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Can Education Reduce Violent Crime? Evidence from Mexico before and after the Drug War Onset

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ABSTRACT *Existing theories relate higher education to lower crime rates, yet we have limited evidence on the crime-reducing effect of education in developing countries. We contribute to this literature by examining the effect of education on homicide in Mexico, where homicide rates decreased by nearly 55 percent from 1992 to 2007, before the surge of drug-related violence. We argue that a large amount of this reduction followed a compulsory schooling law at the secondary level in 1993, when the government undertook key education reforms to promote development and economic integration. We employ different empirical strategies that combine regression analysis, placebo tests, and an instrumental variable approach, and find that attendance in secondary and tertiary schools has a negative effect on homicide rates before the onset of the Drug War, although the evidence for secondary enrolment is more robust. This effect vanishes after the drug war onset, indicating that school attendance has different effects on different types of criminal activity. These findings suggest that policy makers can reduce crime and traditional forms of interpersonal violence by strengthening the education system.*

KEYWORDS: Crime; homicide; education; school enrolment; drug war; Mexico

1. Introduction

Does education decrease homicide and improve individual security? This is a question with significant policy relevance as many developing countries have suffered from high rates of homicide over the past decades, with profound negative externalities on human and economic development (WB, 2017). Moreover, if advances in school attendance lower crime rates, then improving access to education provides a possible avenue to enhance individual security, and a reduction in crime can be an important byproduct of government efforts to expand education.

Existing theories highlight plausible reasons for why education can decrease crime: school attendance rises the opportunity costs of crime and dissuades participation in criminal activity (e.g. Ehrlich, 1975), it reduces the availability of time to get involved in criminal activity (e.g. Lochner, 2004), and it strengthens informal constraints that prevent potential offenders from committing

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a crime (e.g. Hirschi, 1969). Despite the relevance of this literature, however, there is a lack of systematic research on the link between education and crime in developing countries. Previous studies on the subject largely focus on advanced democracies, without considering whether the effects of education policy and schooling on crime also extend to developing countries (e.g. Jacob & Lefgren, 2003; Lochner & Moretti, 2004; Machin, Marie, & Vujić, 2011; see also Juaraez, Urdal, & Vadlamannati, 2020). The few studies focusing on developing countries show mixed results. Some suggest that education decreases violent crime (e.g. Fajnzylber, Lederman, & Loayza, 2002a; Rivera, 2016), while others find no effect (e.g. Fajnzylber, Lederman, & Loayza, 2002b; Kim & Pridemore, 2005).

To examine the effect of education on homicide, we exploit a compulsory schooling law at the secondary level introduced in Mexico in 1993. This law was implemented by the hegemonic one-party regime to promote development and economic integration, and provides an independent increase in enrolment rates in secondary and tertiary schools not likely to be correlated with other factors influencing homicide. Taking advantage of the raise in education following the reform, we employ different empirical strategies to assess the effect of education on homicide rates. Since the compulsory schooling reform was national and implemented in all Mexican states, our empirical estimates identify the size of the cohort treated by the reform and the growth in the number of secondary schools. This approach strengthens our main results by allowing us to capture exogenous variation over time and across units.

We show attendance in secondary and tertiary schools has a negative effect on homicide rates, although the results for secondary enrolment are more robust. This effect vanishes after the onset of the drug war, when the quantity and quality of homicide violence dramatically changed as a result of confrontations between drug criminal organisations. Our results suggest that school attendance has different effects on different types of criminal activity. While the expansion of education is important in its own right, the results suggest that policy makers can also expect welfare policies aimed at strengthening the education system to decrease crime (e.g. Eisner, 2015; Rivera & Zarate-Tenorio, 2016). Our analysis indicates that strategies outside law enforcement can also have substantial effects on the reduction of crime in late development countries, where there is ample scope for implementing better welfare policies.

2. The decline in homicide before the drug war onset

The outbreak of the Mexican Drug War has gained considerable attention from academics and policy makers (see Shirk & Wallman, 2015). This is not surprising, given the magnitude and brutality of drug-related violence. Moreover, the wave of violence came after Mexico's transition to democracy in 2000 and seems to run counter to common arguments relating democracy to lower crime (e.g. Eisner, 2003). In our view, however, it is rather striking that previous studies largely ignored why violent crime declined sharply before the drug war.

Figure 1 shows time series data for violent crime between 1990 and 2015, as measured by the number of homicides per 100,000 inhabitants.[1] Three aspects stand out. First, homicide rates were very high in the early 1990s, peaking in 1992 at 19 homicides per 100,000 inhabitants, and then fell steadily from 19 to 8.6 between 1992 and 2007, a reduction of nearly 55 per cent.[2] Second, the government's war against drug cartels reversed prior advances in individual security, provoking a fast and large growth of violence, which rose to a peak of almost 27 homicides per 100,000 inhabitants in 2010. Third, the average homicide rate during the Mexican Drug War (19.1) is comparable to the average homicide rate in the early 1990s, although there are noticeable differences in the type of violence in these periods. Whereas homicidal violence before the war on drugs tended to result from non-organised interpersonal violence, battles between well-armed criminal groups and/or confrontations with the state security apparatus have figured prominently in the drug war.

There is also significant spatial variation in homicide rates before and after the onset of the Mexican Drug War. Table A1 in the Appendix shows the percentage change in homicide rates in

Figure 1. Homicide Rate in Mexico, 1990–2014.

all of Mexico's 31 states and Mexico City from 1992 to 2006, illustrating the magnitude of the homicide decline described above. It demonstrates that the reduction in homicide encompassed the whole country, except Chihuahua – a Northern border state where homicide rates increased 5.4 per cent – and Nuevo León, where a relatively low homicide rate at the outset did not change.

