Exposure to Local Homicides and Early Educational Attainment and Achievement in Mexico
Extended Abstract

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Introduction: Violent crime is a social problem with enormous direct costs in terms of death tolls, injuries, disabilities, and loss of property (Krug, Mercy, Dahlberg, and Zwi 2002; Miller, Cohen, and Rossman 1993). But the consequences of violence may extend far beyond its immediate victims. Research suggests that experiencing violence in one's surroundings may have consequences for health, development and wellbeing even among those who are not direct victims. Research using causal inference techniques has shown an effect of violence exposure on mental wellbeing (Cornaglia 2011; Michaelsen 2012), the chances of perpetuating violence among youth (Bingenheimer et al. 2005), and temporal reduction in test scores among children (Sharkey 2010).

This paper examines the effect of homicides in the municipality of residence on children's educational attainment in Mexico. We examine the association between local homicide and the probability of grade failure and school dropout over 1990-2010 for all elementary-school (grades 1 to 6) children in Mexico. The topic matters beyond the Mexican case because exposure to environmental violence is highly prevalent in contemporary societies, and it is unequally distributed along socioeconomic and racial lines. The outcomes of interest – elementary-school failure and dropout— are measures of early educational attainment shown to be consequential for later attainment. Children who fail a grade are more likely to drop out (Roderick 1994, Shepard and Smith 1990) and dropping out has strong negative consequences on final educational attainment and labor market success in Mexico (Knaul 2001). A detrimental effect of homicide exposure on early educational outcomes may, then, have long-term consequences on the population attainment and socioeconomic wellbeing.

A likely mechanism for the detrimental effect of environmental violence on children's educational attainment is the increase in stress and anxiety elicited by violence exposure (Crofford 2007; Singer, Anglin, Song, and Lunghofer 1995). However, a negative effect of environmental exposure cannot be assumed a priori. Research on the effect of environmental stressors on birth outcomes has shown a surprising positive effect of local homicide during pregnancy on birth weight in Mexico, likely driven by the increase in mother's use of prenatal care driven by growing sense of vulnerability (Torche and Villarreal 2012). By the same token, Currie and Rossin-Slater (2012) found that women exposed to a hurricane in the first trimester of gestation were less likely to gain excessive weight or to have inadequate prenatal care. Although

these findings likely involve mechanisms different from those that would affect children's educational attainment, they suggest that families can engage in diverse behavioral responses to environmental risks, which could offset or exacerbate their effects. To date, very little is known about the effect of environmental exposures on children's educational outcomes.

Mexico provides a useful case study because the rate of violent crime has changed markedly in the last two decades. Homicides per 100,000 population have dropped from about 18 in the early 1990s to a lowest point of 8 in 2007 to then rise dramatically to 24 in 2010. High levels of violence in the 1990s were partly due to political conflicts, product of the slow and tortuous process of democratization started at the end of the 1980s (Benitez 2004). In addition, crime levels raised considerably in urban centers such as Mexico city, where robbery-related homicide raised from 10.3 per 100,000 residents in 1990 to 16,3 in 1995 (IADB 1998). The decline in the homicide rate from the late 1990s to 2007 appears to be related to macro changes such as decline in poverty and unemployment (Gonzalez-Perez et al. 2012). The sharp increase in violence since 2007 is almost entirely driven by drug trafficking-related homicides (Shirk 2010).

Data and methods: We create an annual panel of all elementary schools in Mexico (1990-2010) to which we merge annual homicide rates in the municipality where the school is located. School-level data comes from the Mexican School Census that the Mexican Ministry of Education (Secretaría de Educación Pública) applies twice a year to all schools in the country[1]. Homicide rate data are obtained from the Mexican Bureau of Statistics (Instituto Nacional de Estadística y Geografía).

Our models also use several controls for demographic and economic trends of the municipality where the school is located, obtained from the National Population Census of 1990, 2000 and 2010 and the National Population Count of 2005, and interpolated to create an annual panel. School-level time-variant characteristics include an indicator variable that equals 1 if the school offers all elementary school grades and 0 if it only offers some of them in year *t*; the average amount of students per classroom in year *t*; the proportion of school principals who also have teaching responsibilities in year *t* (as a proxy for scarcity of resources at the school level); and the total number of teachers in the school in year *t*. We also add an indicator variable coded 1 if the school is private, zero if it is public (this last variable is time-invariant). Municipality characteristics include population in thousands in year *t*.

