher ratio decreases in schools of: low marginality levels, in schools that have sessions in the afternoon and in public schools.

Lastly, previous evidence suggests that the rise in homicides influenced the migration behaviour and mental health status of different segments of the population. Rios (2014) observes that a one-unit increase in the drug-related homicide rate per 10,000 inhabitants is associated with 63.34 Mexicans fleeing their municipality of residency. Changes in the student body composition may have important effects on the results, since the findings depend on which students are changing schools. The effects found in the empirical analysis could be partially or completely explained by these changes. For example, if the brightest students from municipalities that encounter high homicide rates move to safer municipalities, then the negative effects of homicides on educational outcomes would be at least partially driven by the migration of the smartest students. To minimise the effects of this phenomenon, Eq. (1) was estimated for schools where the difference in the total number of students in any two periods was never larger than 15, 20 or 25. The results obtained from these subsamples were similar to those reported in Table 3. Moreover, Márquez-Padilla *et al.* (2015) show that, for the 2007-2010 period, the rise in homicide levels did not affect the enrolment rates of elementary and middle school students.

Finally, Balmori (2014) examines the effect of drug-related violence on depression in Mexico. The author observes a statistically significant increase in clinical and non-clinical depression among women, but not men, because of drug-related violence. The fact that the rise in homicide rates is associated with some segments of the population being displaced from their municipality of residence as well as with an increase in the prevalence of depression, a common symptom of PTSD, implies that, besides the reduction in contact hours, these two factors are also likely to explain why being exposed to violent crimes is negatively associated with educational outcomes.

Conclusions

This study examined the effects of crime exposure on the educational outcomes of elementary and middle school students in Mexico. To measure

crime, homicides rates at the municipal-level were constructed. Educational outcomes were examined using the scores obtained in the ENLACE test and grade failure rates. Subsequently, fixed effects and instrumental variable models were estimated, with each model presenting its own strengths and weaknesses. In both cases a negative relationship between crime exposure and educational outcomes was observed. On one hand, the larger effect of homicides and drug-related homicides in the instrumental variable models suggest that the fixed effects estimations may be downwardly biased. On the other hand, this may also reflect that the instrument used in the study has a stronger relationship to violence in Mexico's northern municipalities, where most of the country's drug-related homicides occurred. Results based on the fixed effects models show that a one-unit increase in the homicide rate per 10,000 inhabitants is associated with a reduction in the average ENLACE scores between 0.0035 and 0.0142 standard deviations. This effect is larger in middle schools, stronger if the homicide occurs closer to the examination date and is relatively stable when using either total homicides or drug-related homicides to measure crime. A rise in the homicide rate is also associated with an increase in the grade failure rate. It is hypothesised that the negative effects of crime exposure on educational outcomes are partly due to a reduction in the number of contact hours, where students do not compensate for this by studying more outside of school.

These findings are comparable to those obtained in previous studies. Michaelsen and Salardi (2015) observe that a one-unit increase in the homicide rate per 10,000 inhabitants reduces average ENLACE scores in different subjects in elementary schools between 0.196 and 0.222 points; while for elementary schools the present study finds a decrease of 0.229 and 0.273 points for Spanish and Mathematics, respectively. With respect to grade failure rates, Caudillo and Torche (2014) show that a one-unit rise in the homicide rate per 10,000 inhabitants increases the grade failure rate in elementary schools by 0.027 percentage points when using a school-level FE model. The results obtained in the present study show an increase in grade failure rates of 0.028 and 0.027 percentage points for elementary and middle schools, respectively.

This article has provided evidence that being exposed to high levels of violence negatively affects educational outcomes. In addition to the short-term effects observed, it can be inferred that the increase in violence will have medium and long-term effects since, by affecting current educational outcomes, early exposure to homicides is likely to impact subsequent educational attainment levels and thus the future flow of income of Mexico's youth. Moreover, since the effects of crime exposure are stronger in public schools and in higher marginalized areas, these negative consequences are potentially amplified among students residing in households located at the

bottom-part of the income distribution. Since educational attainment plays a central role in explaining differences in earnings and general economic well-being, this may generate higher inequality in the future by widening the gap in human capital attainment levels between the rich and the poor.