Even more surprising is the scale of the reduction, as half of the states experienced a decline in homicide rates of more than 50 per cent; two thirds of all states experienced a reduction of at least 30 per cent between 1992 and 2006. The rightmost column presents the homicide rate average over the period 2007–2015. Violence has tended to be concentrated in seven states, which account for nearly 54 per cent of all homicides (i.e. Chihuahua, Baja California, Guerrero, Estado de México, Jalisco, Nuevo León, and Sinaloa). These figures show how drug-related violence has been largely confined to a handful of states and not engulfed the entire country, as sometimes implied by descriptions of Mexico as a case of 'state failure' (e.g. Carpenter, 2015). In brief, we see divergent trends in homicide within Mexico that resemble the spatial concentration of violence in many countries with ongoing civil wars (Cederman & Gleditsch, 2009).

Although there is much research on the surge of drug-related violence, existing studies ignore why homicide rates dropped sharply before the Mexican Drug War. The few studies analysing trends in violent crime before the drug war highlight an increase in homicide related due to subnational democratisation (Villarreal, 2002). Others emphasise the growing power of drug cartels in the mid-nineties and link this to a surge in homicide (Chabat, 2002). These studies may help explain why violent crime increased in the 1990s, but overlook the fact that homicide fell before the drug war.

What thus explains the general and steady decline in homicide before the drug war? Leading theories examine crime as a function of criminal-justice systems and legitimate labour market opportunities (Chalfin & McCrary, 2017). Although we do not dismiss the relevance of these factors, we believe that neither the criminal-justice system nor labour market opportunities can offer a satisfactory explanation for the large, widespread, and sustained decline in homicide before the drug war. Indeed, ineffectiveness and corruption have been persistent and widespread in Mexico's criminal-justice system and are generally considered a main cause of the state's lack of capacity to deter, prosecute, and punish criminal activity (Shirk, 2010). The decline in homicide appears to have

taken place in spite of the weakness of the judicial system, suggesting that law enforcement policies cannot account for the large reduction in homicide. Similarly, it seems unlikely that favourable economic conditions could account for such a decline since Mexico experienced economic crises in 1994 and 2001, with severe consequences for employment and sustained low economic growth while homicide rates were falling steadily. In this article, we argue that the homicide decline at least in part can be attributed to the expansion of secondary and tertiary education across the country.

3. Education policy under authoritarianism

The Institutional Revolutionary Party (PRI) established one of the most durable authoritarian regimes in the 20th century, holding onto power from 1929 until 2000. Since the origins of the one-party hegemonic regime, education policy aimed at consolidating the post-revolutionary nationalism embraced by the PRI. Drawing on the ideals of the Mexican Revolution, in 1934 President Lázaro Cárdenas amended Article 3 of the Constitution, establishing that public education would be socialist and that the state would take control of basic and teacher education. Although President Manuel Avila Camacho suppressed the socialist character of public education in 1946, education policy continued to be oriented towards strengthening the post-revolutionary ideology and consolidating nation-building until the very end of the authoritarian regime. Since the beginning of authoritarianism, moreover, education policy was largely focused on fighting illiteracy and expanding primary education in rural and urban areas (Carranza, 2008). The emphasis on basic education is not surprising, since the education system was ruined at the end of the Revolution and two thirds of the population were illiterate in the 1920s (Moctezuma, 1993).

Education policy under the PRI produced mixed results. Illiteracy rates declined from 68 per cent to 12 per cent between 1921 and 1990, and enrolment in primary schools increased from 20 per cent to almost 95 per cent over the same period. However, a significant number of students did not complete primary education – the 1990 national census showed that nearly 12 million people started primary school but did not finish.[3] Moreover, by the late 1980s, one third of the population in secondary school age did not have access to secondary education, and two thirds of the population in tertiary school age did not attend tertiary education. Against this context, President Carlos Salinas de Gortari (1988–1994) promoted several reforms intended to raise educational attendance and transform the education system.

Salinas took power after a highly contested presidential election in 1988, when many observers alleged that the PRI engaged in electoral fraud to deny a likely victory for the opposition challenger Cuauhtémoc Cárdenas. The hallmark of the Salinas government was a modernisation project aimed at improving competitiveness and incorporating the country into the international economy. In his 1989 Annual Report, President Salinas stressed his conviction that 'education is an irreplaceable condition for economic and social modernization, it is the sector with the highest priority in the government's duties'. Two years later, Salinas highlighted how better education will mean a more equal distribution of income and will allow taking advantage of the opportunities opened by economic interconnectedness.[4] Consistent with this, the Mexican government increased education expenditures from 3.3 per cent of the GDP in 1988 to 5.2 per cent in 1993. Furthermore, the government undertook major reforms to decentralise the education system and expand secondary and tertiary school attendance. In 1992, the federal government transferred its responsibility over basic and teacher education to subnational governments across the country.[5] The rationale of the reform was that a highly centralised structure had prevented progress of public education and had enabled the National Union of Educational Workers (SNTE) to gain control over the education system.

A second major reform of the education system came in 1993, when Article 3 of the Constitution was amended to establish that secondary education should be compulsory. This represented a significant change in education policy, as it forced the government to guarantee the supply of educational opportunities for the secondary school aged population across the country. Importantly,

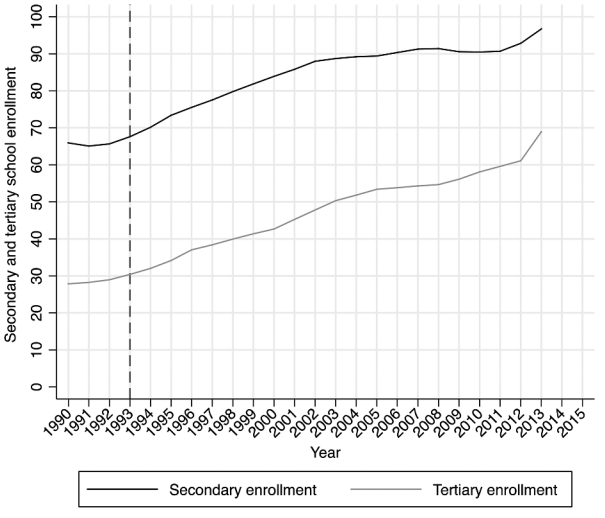

Figure 2. Enrolment in secondary and tertiary schools in Mexico, 1990–2015.