The outcomes of interest are defined as follows. Grade failure is the proportion of elementary-school students in each school who did not achieve the minimum overall grade

[1] We include all regular elementary schools in the country, but exclude "indigenous" and "communitarian" schools – serving about 6% of Mexican school-age children—because information about these schools come from a different source and because their organizational characteristics differ from regular elementary schools (INEE 2011).

necessary for passing to the next grade (in the Mexican context, a passing grade is 6/10). Failing a grade indicates that the child has not acquired the basic abilities needed to make adequate school progress in the following grade. The dropout rate captures the proportion of elementary-school students in each school who enroll in year *t* but fail to re-enroll in year *t+1*, excluding those who fail a grade. The dropout rate includes students who leave school during the academic year, as well as those not signing up for the next academic year. Because dropout is measured at the school level, it includes children who leave the educational system altogether but also those who out-migrate from the municipality of residence or simply change schools.

Analytical Strategy: We use several causal inference approaches for the analysis of panel data. Each of this approach is designed to address spuriousness in the association between municipal homicide rates and educational outcomes. In all, we estimate six models for each dependent variable. Our first model is represented in Equation 1.

$$(Failure)_{it} = \beta_0 + \beta_1(Homicide)_{jt}\, \beta_2(\mathrm{T}) + \beta_3(\boldsymbol{SC})_{it} + \beta_4(\boldsymbol{MC})_{jt} + \alpha_i + u_{it} \qquad \text{Eq.1}$$

Where Failure identifies *failure rate* in school *i* and year *t*, Homicide measures the homicide rate (homicides per 1,000 population) in municipality *j* (where school *i* is located) in year *t*. T is a linear formulation of time measured in years. SC is a vector of time-variant school characteristics, MC is a vector of time-variant municipality characteristics, α_i is a school-level fixed effect and u_{it} is an idiosyncratic error term assumed to be independent of all other terms in the equation. An identical model is used to examine the determinants of the dropout rate. The only difference is that the analysis of school failure considers the entire 1990-2010 period, while the analysis of dropout is restricted to the 1998-2010 period given data constraints. School-level fixed effects are intended to capture any school-level factor that may be correlated with both homicide rate and students' outcomes and that does not change over time (socioeconomic characteristics of parents and the neighborhood, school resources, etc.). This and all the following models are weighted using the total enrollment of each school-year. Standard errors are clustered at the school level.

Model 2 replaces a linear formulation of time with year fixed effects. This model provides a flexible account of temporal changes that is not constrained by a linear (or any other parametric) formulation. Models 1 and 2 exploit the panel features of the data but they do not account for potential temporal autocorrelation of the error term. Model 3 reformulates model 1, adding a first-order autocorrelation term (higher-order terms produce identical results). Model 4 extends model 2 by accounting for first-order autocorrelation.

School- and year- fixed effects models account for any time invariant factor at the school level and for any trends that are common across all schools. However, if unobserved trends exist that are correlated with both trends in homicides and in children's educational outcomes, these trends will introduce bias en in the coefficients. In order to account for such trends, we implement models with group-specific intercepts and slopes (GSIS). GSIS models can be seen as group-level fixed effects. Instead of estimating one fixed effect for each school in the sample, we define meaningful groups of schools that share common attributes and estimate an intercept and one slope for each group. Group-specific intercepts account for any baseline differences across groups, while group-specific slopes account for any trends over time at the group level that may be correlated with changes in violence and children's educational attainment. As such, group trajectories provide a counterfactual for each school's trajectory (Morgan and Winship 2010: 269).

The GSIS strategy has several advantages over the FE approach. It models the different starting points and trajectories for control and treatment groups in a more accurate way, and is more efficient, since it does not estimate an intercept for every school or municipality, but rather one for every group (Morgan and Winship 2010). An assumption of the GSIS models, however, is that any unaccounted school-level or time-varying noise embedded within the school error term is random. In contrast, the FE approach assumes only the time-varying error is random, while allowing individual, fixed error to be correlated with the predictors without biasing the estimation.

