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CRIME AND PERSISTENT PUNISHMENT

A LONG-RUN PERSPECTIVE ON THE LINKS BETWEEN VIOLENCE AND CHRONIC POVERTY IN MEXICO

Adán L. Martínez-Cruz
Carlos Rodríguez-Castelán

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ABSTRACT

The relationship between violence and chronic poverty has been studied mostly in the context of war or long-term episodes of conflict. In contrast to previous studies, this paper explores whether violence that does not include the shattering of infrastructure impacts the chance that poverty may remain chronic. A long-run perspective is gained by analyzing unique, recently gathered panel data at the municipality level in the Mexican context, covering the period from 1990 to 2010. Violence is measured as the number of non-drug related homicides per 100,000 inhabitants. A municipality is classified as chronically poor if the percentage of people in food poverty remains above the national average during two consecutive periods. Econometric analysis is carried out through discrete choice models. Putting the results in context, consider of a chronically poor municipality in 2005 in which average household income is below the 25th percentile in 2000. If this municipality had a 10.47 nondrug- related homicide rate, the 75th percentile in 2000, its chance of remaining chronically poor into 2005 was almost double the corresponding chance of a municipality with the same mean household income but at the national median of violence in 2000 (zero non-drug-related homicides).

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Crime and Persistent Punishment:

A Long-Run Perspective on the Links between Violence and Chronic Poverty in Mexico

Adán L. Martínez-Cruz[*] Carlos Rodríguez-Castelán[†]

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[*] Senior Researcher at ETH Zurich. E-mail: madan@ethz.ch (corresponding author).
[†] Senior Economist at World Bank. E-mail: crodriguezc@worldbank.org.

1. Introduction

Violence has become one of the biggest problems in the Latin America and Caribbean region (UNOCD 2011). The Mexican case offers a dramatic example. After a 15-year decline, average homicides almost doubled from 2005 to 2010, mostly because of an increase in drug-related violence. At the same time, poverty rates in Mexico remained almost unchanged during 1990–2010. This lack of improvement has occurred despite the launching, in 1997, of *Progresa* (now known as *Prospera*), an internationally awarded conditional cash transfer program designed to combat poverty.

The relationship between violence and poverty has been widely explored by a literature to which economists are relative newcomers (Blattman and Miguel 2010). In particular, there is a long-standing literature studying the relationship between poverty and violence in the context of civil war and long-term violent conflicts (see Justino 2012 for references). This literature emphasizes the ruin of infrastructure as the main reason for the impact of violence on poverty. The identification strategies are challenging in civil war contexts. Econometrically, omitted bias and endogeneity arise from the chronic feature of most civil wars, deterring researchers from observing exogenous changes in either crime or poverty.

As highlighted by Goodhand (2003), scholars have overlooked the specificities of the relationship between violence and chronic poverty, which might explain the lack of studies focusing on this particular issue. While the relationship between violence and transitory poverty is most likely endogenous, this might not be the case of the determinants of chronic poverty. In Goodhand's perspective, it is unlikely that chronic poverty generates violence because chronically poor people are less likely to play a leading role in fomenting violent social conflict. This lack of active participation in violence would be a direct consequence of the lack of sufficient assets to become involved. These assets include physical and health assets, that is, chronically poor people may lack the health conditions to become involved in violent events. While Goodhand's arguments focus on contexts of war, they may be extended to more ordinary sorts of violence, such as homicides. An increase in homicides may boost the probability of observing chronic poverty because the psychological impacts of witnessing violence translate into reduced health conditions, school graduation rates, labor market participation, and, ultimately, human capital accumulation. This causal mechanism is consistent with behavioral poverty traps. Kraay and McKenzie (2014) argue persuasively that behavioral poverty traps explain observed chronic poverty more accurately than other well-established mechanisms such as savings-based or nutritional poverty traps.