the reform was not purely centred on secondary education but targeted tertiary levels too, since government expected to increase enrolment rates in higher levels of education – most notably tertiary education – by increasing attendance in secondary schools (Moctezuma, 1993). Moreover, the education policy introduced by President Salinas was sustained by his successor President Ernesto Zedillo, who helped to deepen and consolidate the modernisation project in the 1990s (Latapí, 2004).[6]

Figure 2 displays time series data for secondary and tertiary school enrolment between 1990 and 2015. It demonstrates how the compulsory schooling reform had a strong positive effect on school attendance in secondary education, rising from 66 per cent in 1992 to 84 per cent in 2000 when the PRI was defeated. It also reveals a very similar pattern for school enrolment in tertiary education, increasing from 29 per cent to 43 per cent over the same period. In absolute terms, the number of students in secondary schools increased from approximately 4,200,000 to 5,300,000 and from 1,800,000 to 2,600,000 in tertiary schools. Note that nearly 50 per cent of the increase in secondary and tertiary school enrolment between 1992 and 2000 is observed immediately in the first three years of the reform.[7]

The reform increased attention to education in general and encouraged tertiary enrolment, but above all it accelerated continuation rates, which increased by 7 percentage points (from 75%-82%) in the years before the reform (1990–1994) and by a 12 percentage points (from 82%-94%) from 1994–1997. Overall, although our data do not extend further back than 1990, Figure 2 suggests that the reform increased enrolment in secondary and tertiary schools, and that changes in enrolment rates do not simply reflect prior increasing trends in school enrolment. Indeed, alternative data compiled by UNESCO indicate an actual drop in secondary enrolment during the early 1980s and confirm a plateau in the early 1990s (see the Online Appendix, Figure A1).[8] Importantly, the large and steady expansion of school attendance was also widespread and took place throughout the country (see the Online Appendix, Figures A2-A3).

4. Education and crime

We review in this section the theoretical literature on the education–crime nexus and detail a number of mechanisms through which educational attendance can influence individual decisions with regards to crime: deterrence, incapacitation, and social bonds.

A first mechanism through which education can affect crime is deterrence. Economic theory suggests that criminal behaviour is rational and responds to incentives shaping the expected costs and benefits of crime. Becker's (1968) economic model proposes a scenario where individuals decide whether to get involved in criminal activities by assessing the potential costs and benefits associated with committing a crime and predicts that crime is more likely when the expected benefits outweigh the expected costs. From this perspective, individual decisions to engage in crime are determined by the utility related to abstaining from crime, the probability of apprehension, and the severity of punishment. A vast literature relates the utility of keeping away from crime to legal wages earned in the labour market, whereby increases in legal wages should lower crime by decreasing the relative benefits of crime (e.g. Ehrlich, 1973).

Related research emphasises how the expected economic costs associated with less years of education can deter or dissuade individuals from participating in criminal activity. Put differently, the expected economic losses as a result of the lack of education or lower levels of school attendance can help prevent criminal involvement and the commission of crime. Specifically, education can affect individual decisions about crime through its effect on actors' expectations about further returns of schooling, namely lowering the risk of unemployment and increasing future income. Economic theory anticipates that education raises individual patience and risk aversion, because education is expected to improve employment opportunities and higher wages in the legal labour market. Such expectations about the payoffs of education will in turn affect decisions about crime by raising the opportunity costs as well as the utility of abstaining from it (e.g. Ehrlich, 1975; Lochner, 2004; Lochner & Moretti, 2004). This explanation echoes an earlier sociological literature that points to the role of social bonds, suggesting that a commitment to future goals that are related to schooling can help prevent individuals from committing criminal acts (Hirschi, 1969).

Other explanations suggest that education affects crime through incapacitation. Much research points to the role of criminal-judicial systems, suggesting that increasing incarceration rates should lower crime rates. One reason for this is that offenders are taken out of the streets, without opportunity of getting involved and committing further criminal actions while imprisoned (e.g. Barbarino & Mastrobuoni, 2014; Marvell & Moody, 1994). Others argue that schooling can have an incapacitation effect since potential offenders – most notably young actors – spent more time at the school, reducing the available time for engaging in criminal activity (e.g. Hirschi, 1969; Jacob & Lefgren, 2003). This literature suggests that the probability of participation in criminal activities will be lower for individuals attending school relative to those not enrolled and highlights how states can deter crime by strengthening criminal-judicial institutions (*sticks*) and also contain crime by improving educational attendance (*carrots*).

A third explanation emphasises how education shapes criminal or deviant behaviour by strengthening individuals' attachment to social norms and social institutions. Following Durkheim's pioneering argument that 'the more weakened the groups to which [the individual] belong, the less he depends on them, the more he consequently depends only on himself and recognizes no other rules of conduct than what are founded on his private interests' (quoted in LaFree, 1998, p. 66), social bond theory looks highlights the relevance of informal mechanisms of social control that help prevent deviant behaviour (Hirschi, 1969). From this perspective, individuals do not choose to participate in criminal actions because the expected utility of crime is high, but because social bonds and informal mechanisms of control are weak. To the extent that attachment to other social actors and institutions like parents, schools, and peers contributes to build and strengthen social relationships and conformity with social norms, schooling is expected to generate and consolidate informal constraints on criminal behaviour (e.g. Hirschi, 1969).