References

[1] Abouk, R. and Adams, S. (2013). "School shootings and private school enrolment". *Economics Letters*, 118, 297-299.

[2] Balmori, J. (2014). Three essays on law and development in Mexico. (Doctoral Dissertation). Cornell University, Ithaca.

[3] Basu, S. and Pearlman, S. (2017). "Violence and migration: evidence from Mexico's drug war". *IZA Journal of Development and Migration*, 7, 18.

[4] Brown, R. and Velásquez, A. (2017). "The effects of violent crime on the human capital accumulation of young adults". *Journal of Development Economics*, 127, 1-12.

[5] Castillo, J., Mejía, D., and Restrepo, P. (2014). "Scarcity without Leviathan: The violent effects of cocaine supply shortages in the Mexican drug war". Center for Global Development Working Paper No. 356.

[6] Caudillo, M. and Torche, F. (2014). "Exposure to local homicides and early educational achievement in Mexico". *Sociology of Education*, 82, 89-105.

[7] Chamarbagwala, R. and Morán, H. (2011). "The human capital consequences of civil war: Evidence from Guatemala". *Journal of Development Economics*, 94, 41-61.

[8] Dell, M. (2015). "Trafficking networks and the Mexican drug war". *American Economic Review*, 105, 1738-1779.

[9] Ding, W., Lehrer, S., Rosenquist, N., and Audrain-McGovern, J. (2009). "The impact of poor health on academic performance: New evidence using genetic markers". *Journal of Health Economics*, 28, 578-597.

[10] Dube, A., Dube, O., and García-Ponce, O. (2013). "Cross-border spillover: U.S. gun laws and violence in Mexico". *American Political Science Review*, 107, 397-417.

[11] Duran-Martinez, A. (2015). "To kill and tell? State power, criminal competition and drug violence." *Journal of Conflict Resolution*, 59, 1377-1402.

[12] Enamorado, T., López-Calva, L., and Rodríguez-Castelán, C. (2014). "Crime and growth convergence: Evidence from Mexico". *Economics Letters*, 125, 9-13.

[13] Gerardino, M. (2014). The effect of violence on the educational gender gap. Unpublished manuscript.

[14] Grogger, J. (1997). "Local violence and educational attainment". *Journal of Human Resources*, 32, 659-682.

[15] Guerrero-Gutiérrez, E. (2011). Security, drugs, and violence in Mexico: A survey. Paper presented at the 7th North American Forum Meeting, Washington, D.C.

[16] Harding, D. (2010). *Living in the Drama: Community, Conflict, and Culture among Inner-City Boys*. Chicago, IL: University of Chicago Press.

[17] INEGI (2012). Resultados de la ENVIPE 2012. Boletín de prensa núm. 339/12. Aguascalientes: INEGI.

[18] Justino, P., Leone, M., and Salardi, P. (2014). "Short- and long-term impact of violence on education: The case of Timor-Leste". *World Bank Economic Review*, 28, 320-353.

[19] León, G. (2012). "Civil conflict and human capital accumulation: The long-term effects of political violence in Perú". *Journal of Human Resources*, 47, 991-1022.

[20] Márquez-Padilla, F., Pérez-Arce, F., and Rodríguez-Castelán, C. (2015). "The (non-) effect of violence on education: Evidence from the "war on drugs" in Mexico". World Bank Working Paper No. 7230.

[21] Michaelsen, M. and Salardi, P. (2015). Violence, psychological stress and educational performance in Mexico. Paper presented at the Pacific Conference for Development Economics, San Diego.

[22] Monteiro, J. and Rocha, R. (2017). "Drug battles and school achievement: Evidence from Rio de Janeiro's favelas". *Review of Economics and Statistics*, 99(2), 213-228.