This study seeks evidence on whether ordinary violence increases the likelihood of detecting chronic poverty at the municipality level in Mexico. A municipality is classified as chronically poor if the percentage of people in food poverty remains above the national average during two consecutive periods. Violence is measured as the number of non–drug-related homicides per 100,000 inhabitants at the municipality level. A long-run perspective is gained by analyzing unique, recently gathered panel data on income, poverty, and criminality at the municipality level. Data are reported for four years: 1990, 2000, 2005, and 2010.

Given both the binary nature of the dependent variable and the panel availability of the data, parameter estimates are obtained from a nonlinear panel model, a mixed effects logit model. This model allows the intercept to behave as a random variable that may or may not depend on other variables. Under the argument that the intercept may likely be correlated with the error term, fixed effects models are usually preferred. However, given the loss of degrees of freedom if many municipalities exhibit no change in the condition of poverty, the estimation of fixed effects logit becomes impractical. Allowing the intercept to behave as a random coefficient that depends on other variables represents an alternative to control for the possible correlation between the intercept and the error term (see Cameron and Trivedi 2005).

Conveniently, the Mexican case provides a context in which endogeneity is likely not an issue because, while no large changes in poverty condition are observed (Dávalos et al. 2015), non–drug-related violence has steadily decreased since 1990. The impacts of non–drug-related violence cannot be confounded with the impacts of the recent rise in drug-related violence because the analyzed data cover a period during which drug-related violence was not a major problem in Mexico. In addition, both chronic poverty and ordinary violence are included in the econometric specifications as categorical variables, thus reflecting the relative performance of each municipality with respect to the national average. This statistical artifact allows us to make the argument that, while the absolute numbers associated with poverty and violence can be endogenous at the municipality level, the relative performances with respect to a mobile national average are unlikely to be endogenous.

The results of this study suggest that crime is an important determinant of the probability a municipality will remain poor during two consecutive periods and thus may be considered chronically poor by our definition. To put our results in context, consider a chronically poor municipality in 2005 in which the average household income is below the 25th percentile of the income distribution in 2000 (Mex$323,000 in constant 2010 prices). If the municipality had a non–drug-related homicide rate of 10.5, the 75th percentile in 2000, the chance it would remain chronically poor subsequently would be almost double the corresponding chance of an identical community with zero non–drug-related homicides, the national median in 2000.

The rest of this paper proceeds as follows. Section 2 presents a literature review of the evidence on the topic. Section 3 describes the data sources and describes some basic stylized facts on violence and chronic poverty in Mexico. Section 4 lays out the empirical strategy. Section 5 summarizes the results of the analysis. Section 6 concludes.

2. Previous Literature

With the exception of the recent surge in economic studies focusing on the impacts of drug-related violence on a wide range of outcomes, few economic studies have tested the relationship between violence and poverty.[1] A couple of these studies have sought the impacts from shocks in income on

[1] But, for instance, see Arias and Esquivel (2013); Enamorado, López-Calva, and Rodríguez-Castelán (2014); Enamorado et al. (2016); Márquez-Padilla, Pérez-Arce and Rodríguez-Castelán (2015), and; Michaelsen and Salardi (2013).

crime using rainfall as an instrument in contexts where societies depend heavily on agricultural activities. Income shocks associated with extreme rainfall have been found to double the incidence of murder of elderly women by relatives in rural Tanzania (Miguel 2005). Income shocks provoked by a 1 percent reduction in the price of rye have been linked to an 8 percent rise in property crimes in 19th century Germany (Mehlum, Miguel, and Torvik 2006).[2]

Miguel and Roland (2011) assess whether violence produces poverty traps in the Vietnamese context. They find that human capital and the quality of life in Vietnamese regions heavily affected by bombing attacks during the Vietnam War converge with the levels of human capital and the quality of life in regions that had experienced fewer bombing attacks. These results suggest that loss of infrastructure in wartime does not provoke long-run poverty traps. This finding is consistent with the cross-country literature showing rapid postwar economic recovery and with the simplest Solow model, according to which the partial destruction of physical capital is followed by a temporary boost in capital accumulation until the steady-state is reached (Blattman and Miguel 2010).