The key implication of these theories is that individuals attending school should be less likely to engage in criminal activities relative to those with no access or less education. Although existing explanations focus on the micro-level relationship between education and propensity to engage in crime, the theoretical literature implies aggregate effects of school attendance on the supply of crime. Specifically, these explanations have strong predictive power and can account for the large and

sustained decline in violent crime before the Mexican Drug War for two reasons: (a) the profile of actors participating in criminal activity and (b) the age composition of the country's population. First, empirical studies demonstrate that age is among the strongest and most robust correlates of non-violent and violent crime. Much research shows that adolescents (aged 13–17) and young adults (aged 18–24) are much more likely to engage in deviant behaviour and criminal activities (e.g. Hirschi & Gottfredson, 1983; Piquero, Farrington, & Blumstein, 2007), including homicide (e.g. Blumstein & Rosenfeld, 1998; Cook & Laub, 1998). In fact, the age distribution of crime has been referred as a 'law of nature', suggesting that more youth-dominant populations face the highest risk of crime involvement (Goring 1913, quoted in Hirschi & Gottfredson, 1983).

Second, in 1990 adolescents and young adults represented 17.8 and 21.5 per cent of the total adult population (13 years and above) in Mexico, respectively. This means that nearly 40 per cent of the total adult population fell in the cohort where individuals are most at risk of getting involved in criminal behaviour. It is thus not surprising that nearly one fifth of the total number of homicide victims were distributed among these cohorts in the early nineties (González, Vega, Vega, Muñoz, & Cabrera, 2009). Since adolescents and young adults aged 18 are also those who enrol in secondary and tertiary schools, and these levels of education substantively increased since 1993, we expect a large negative effect of secondary and tertiary enrolment rates on violent crime before the Mexican Drug War.

Importantly, we expect no effect of education attendance on homicide rates after the onset of the drug war, largely because the quality and quantity of violence changed dramatically from common forms of interpersonal violence to armed confrontations between criminal organisations (and between criminal organisations and the state) that seek to keep or expand control over drug markets (Shirk & Wallman, 2015). Since its outbreak, the Mexican Drug War has embodied deadly battles between relatively small and well-trained groups with a strong weaponry capacity. Unlike traditional forms of interpersonal violence driven by individuals' motives and a given structure of opportunities, drug-related violence draws on organisational imperatives, where violence emerges from criminal organisations' incentives that are commonly shaped by government law enforcement policies, cocaine seizures in other countries, and availability of arms, among others (e.g. Castillo, Mejia, & Restrepo, 2020; Dube, Dube, & García-Ponce, 2013). Since education attendance influences incentives for criminal activity and interpersonal violence and not decisions of criminal organisations shaping trends of drug-related homicides, we anticipate a negative effect of schooling on homicide before the onset of the drug war, but no relationship after outbreak of drug violence. The following hypotheses summarise our argument:

H1: Secondary and tertiary school enrolment will reduce homicide rates before the onset of the drug war.
H2: Secondary and tertiary school enrolment have no effect on homicide rates after the onset of the drug war.

5. Baseline estimates

We assess our argument using panel data for Mexico's 31 states and Mexico City over the period 1990–2015, given data availability on school attendance and economic covariates. The state-year is our unit of analysis because most of our data are available only at the state-level as the lowest level of aggregation. We hasten to note that there may be considerable variation in crime rates across the municipalities within states. However, since aggregation to higher levels will tend to decrease variation and may average over divergent trends over lower-level units, this would be more likely to obscure relationship than to generate spurious findings.

We measure violent crime using homicide rates per 100,000 inhabitants, using data from the National Institute of Statistics and Geography (INEGI) and the National Population Council (CONAPO).[9] Our key independent variables are educational attendance in secondary and tertiary public schools, based on data from the Secretary of Public Education (SEP). We measure secondary

Table 1. Two-way fixed effects estimates of homicide rates

	Pre and post drug war onset		*Pre drug war onset*		*Post drug war onset*	
	1	2	3	4	5	6
Secondary enrolment	−0.250*		−0.192+		0.249	
	(0.101)		(0.112)		(0.366)	
Tertiary enrolment		−0.309+		−0.133		−0.185
		(0.159)		(0.146)		(0.302)
Ln GDP pc	7.077	9.276+	3.056	4.812	−27.169	−25.653
	(4.794)	(5.104)	(5.995)	(5.927)	(19.586)	(18.798)
Economic growth	−5.637	−8.001	0.745	−1.947	10.763	9.961
	(7.712)	(7.937)	(5.818)	(5.763)	(16.600)	(15.927)
Urban population	−0.000	−0.000	−0.000*	−0.000*	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Youth bulges	−1.607+	−1.554	−1.246	−1.334	0.004	−0.627
	(0.917)	(0.967)	(0.852)	(0.881)	(1.768)	(2.063)
Democracy	−0.745	−1.542	2.424*	2.074+	−3.058	−3.622
	(1.341)	(1.105)	(1.154)	(1.092)	(2.988)	(2.943)
Constant	1.874	−27.792	31.617	3.486	301.213	339.009
	(63.781)	(67.389)	(86.560)	(83.495)	(224.716)	(243.221)
R^2	0.257	0.258	0.521	0.509	0.231	0.230
Unit and year FE	YES	YES	YES	YES	YES	YES
No. of groups	32	32	32	32	32	32
Observations	800	800	512	512	288	288

Clustered Standard Errors by state in parentheses. FE not shown.
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; $^{+}$ $p < 0.10$.

enrolment dividing the total number of students that attend secondary public schools by the total population of the 13–15 years old cohort. Similarly, we estimate tertiary enrolment dividing the total number of students in tertiary public schools by the total population of the 16–18 years old cohort. We detail the data and report descriptive statistics in Tables A2–A3 in the Appendix.