We use two types of grouping for our GSIS models (Models 5 and 6). First, we use Mexican states as groups. Mexico is a federal system divided into 32 states. States are relevant administrative units as they vary in levels of economic advantage, political climate, and economic and educational policy. Second, we group municipalities into five categories based on their level of socioeconomic advantage in 1990 and use municipality SES quintiles as our group criteria[2]. Equation 2 presents the formulation for GSIS at the state level:

$$(Failure)_{it} = \beta_0 + \beta_1(Homicide)_{jt} + \beta_2(State_k) + \beta_3(T) + \beta_4(State_k \times T) + \beta_5(SC)_{it} + \beta_6(MC)_{jt} + e_{it} \quad \text{Eq. 2}$$

Where failure rate in school *i* and year *t* is explained by the homicide rate in the municipality *j* (where school *i* is located) in year *t*, a set of 31 dummies for the state of residence, the interaction of state and time (T), and the same school and municipality time-variant characteristics used in the fixed-effects models. An identical formulation is used for the quintiles based on municipality SES. By estimating the six outlined models for each outcome of interest we provide a robust assessment of the effect of local violence as well as plausible bounds for the effects.

[2] We applied principal components analysis (PCA) to a series of municipal socioeconomic indicators reported by the National Population Council (CONAPO). Then, we obtained quintiles of the first component index to generate five SES categories.

Preliminary findings. Table 1 presents our findings for failure rate. In all the models estimated the parameter estimate associated with the local homicide rate is positive and significant. A positive coefficient indicates that the increase in the municipal homicide rate results in an increase in the probability of grade failure in the schools located in the municipality. The effects range in magnitude from .0018 in Model 4 (school and year fixed effects and correction for first-order serial correlation), to .0098 in Model 5 (state-level GSIS).

These effects are small but relevant at the population level. If we consider the smallest effect of .0018 and apply it to the approximately 14.5 million children attending elementary school in Mexico in 2010, this effect would result in an increase of 26,100 (14.5 million * .0018) elementary-school students failing a grade. If we use our largest estimate, this increase would be additional 142,100 (14.5 million * .0098) children failing as a result of the increase in the municipal homicide rate.

The effect of the local homicide rate on the probability of elementary school dropout is also substantial and statistically significant (Table 2). The parameter estimates range from .0036 obtained from the model with school and year FE and controls for serial correlation (Model 4), to .014 for the model with GSIS based on quintiles of municipal socioeconomic disadvantage (Model 6). Using the same calculations we used for the failure rate, the smallest of these estimates would imply an additional 52,200 children dropping out of elementary school, while the largest estimate would suggest that 203,000 additional children would drop out as a result of local crime.

Note that for both dependent variables, the models using a group-specific intercepts and slopes (GSIS) approach produce the largest estimates, while models with school and year fixed effects and controls for serial correlation result in the smallest estimates. It is plausible that aggregate grouping of the GSIS models is not sufficient to account for unobserved heterogeneity correlated with the outcome across schools. Instead, fixed effects models with adjustment for serial correlation result in more conservative (and probably more realistic) estimates.

Discussion: Our findings suggest that the increase in the municipal-level homicide rate has a significant effect on educational attainment and achievement among elementary-school age children. Exposure to local homicide increases the changes that children fail a grade and dropout from school. These findings are a potential source of concern because early educational attainment and achievement reduce the chances that children will continue in the educational system and reduces children's completed level of educational attainment.

At the moment our findings are intriguing but preliminary. We have estimated reduced-form coefficient that capture a myriad of pathways plausibly linking exposure to local homicide

to children's educational outcomes. We are currently undertaking several additional analyses to examine the robustness of the effects, potential sources of spuriousness, as well as their potential mechanisms. These steps include: (a) Examination of additional municipal-level trends plausibly correlated with the local homicide rate and with children's educational outcomes that may induce a spuriousness in the relationship (for example, increase in robbery, burglary and other types of crime, educational expenditures, additional measures of the economic cycle, among others), (b) Study of the role of migration in altering the composition of the population at risk of school dropout or failure at the local level, (c) Analysis of grade-specific failure and dropout rates, (d) A more sophisticated conceptualization of the treatment –the local homicide rate— which examines thresholds of magnitude, nonlinearities, and crime spikes, and (e) Use of spatially-lagged homicide rates to account for the fact that the effect of violence is not necessarily circumscribed to municipal boundaries, and may extend to a wider spatial context.

Table 1. Effect of municipal homicide rate on elementary school grade failure. Mexico 1990-2010[1].