In contrast to Miguel and Roland (2011), this paper seeks impacts on chronic poverty from a type of violence that produces no destruction of infrastructure, namely, the number of non–drug-related homicides. The destruction of infrastructure is not a prerequisite for long-term effects from violence. Multigenerational effects from exposure to neighborhood violence have been documented. Specifically, violence deters emotional development and increases aggressive behavior and anxiety, thereby affecting learning capabilities and concentration skills (Aizer 2008; Sharkey and Elwert 2011). These psychological effects translate into a deterioration in health conditions, school graduation rates, and labor market participation (Fernández, Ibáñez, and Peña 2011; Ludwig et al. 2012; Sampson 2012; Wodtke, Harding, and Elwert 2011). Ultimately, exposure to neighborhood violence translates into lower rates of human capital accumulation, which ultimately imply lower expected lifetime earnings. In a context in which an individual is already poor, an expansion in violence is expected to increase the probability of continuing to live in poverty because of the reduced human capital accumulation. This form of poverty trap is consistent with Kraay and McKenzie's (2014) behavioral poverty traps. Behavioral traps suggest poverty may be self-reinforcing because of the way poverty affects decision making. The traps imply, for instance, that underinvestment is not a consequence of lack of monetary resources so much as a consequence of the limits in mental concentration imposed by poverty on the individual living in poverty. Kraay and McKenzie (2014) persuasively argue that the empirical evidence can be interpreted to support the notion that behavioral poverty traps and their macrocounterparts—geographical poverty traps—explain chronic poverty more accurately than other well-established mechanisms such as savings-based or nutritional poverty traps.

Studies focusing on Mexico have recently documented negative impacts on school performance and human capital accumulation, the spread of unemployment, and the decline in hours worked in the

[2] This paper can also be linked to the literature explaining entrance into and exit from poverty. The econometric approach in this study seeks factors explaining the probability of remaining in poverty and leaves to future research the issue of the factors explaining poverty mobility. See Dang and Lanjouw (2013) for further references. Also, a closely related literature seeks how income inequality drives crime and violence. See Enamorado, López-Calva, and Rodríguez-Castelán (2014) for further references.

context of drug-related violence (Arias and Esquivel 2013; BenYishay and Pearlman 2013; Michaelsen and Salardi 2013). Although drug-related violence differs in nature and intensity from non–drug-related violence, both types of violence share the feature that no loss of infrastructure occurs. In this sense, evidence from the research on drug-related violence is interpreted as suggestive of the possible effects of non–drug-related violence on chronic poverty in the Mexican context.

So far, research on poverty and research on violence in the Mexican context have not intersected. Research on poverty has mostly focused on impacts from the NAFTA, migration and remittances, and Progresa-Prospera and other social programs (for example, see Attanasio, Meghir, and Santiago 2012; de Brauw and Hoddinott 2011; de la Fuente 2010; Hanson 2007; Hoddinott and Skoufias 2004; Sadoulet and de Janvry 2001; Schultz 2004; Taylor et al. 2005). Research on violence has mostly focused on impacts from drug-related violence on outcome variables such as migration and income growth (Basu and Pearlman 2013; Enamorado, López-Calva, and Rodríguez-Castelán 2014; Rios 2014). This paper brings together both streams of the literature.

3. Data and Stylized Facts

Violence indicators

Violence is measured as homicides per 100,000 inhabitants at the municipal level. Three reasons justify the use of this measure. First, homicides represent a form of crime that is both violent and visible. Second, in contrast to other measures of violence, homicides do not suffer from reporting bias. Third, homicide statistics were consistently reported at the municipal level during the period under analysis. Data from 1990 to 2010 at the municipal level in Mexico have been gathered from the webpage of the Vital Statistics Registry.[3]