Table 1 reports results of OLS estimates of homicide rates for all Mexican states. We control for GDP per capita (logged), economic growth, urban population (logged), youth bulges, and democracy. All estimates include unit and year fixed effects to control for unobserved state characteristics and other factors like income inequality and police capacity that move slowly across time, and we do not include in the estimates due to the lack of data availability. Models 1–2 present results for the 1990–2015 period; we do not include secondary and tertiary school enrolment simultaneously given the high correlation between them (.85). Then we report different models for the periods *before* and *after* the drug war onset, allowing us to assess different effects of education attendance on different forms of homicide (Models 3–6). This approach is similar to estimating an interaction between the time period and school attendance since the year fixed effects subsume the time period constituent term, at the same time it considers that the effect of the other covariates differs *before* and *after* the drug war onset. To be clear, the Mexican Drug War officially started on December 2006, but the rise of criminal violence took place until 2008. In fact, 2007 has been the least violent year since 1990, thereby we first consider the 1990–2007 period in Models 3–4.

The coefficients for secondary and tertiary school enrolment are negative and statistically significant when we consider the period 1990–2015. Consistent with our hypotheses, however, Models 3–6 show that the crime-reducing effect of education only holds for secondary school enrolment in the period before the drug war onset, as the coefficient for secondary schooling is statistically significant at conventional levels in Model 3.[10] Substantively, the results show that a one standard deviation increase in secondary school enrolment, which corresponds to 12 percentage points, reduces homicides rates by 2.3. Considering that school enrolment in the pre-drug war period

increased from 67 to approximately 90, the reduction in homicide rates corresponds to approximately 5 homicides per 100,000 inhabitants. This reduction is substantive considering that homicide rates went from 16 to 9 in the same period. In turn, the coefficient for tertiary schooling is negative as expected but loses its significance in Models 4 and 6, when we break the sample before and after the drug war onset. A plausible explanation for this non-finding is that the education reform caused a rapid and substantial increase in secondary school enrolment but the parallel positive effect of the reform on tertiary education was not immediate, and thus the impact of tertiary schooling on homicide is unlikely to be seen once we break the sample and consider the period 1990–2007.

Overall, the results from Table 1 are consistent with our claim that school attendance is more likely to influence individuals' incentives for crime and interpersonal violence, instead of drug-related homicides that tend to follow the organisational incentives of drug cartels. Finally, we anticipated a homicide decline as a consequence of increasing enrolment in secondary and tertiary schools, drawing on extensive evidence that adolescents and young adults are much more likely to participate in non-violent and violent crime and considering the age composition structure of Mexico in the early 1990s. The models reported above provide support for this argument, however, if our argument is correct, we should not expect a relationship between primary school enrolment and homicide rates. This simple placebo test yields additional support for our argument since we find that higher primary school enrolment does not predict to lower homicide rates (see Model 2, Table A5 in the Appendix).

6. IV estimates

The previous analyses provide suggestive evidence of a pacifying effect of education, but the potential endogenous relationship remains a challenge in establishing the homicide-reducing effect of education. In the remainder we only focus on the 1990–2007 period, as we found strong evidence that the school enrolment does not affect homicide after drug war onset, when the logic of violence changed as a result of inter-cartel competition.

Decisions about schooling may be related to unobserved characteristics that affect decisions about participation in criminal activities. Moreover, governments in high crime contexts are likely to allocate more resources to the criminal-justice system and this may lead to a reduction in education expenditures, yielding a spurious correlation between schooling and crime. We address this challenge using an instrumental variable approach. Because the compulsory schooling reform was national and implemented in all states the same year and there is no variation across units, we exploit a different source of variation across units and over time, identifying the cumulative proportion of the population that was treated by the reform over time and the growth in secondary schools that took place after the reform. Specifically, we identify the cumulative share of male individuals in each state who were treated by the reform by measuring the share of male individuals who are 16 years old or older in each year, and who were 15 years old or younger in 1993. We consider that the size of the treated cohort by the reform provides sufficient exogenous variation and meets the relevance and exclusion restrictions. It affects school enrolment because the size of the identified cohort was the main target of the reform that made secondary school compulsory. Similarly, the introduction of the reform aimed at a specific group of the youth population provides strong theoretical reasons to believe that the size of the treated cohort affected homicide rates only through school enrolment.

We also include the number of secondary schools in each state. Although it is unlikely that school investment was randomly allocated after the reform, one could question whether previous decisions regarding school infrastructure were determined by homicide rates, either because the government could have attempted to reduce crime by improving the education or because high crime contexts could have dissuaded the government from building new schooling infrastructure.[11] However, descriptive evidence at the state-level suggests that policy decisions about schooling infrastructure were not determined by pre-existing homicide (see the Online Appendix, Figures A4-A5). We thus exploit the fact that the education reform positively affected infrastructure of secondary schools, while educational infrastructure was unrelated with previous homicide rates.