[23] O'Neil, S. (2009). "The real war in Mexico: How democracy can defeat the drug cartels". *Foreign Affairs*, 88(4): 63-77.

[24] Osofsky, H., Osofsky, J., Sklarew, B., Twemlow, S., and Wilkinson, S. (2004). Children's exposure to community violence: Psychoanalytic perspectives on evaluation and treatment. In Sklarew, B., Twemlow, S., and Wilkinson, S. (Eds.), *Analysts in the Trenches: Streets, Schools, War Zones* (pp. 237-256). Abingdon: Routledge.

[25] Policía Federal (2015). Oficio PF/OCG/DGE/0083/2015. México: Policía Federal. Oficina del Comisionado General. Dirección General de Enlace.

[26] PGR (2014). Oficio: SJAI/DGAJ/00826/2014. México: Procuraduría General de la República. Subprocuraduría Jurídica de Asuntos Internacionales. Dirección General de Asuntos Jurídicos.

[27] Poutvaara, P. and Ropponen, O. (2018). "Shocking news and cognitive performance". *European Journal of Political Economy*, 51, 93-106.

[28] Rios, V. (2014). "The role of drug violence and extortion in promoting Mexican migration: Unexpected consequences of a drug war". *Latin American Research Review*, 49, 199-217.

[29] Robles, G., Calderón, G., and Magaloni, B. (2015). "The economic consequences of drug trafficking violence in Mexico". Stanford University Working Paper.

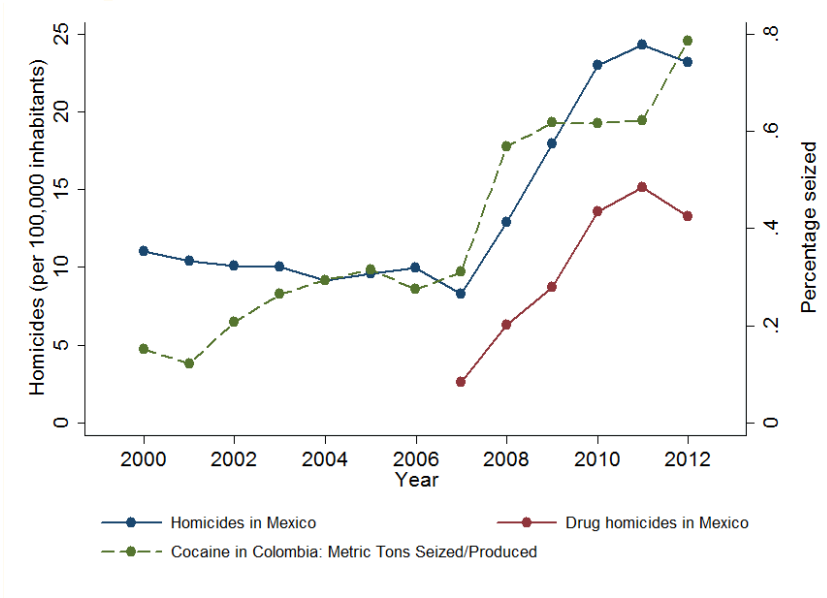
[30] Sampson, R., Raudenbush, S., and Earls, F. (1997). "Neighborhoods and violent crime: A multilevel study of collective efficacy". *Science*, 277, 918-924.

[31] Shemyakina, O. (2011). "The effect of armed conflict on accumulation of schooling: Results from Tajikistan". *Journal of Development Economics*, 95, 186-200.

[32] UNODC (2014). World Drug Report. Vienna: United Nations Office on Drugs and Crime.

[33] World Bank (2014). World Development Indicators. Washington, DC: World Bank.

Figure A.1
Homicides in Mexico and cocaine seizures in Colombia, 2000-2012



Source: Author's elaboration based on SIMBAD, Policía Federal (2015) and UNODC (2014).