Data on chronic poverty

The long-term effects of violence on chronic poverty have been estimated by analyzing panel data on poverty across municipalities. The poverty mapping methodology has been used to obtain poverty measures for 1990, 2000, 2005, and 2010. The methodology imputes income to households in the population census (1990, 2000, and 2010) and in the population count (2005). The imputed income data are based on predictions yielded by statistical models estimated on household survey data (the National Household Income and Expenditure Survey 1992, 2000, 2005, and 2010).[4] Empirical evidence suggests that the methodology yields reliable values, particularly in the data aggregated on municipalities in Mexico (see Alderman et al. 2002; Elbers et al. 2001; Enamorado, López-Calva, and Rodríguez-Castelán 2014; López-Calva et al. 2005).

A municipality is classified as chronically poor if the percentage of people living in food poverty remains above the national average during two consecutive periods. This indicator of chronic poverty

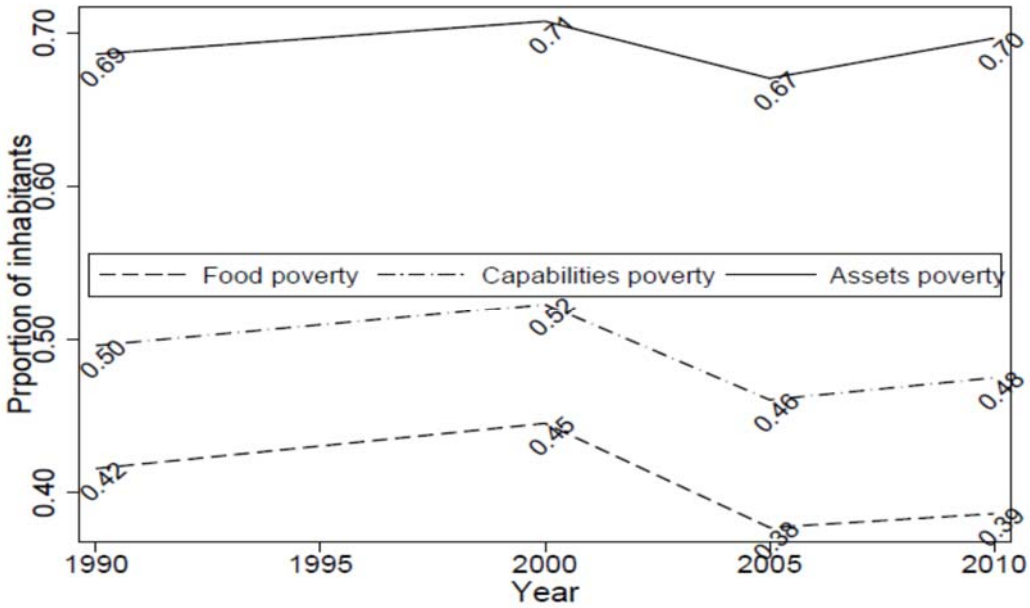
[3] See "Mortalidad," National Institute of Statistics and Geography, Aguascalientes, Mexico, http://www.inegi.org.mx/sistemas/olap/Proyectos/bd/continuas/mortalidad/DefuncionesHom.asp.
[4] See Elbers, Lanjouw, and Lanjouw (2003) for details on the poverty mapping methodology.

is consistent with the idea that poverty is a condition in which people are persistently deprived with respect to a basic, well-defined standard. This conceptualization follows the dynamics of poverty spells approach by (a) capturing the duration of poverty and (b) identifying the chronic condition based on the number of consecutive periods during which poverty has been experienced.[5] This definition of chronic poverty has a disadvantage, however: the poverty headcount is anonymous. The measure therefore cannot provide information on whether the composition of the people living in poverty changes from one period to another. Thus, a constant percentage share may mask the fact that some people have exited poverty, while others have fallen into poverty.[6]

Stylized facts

Poverty rates have remained almost unchanged in Mexico since 1990 (figure 1). Food poverty refers to a situation in which a household's income is not sufficient to meet minimum food requirements. Capabilities poverty refers to a situation in which a household's income is not sufficient to meet minimum food, health care, and education requirements. Assets poverty refers to a situation in which a household cannot afford to meet the minimum food, health care, education, housing, and transportation requirements (CONEVAL 2012).