Table 2. IV estimates of homicide rates

	1.1 First-Stage *Secondary enrolment*	1.2 Second-stage *Homicide rates*	2.1 First-stage *Tertiary enrolment*	2.2 Second-stage *Homicide rates*	3.1 First-stage *Tertiary enrolment*	3.2 Second-stage *Homicide rates*
Treated cohort	57.662***		84.034***		57.170***	
	(8.903)		(6.428)		(8.696)	
Schools (secondary)	0.027***				0.027***	
	(0.002)				(0.002)	
Schools (tertiary)			0.021***			
			(0.002)			
Secondary enrolment		−0.553***				−0.588***
		(0.062)				(0.066)
Tertiary enrolment				−0.485***		
				(0.070)		
Ln GDP pc	−3.502	1.534	3.739+	6.830*	−3.469	1.933
	(2.401)	(3.092)	(2.081)	(3.076)	(2.434)	(3.129)
Economic growth	−0.744	−1.348	−4.264	−2.924	−0.742	−1.483
	(3.390)	(3.796)	(2.792)	(3.559)	(3.396)	(3.847)
Urban population	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Youth bulges	−0.811**	−0.720**	−0.153	−0.291	−0.815**	−0.700**
	(0.298)	(0.259)	(0.252)	(0.264)	(0.293)	(0.260)
Democracy	1.418*	2.369***	−0.478	1.108+	1.418*	2.390***
	(0.607)	(0.645)	(0.487)	(0.637)	(0.607)	(0.653)
HCI					0.039	0.429+
					(0.226)	(0.222)
Constant	137.469***	54.508	−3.725	−43.480	137.033***	49.228
	(33.253)	(42.696)	(29.480)	(39.943)	(33.854)	(43.252)
R^2		0.820		0.818		0.817
F-statistic		68.703		63.682		67.750
Kleibergen-Paap rk LM statistic		70.267		74.731		83.311
χ^2 p-value		0.000		0.000		0.000
Hansen J statistic		0.274		20.707		0.757
χ^2 p-value		0.601		0.000		0.384
Unit FE		Yes		Yes		Yes
No. of groups		32		32		32
Observations		512		512		512

Unit fixed effects not shown. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; $^{+}$ $p < 0.10$.

Table 2 reports results from our IV estimates, considering the period before the drug war onset. Models include unit fixed effects and exclude year fixed effects since one of our instruments – treated cohort – incorporates the year effect.[12] The first-stage results across models show that our instruments have the expected positive effect on enrolment rates; the reduced form models indicate that the instruments are negatively correlated with homicide rates, except for tertiary schools (see the Appendix, Table A4). Turning to the second-stage results, the coefficient for secondary school enrolment in Model 1.2 is negative and statistically significant, yielding additional support for our argument. The underidentification test from the Kleibergen-Paap LM statistic indicates that the instruments are relevant, and we cannot reject the null hypothesis that the overidentifying restrictions are valid for secondary school enrolment, based on the Hansen J statistic. Substantively, Model 1.2 suggests that a one standard deviation increase in secondary school enrolment reduces homicide rates by 6. This effect is substantively large if we consider that homicides rates declined by 9 homicides per 100,000 between 1992 and 2007. Although the coefficient of tertiary school enrolment is negative

and significant and the instrument is relevant based on the underidentification test, the Hansen J statistic suggests that we can reject the null hypothesis that the overidentifying restrictions are valid for tertiary school enrolment.

In the remainder we consider alternative explanations and perform sensitivity analyses reported in Models 3.1 and 3.2. We only focus on secondary school enrolment since we cannot confirm the validity of the overidentifying restrictions for tertiary school enrolment (see Model 2.2). First, the administration of President Salinas undertook a large-scale poverty relief programme (PRONASOL) aimed at improving public goods provision and social development. Although PRONASOL was only in effect during the Salinas' administration (1989–1994), it could be argued that this poverty relief programme may have reduced homicide rates in the medium-term due to its effects on social welfare. We disagree since there is evidence that PRONASOL had very limited effects on poverty and social welfare, largely because the government used PRONASOL to provide benefit to local supporters and this undermined the efficiency of the programme in reducing poverty: PRONASOL improved provision of basic services only marginally and did not reduce poverty as measured by premature infant deaths (Díaz-Cayeros, Estevez, & Magaloni, 2016).

Second, Canada, Mexico, and the United States launched the North American Free Trade Agreement (NAFTA) in 1994. NAFTA was the hallmark of the modernisation project under Salinas, and it was expected to promote development and improve economic conditions. It may be thus argued that NAFTA influenced homicide rates indirectly via its effect on economic development and social welfare. Without disregarding this potential effect, we believe that the general decline in homicide cannot be attributed to greater intra-regional commerce since previous studies reveal strong clustered patterns; that is, NAFTA tended to improve economic development in Northern states, but not the poorer South (Esquivel, Lederman, Messmacher, & Villoro, 2002). In an attempt to rule out potential bias in the estimates reported above, in Models 3.1–3.2 we include the human capital index (HCI), which helps capture potential indirect effects of PRONASOL and NAFTA on homicide reduction.[13] As seen in Model 3.2, the sign and size of the coefficient for secondary school enrolment is very similar than the coefficient from Model 1.2, and the results for the underidentification test and the Hansen J statistic behave as expected, suggesting that our findings do not merely reflect the implementation of an extensive anti-poverty programme before the education reform. Importantly, these estimations did not alter the substance of our results for secondary enrolment. Tables A(5–6) in the Appendix show further robustness tests, controlling for specific time-trends and including falsification test to show that our instruments do not predict other outcomes such as the human development index, democracy, and economic growth. These results strengthen our confidence that the instrument is not simply correlated with other unmeasured features likely to affect homicide rates, as well as that primary enrolment rate does not predict to lower homicide rates.

7. Conclusion

Existing research highlights plausible reasons for why education decreases crime, and our results offer consistent evidence of a sizeable negative effect of schooling on homicide. The literature proposes different channels through which schooling reduces crime and investigating the specific mechanisms in more detail deserves more attention in future research. However, our findings have important policy implications as education policies can have a pacifying effect by expanding access to education. Our strategy to focus on the 1993 compulsory schooling law at the secondary level allows us to have greater confidence in the causal identification. The educational reform was introduced by the authoritarian government to increase international competitiveness but turned out to have important side-effects on homicide. Therefore, this study provides a justification for strategies that seek to target crime through investment in education, especially in developing countries where educational systems are weakly developed, but even limited amounts of physical capital can go a long way in improving education when the cost of human labour is relatively low.