VARIABLES	M1 School FE	M2 School & Year FE	M3 School FE AR	M4 School & Year FE AR	M5 State GSIS	M6 Municipal SES GSIS
Homicide rate	0.0064**	0.0027**	0.0044**	0.0018**	0.0098**	0.0047**
	(0.0019)	(0.0003)	(0.0000)	(0.0000)	(0.0005)	(0.0004)
Time	-0.0035**		-0.0032**		-0.0025**	-0.0027**
	(0.0001)		(0.0000)		(0.0001)	(0.0000)
All-grades	-0.0065**	-0.0061**	0.0120**	-0.0023**	-0.0038**	-0.0016**
	(0.0007)	(0.0005)	(0.0000)	(0.0000)	(0.0006)	(0.0006)
Principal teaches	0.0021**	0.0017**	0.0027**	0.0009**	0.0122**	0.0097**
	(0.0003)	(0.0002)	(0.0000)	(0.0000)	(0.0003)	(0.0003)
Students per classroom	0.0004**	0.0002**	0.0007**	0.0003**	-0.0001**	0.0001**
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number teachers	-0.0010**	-0.0010**	-0.0004**	-0.0009**	-0.0010**	-0.0009**
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Munic. Size	0.0000*	0.0000**	0.0000**	0.0000**	-0.0000**	-0.0000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Private school					-0.0395**	-0.0369**
					(0.0004)	(0.0003)
Constant	0.0879**	0.0964**	0.0511**	-0.0359**	0.0864**	0.0824**
	(0.0040)	(0.0016)	(0.0000)	(0.0003)	(0.0016)	(0.0007)
School-year N	1,397,577	1,397,577	1,397,577	1,397,577	1,397,577	1,397,577

[1] M1: Model with school fixed effects, M2: Model with school and year fixed effects, M3: Model with school fixed effects and correction for first order autoregressive error term, M4: Model with school and year fixed effects and correction for first-order autoregressive error term, M5: Model with state-level group-specific intercepts and slopes, M6: Model with municipal SES quintiles-level group specific intercept and slopes. Ancillary parameter estimates for each model not presented to conserve space.

** p<.01, * p<.05, + p<.10

Table 2. Effect of municipal homicide rate on elementary school dropout. Mexico 1998-2010[1].

	M1 School FE	M2 School&Year FE	M3 School FE AR	M4 School&Year FE AR	M5 State GSIS	M6 Munic SES GSIS
Homicide rate	0.0069**	0.0072**	0.0041**	0.0036**	0.0119**	0.0140**
	(0.0009)	(0.0010)	(0.0001)	(0.0001)	(0.0008)	(0.0007)
Time	0.0005**		0.0005**		-0.0009**	-0.0006**
	(0.0001)		(0.0000)		(0.0002)	(0.0000)
All-grades	0.0564**	0.0565**	0.0460**	0.0460**	0.0327**	0.0326**
	(0.0033)	(0.0033)	(0.0001)	(0.0001)	(0.0026)	(0.0026)
Principal teaches	0.0051**	0.0051**	0.0075**	0.0075**	0.0065**	0.0053**
	(0.0010)	(0.0010)	(0.0000)	(0.0000)	(0.0006)	(0.0005)
Students per classroom	0.0064**	0.0064**	0.0070**	0.0070**	0.0003**	0.0004**
	(0.0004)	(0.0004)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number teachers	0.0097**	0.0097**	0.0079**	0.0079**	-0.0002**	-0.0002**
	(0.0006)	(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Munic. Size	0.0000**	0.0000**	0.0000**	0.0000**	0.0000**	0.0000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Private school					0.0205**	0.0210**
					(0.0006)	(0.0006)
Constant	-0.3536**	-0.3464**	-0.2819**	-0.2751**	-0.0203**	-0.0264**
	(0.0124)	(0.0114)	(0.0002)	(0.0002)	(0.0040)	(0.0028)
School-year N	895,411	895,411	895,411	895,411	895,411	895,411

[1] M1: Model with school fixed effects, M2: Model with school and year fixed effects, M3: Model with school fixed effects and correction for first order autoregressive error term, M4: Model with school and year fixed effects and correction for first-order autoregressive error term, M5: Model with state-level group-specific intercepts and slopes, M6: Model with municipal SES quintiles-level group specific intercept and slopes. Ancillary parameter estimates for each model not presented to conserve space.

** p<.01, * p<.05, + p<.10

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