Figure 1. Poverty Rates, Mexico, 1990–2010



The lack of a significant change in poverty rates has been accompanied by a lack of social mobility in municipalities. In table 1, the diagonal—indicated by the numbers highlighted in italics descending from left to right across the table—reports municipalities showing no change in the incidence of food poverty. Thus, in 1990–2010, no change in the food poverty rate was observed in 51 percent of the

[5] Details on the spells approach can be found in Bane and Ellwood (1986), Foster (2007), and Stevens (1994).

[6] Different measures of poverty may also imply diverse public policy recommendations. Discussions on the conceptualization of chronic poverty may be found in Foster (2007), Green and Hulme (2005), and Hulme and Shepperd (2003).

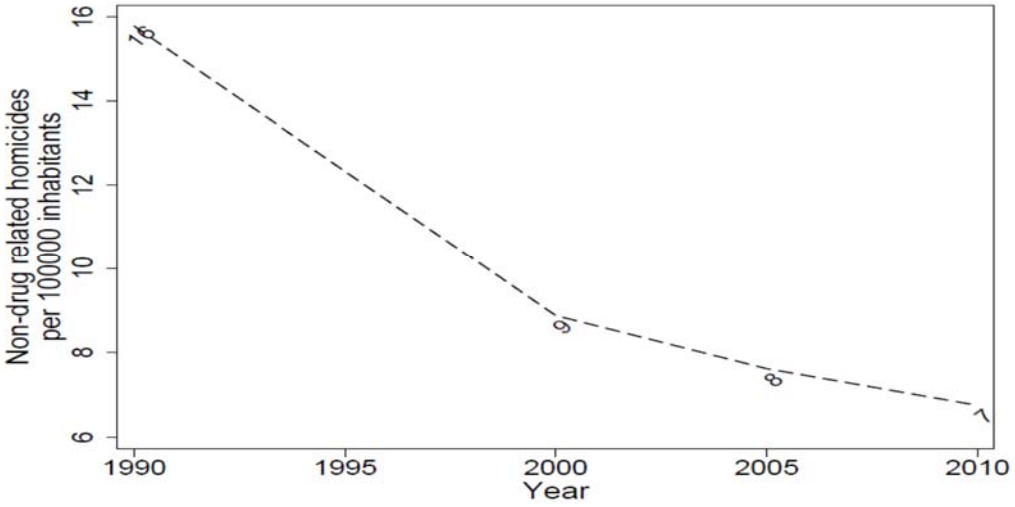
municipalities (1,207).[7] Municipalities transitioning to a rising trend in food poverty are reported above the diagonal. During the period, 20 percent of the municipalities transitioned to a higher rate of food poverty (477).[8] Municipalities experiencing a falling trend in food poverty are reported under the diagonal. During the period, only 29 percent transitioned to a more favorable food poverty situation (688).[9]

Table 1. Municipalities Transitioning to a Higher or Lower Food Poverty Rate, 1990–2010

Food poverty, 1990	*Food poverty, 2010*				*Total*
	≤25%	*>25% and ≤50%*	*>50% and ≤75%*	*>75%*	
≤25%	*463*	124	34	3	624
>25% and ≤50%	326	*420*	171	33	950
>50% and ≤75%	48	211	*244*	112	615
>75%	5	19	79	*80*	183
Total	842	774	528	228	2,372