Whereas much research emphasises the private returns of education to individuals, this study reveals evidence that education not only improves human capital with substantive private returns, but also brings large social benefits by reducing the aggregate supply of crime and strengthening individual security. More broadly, our results support existing studies underlining the social returns and nonproduction benefits of education policies (e.g. Dinçer, Kaushal, & Grossman, 2014; Jetter & Parmeter, 2018). These findings also challenge so-called *mano dura* or heavy-handed approaches to crime that are linked to human rights violations in many new democracies, and instead point to the relevance of non-coercive or 'soft' responses to public insecurity that can outperform heavy-handed policies.

This article draws attention to an important long-term trend of declining violent crime prior to the Mexican Drug War, which has received little attention despite the substantial magnitude of the decline, and our evidence suggests that the expansion of education is an important force behind this. Some may argue that this is of limited relevance for practical measures to contain the current drug-related violence, especially if the previous reform has already realised many of the large gains that can be expected from education. But to paraphrase the UK New Labour slogan, efforts to be tough on crime alone may be of limited value without also devoting attention to the likely causes of crime and long-term influences. The challenges of the drug war will certainly require strengthening the state security apparatus and improving the judicial system, but the long-term impact of advances in education suggests a more favourable future outlook with regards to the problem of homicide and violent crime than what is suggested in many discussions focusing exclusively on drug-related violence in Mexico.

Notes

1. We lack available data to report trends in other types of crime such as robbery, theft, and assault, but homicide is the most reliable and accurate measure of violent crime (e.g. Cook & Laub, 1998).
2. Longer time-series data on homicide from the Instituto Nacional de Estadística, Geografía e Informática (INEGI) show a dramatic decline from rates above 60 per 100k in the 1940s to 10 in the early 200s. See http://www.mexicomaxico.org/Voto/Homicidios100M.htm
3. See https://www.sep.gob.mx/work/models/sep1/Resource/b490561c-5c33-4254-ad1c-aad33765928a/07104.pdf
4. See http://www.diputados.gob.mx/sedia/sia/re/RE-ISS-09-06-17.pdf
5. The reform also included changes in curricular laws and teachers' wages and capacitation.
6. Zedillo was Secretary of Education under the Salinas government and played an important role in designing and implementing several reforms during the previous administration.
7. There are several possible reasons for why we also see an increase in school enrolment beyond the immediate three years following the reform. The reform may not necessarily have been fully implemented immediately, and some in the age range may not have enrolled, even if schooling was made compulsory. Second, the reform also increased schooling infrastructure in a way that likely increased further recruitment and retention. Finally, because the level of enrolment was relatively low at the time when the reform was introduced (less than 70%), the full effects of the reform were likely to be gradual.
8. See https://data.worldbank.org/indicator/SE.SEC.ENRR?view=chart
9. It would be ideal to use either individual level data on perpetrators of crime or homicide rates of young males to better reflect the expected effect of education among out-of-school youth. Unfortunately, there is no systematic individual level data on perpetrators of criminal activities in Mexico. We also reviewed the available data from the National System of Health Information (SINAIS) but we are unfortunately unable to use these, due to the large number of missing values in the number of homicides by gender in different age cohorts for Mexican states over the period of analysis, particularly during the 1990s.
10. These results hold in models that omit all control variables, and are robust to the use of conditional poisson estimates with both unit and year fixed effects (see the Online Appendix).
11. We return to this issue later but hasten to note for now that allocation of schooling infrastructure likely followed a political logic, since there is strong evidence that the PRI used public services provision as a survival strategy to defeat the opposition in subnational elections.
12. As described above, the treated cohort variable is created with the year variable and thus it is not appropriate to include year dummies in the models.
13. FDI figures are more appropriate to assess the effect of NAFTA but unfortunately there is not available data at the subnational level before 2000; hence, we lose more than 50 per cent of the observations.

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Appendix

This Appendix provides further details on measurement, descriptive statistics, and additional empirical estimates. Supplementary information can be found in the Online Appendix.

Table A1. Homicide rates across states

	Homicide rate in 1992	Homicide rate in 2006	Percentage change in homicide rate, 1992–2006	Average in homicide rate, 2007–2015
Aguascalientes	4.68	2.45	−47.67	4.69
Baja California	17.24	16.18	−6.13	27.53
Baja California Sur	5.69	4.91	−13.75	8.53
Campeche	15.66	4.43	−71.75	7.06
Coahuila	11.25	4.69	−58.32	18.53
Colima	29.46	7.65	−74.03	19.85
Chiapas	14.70	13.36	−9.15	7.03
Chihuahua	18.96	19.98	5.38	80.94
Ciudad de México	16.39	9.75	−40.53	12.21
Durango	46.69	13.01	−72.13	38.18
Guanajuato	9.13	4.31	−52.76	9.99
Guerrero	61.45	26.00	−57.70	49.98
Hidalgo	6.83	2.06	−69.90	5.45
Jalisco	14.64	7.13	−51.31	13.60
Estado de México	38.27	12.90	−66.29	14.30
Michoacán	39.93	25.69	−35.67	17.95
Morelos	30.42	9.56	−68.57	22.21
Nayarit	30.75	11.22	−63.51	24.46
Nuevo León	4.05	4.05	0	17.97
Oaxaca	43.95	15.48	−64.78	17.23
Puebla	13.18	6.71	−49.10	7.23
Queretaro	7.11	4.14	−41.72	5.80
Quintana Roo	9.62	5.81	−39.63	9.95
San Luis Potosí	13.55	6.73	−50.32	10.63
Sinaloa	27.04	18.38	−32.04	45.87
Sonora	13.17	10.63	−19.26	20.40
Tabasco	8.97	7.39	−17.57	8.85
Tamaulipas	20.69	16.63	−19.62	21.87
Tlaxcala	5.74	4.50	−21.59	5.90
Veracruz	12.34	5.24	−57.55	8.81
Yucatan	3.43	2.31	−32.66	2.25
Zacatecas	14.06	6.05	−56.94	14.81