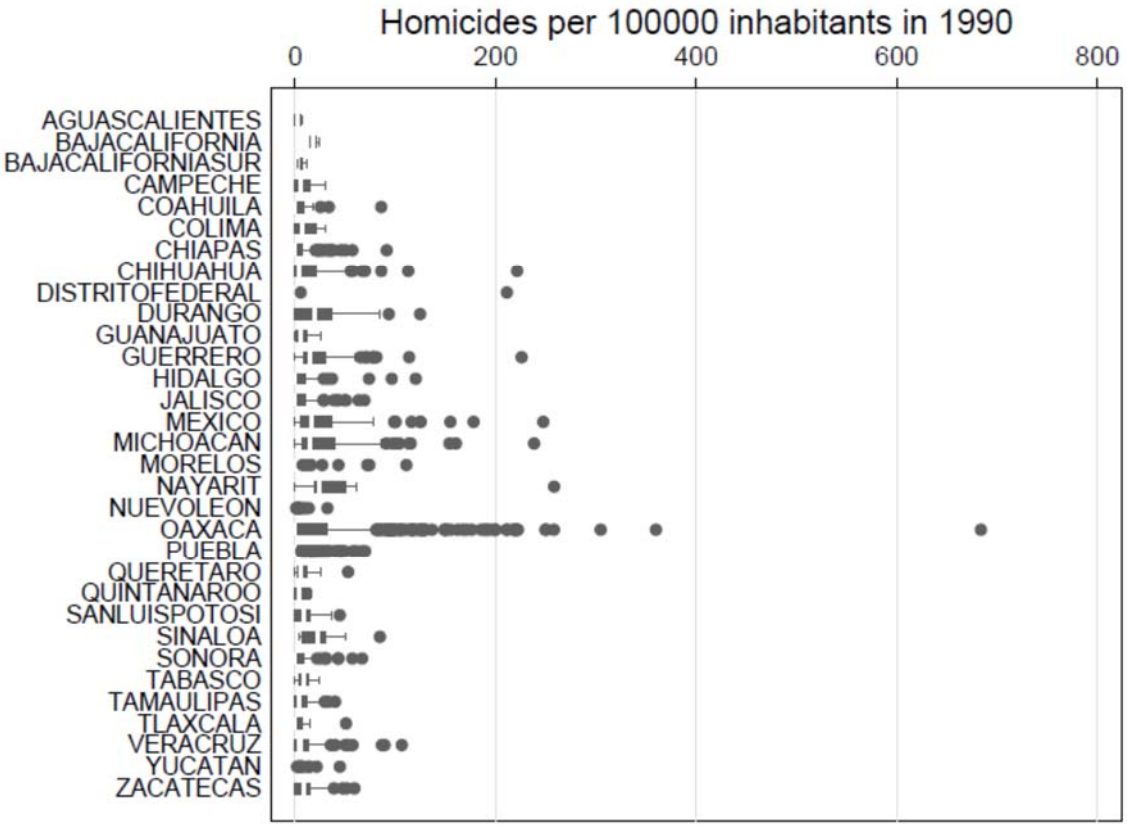
Figure 2 illustrates the trends in annual average non–drug-related homicides per 100,000 inhabitants across the country in 1990–2010. In contrast to the documented increase in drug-related homicides, annual average non–drug-related homicides steadily declined during the period.[10] The figure, however, hides a large amount of intrastate heterogeneity. Thus, in the state of Aguascalientes in 1990, the largest homicide rate was 7.3 per 100,000 population (figure 3). In contrast, the state of Oaxaca contains a municipality with a rate of 684. The national average in 1990 was 16, but the average non–drug-related homicide rate in 27 of 32 states was above 16. Though the maxima are different, similar patterns may be observed in 2000, 2005, and 2010.

Figure 2. Non–Drug-Related Homicides, per 100,000 Inhabitants, Mexico, 1990–2010



[7] 463 + 420 +244 + 80 = 1,207.
[8] 124 + 34 + 171 + 3 + 33 + 112 = 477.
[9] 326 + 48 + 5 +211 + 19 + 79 = 688.
[10] Details on drug-related violence may be found in Guerrero-Gutiérrez (2009, 2011).