Table A2. Description of CONTROL VARIables

Variable	Description	Source
Ln GDP per capita	GDP per capita in 1992 pesos (logged)	INEGI
Economic growth	The growth rate of GDP per capita from the previous year	INEGI
Ln urban population	Percentage of population living in urban areas	INEGI
Youth bulges	Percentage of youth males aged 15–24 relative to the total adult population	CONAPO
Democracy	Coded as democracy since the first election in each state where the opposition won, that is, since the failure of the PRI	Based on data from CIDAC

Table A3. Descriptive statistics

	Obs.	Mean	Std. Dev.	Min	Max
Pre-drug war onset, 1990–2007					
Homicide rates	544	13.542	9.461	1.819	61.45
Secondary school enrolment	544	78.693	12.191	44.602	106.557
Tertiary school enrolment	544	46.234	13.074	17.231	87.448
Ln GDP per capita	544	11.690	.578	10.938	14.217
Economic growth	512	.012	.043	−.157	.146
Urban population	544	2,057,455	2,041831	248,665	1.18e+07
Youth bulges	544	31.746	2.839	24.644	40.139
Democracy	544	.242	.429	0	1
Post-drug war onset, 2008–2015					
Homicide rates	288	18.131	20.486	1.791	190.218
Secondary school enrolment	288	94.054	6.836	79.665	121.168
Tertiary school enrolment	288	66.048	9.944	45.681	116.125
Ln GDP per capita	288	11.752	.534	10.912	14.037
Economic growth	288	−.002	.057	−.425	.184
Urban population	288	3,092423	2,841,273	477,196.6	1.65e+07
Youth bulges	288	27.098	1.752	21.295	31.243
Democracy	288	.666	.472	0	1

Table A4. Reduced form models of homicide rates – two-way fixed effects estimates

	1	2	3	4
Treated cohort	−36.995+	−70.273**	−17.279+	−35.020***
	(20.413)	(24.046)	(8.552)	(7.574)
Schools (secondary)	−0.014*		−0.014+	
	(0.005)		(0.004)	
Schools (tertiary)	3.223	2.131		−0.006
	(5.398)	(6.019)		(0.006)
Ln GDP pc	−0.727	0.634		
	(3.957)	(4.558)		
Economic growth	0.000	−0.000*		
	(0.000)	(0.000)		
Urban population	−0.415	−1.082		
	(0.681)	(0.777)		
Youth bulges	1.642	1.885		
	(1.084)	(1.175)		
Democracy		−0.001		
		(0.005)		
Constant	3.846	35.911		
	(77.756)	(87.566)		
R^2	0.511	0.453	0.473	0.392
Unit and year FE	Yes	Yes	Yes	Yes
Observations	512	512	512	512

Notes: Models 1–2 include all control covariates, and Model 3–4 exclude all control covariates. FE not shown.
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; $^{+}$ $p < 0.10$.

Table A5. State-specific time trends and placebo test

	1	2
Secondary enrolment	−0.180**	
	(0.057)	
Ln GDP per capita	8.660*	5.696
	(3.586)	(5.601)
Economic growth	−4.748	−1.058
	(3.411)	(5.435)
Urban population	−0.000*	−0.000*
	(0.000)	(0.000)
Youth bulges	2.912***	−0.992
	(0.693)	(0.923)
Democracy	0.775	2.316*
	(0.679)	(1.100)
Treated cohort		
Schools (secondary)		
Population size		
Primary enrolment		0.282+
		(0.139)
Constant	−3392.116***	−36.659
	(762.562)	(93.512)
R^2		0.519
Observations	512	512
State-specific time trends	Yes	No
Unit FE	Yes	Yes
Time FE	Yes	Yes

Notes: Standard errors clustered on state.
Unit and time FE not shown.
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; $^{+}$ $p < 0.10$.
In Table A5, Model 1 includes state-specific time trends using an interaction between state and year; the coefficient for secondary school enrolment holds negative and significant. In a placebo test, we consider the link between primary school enrolment and homicide rates. We do not expect a negative effect on homicide rates, since primary schooling does not affect the population that is most likely to get involved in criminal activity. Model 2 in Table A5 considers primary enrolment rate, for which we do not find a negative coefficient on homicide rates

Table A6. Falsification tests

	Dependent variable					
	Human development index		*Democracy*		*Economic growth*	
	1	2	3	4	5	6
Treated cohort	−2.046	−1.727	8.141	9.448	0.427	1.533***
	(23.602)	(21.028)	(12.687)	(12.898)	(0.312)	(0.408)
Schools (sec.)	0.000	0.001	−0.000	−0.000	−0.000	0.000*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Ln GDP per capita		−1.986		0.320		0.151***
		(1.496)		(0.585)		(0.023)
Economic growth		1.691		−0.436		
		(1.281)		(0.477)		
Population size		−0.000+		0.000		−0.000
		(0.000)		(0.000)		(0.000)
Democracy		−0.082				−0.005
		(0.324)				(0.006)
Constant	4.811***	28.946	0.084	−3.696	0.024*	−1.743***
	(0.610)	(17.884)	(0.194)	(6.879)	(0.009)	(0.267)
R2	0.522	0.512	0.335	0.331	0.481	0.532
Unit and year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	512	512	512	512	512	512

Table A6 reports three falsification tests to assess whether our instruments predict to the human development index, democracy, and economic growth. Models 1, 3, and 5 exclude controls, while Models 2,4, and 6 include standard control covariates. We find no evidence that the instruments predict to these variables, strengthening our confidence that the instruments are not simply correlated with other unmeasured features likely to affect homicide rates. An exception is Model 6, where the instruments have a positive and significant effect on economic growth, although the coefficients are not statistically significant in the model without controls (Model 5). Moreover, we hasten to note that there is no evidence in both the baseline and IV estimates that economic growth does not affect homicide rates.