Figure 3. Non–Drug-Related Homicides, per 100,000 Inhabitants, by State, 1990



4. Estimation Strategy

Three features of the data allow the identification of a plausible impact of violence on the probability of remaining in chronic poverty: (a) the relatively constant average share of people living in chronic poverty and experiencing a lack of social mobility in municipalities (see figure 1 and table 1), (b) the downward trend in average non–drug-related violence (see figure 2), and (c) the intrastate heterogeneity in violence (see figure 3).

Endogeneity is arguably not an issue in a context in which poverty rates remain relatively constant, while violence steadily declines. Endogeneity implies that an increase in poverty may be caused by an increase in violence, but it may also be plausible that the relationship is the other way around. However, that poverty might cause violence seems unlikely in a context in which violence is steadily decreasing, but no large changes in poverty are observed.

In a context of a downward trend in average violence, the heterogeneity in violence rates across municipalities becomes essential to the inference of a causal relationship. The differences in violence rates provide the basic identification strategy. Heterogeneity must ultimately imply statistically significant differences in violence rates across municipalities classified according to poverty rates. Table 2 presents a comparison of lagged homicides per 100,000 inhabitants across municipalities

classified by chronic poverty status. Municipalities predominately chronically poor had suffered from higher rates of violence during a previous period. This conclusion holds in 2000 and 2005.

Table 2. Lagged Non–Drug-Related Homicide Rates, by Chronic Poverty Category

Non–drug-related homicides in previous period	*Municipality was chronically poor, year*					
	2000		*2005*		*2010*	
	No	*Yes*	*No*	*Yes*	*No*	*Yes*
Number	1,536	813	1,481	868	1,509	840
Per 100,000 population	12.41	22.14	7.45	11.31	7.28	8.22
Standard deviation	(24.99)	(49.55)	(16.91)	(25.38)	(14.53)	(19.68)
P-value of t-test[a]	0.00		0.00		0.11	

[a.] Null hypothesis: homicide rates are lower in non–chronically poor municipalities than in chronically poor municipalities.

A downward trend in violence does not provide a good identification context if the trend is observed only in one of the categories under study. If the downward trend differs across poverty conditions, omitted variable bias and endogeneity may continue to be issues needing to be solved because both endogeneity and omitted variables may explain the differences in the trends. Table 2 illustrates that the downward trend in violence is observed in both poor and nonpoor municipalities. This holds for 2000, 2005, and 2010. This feature, together with the fact that the differences remain statistically significant, imply that the differences in violence between chronically and non–chronically poor municipalities remain even in contexts in which the incidence of criminality declines. This holds for 2000 and 2005. In 2010, poor municipalities reached the levels of violence observed in nonpoor municipalities. This feature plays in favor of the identification strategy because it shows that the decline in non–drug-related violence is more pronounced in poor municipalities, which makes the argument that there is no endogeneity more convincing.

An additional visual aid is useful in supplying insights into the multivariate analysis that is presented in the next section. Figure 4 reports yearly average homicides per 100,000 inhabitants by the share of people living in food poverty in municipalities. The averages refer to non–drug-related homicides, drug-related homicides, and total homicides. The top left panel illustrates the trend in homicides in municipalities with fewer than 25 percent of the inhabitants living in food poverty. The top right panel reports the trend in municipalities with the share of inhabitants living in food poverty ranging between 25 percent and 50 percent. The bottom right panel reports the trend in homicides in municipalities with the largest shares of poor people, that is, 75 percent to 100 percent. The dashed line corresponds to non–drug-related homicides. In the four groups of municipalities, the trends in non–drug-related homicides follow the average national trend shown in figure 2. Thus, non–drug-related homicides declined in the four types of municipalities, regardless of the share of poor individuals in the municipalities. This illustrates that the poorest municipalities do not present a systematically different pattern in homicides relative to more well off municipalities. If, for instance, the poorest municipalities had experienced an increase in non–drug-related violence, then we might be suspicious there is likely an endogenous association between residence in the poorest municipalities and an increase in violence.

Figure 4. Homicides per 100,000 Inhabitants, by Share of People Living in Food Poverty, Municipalities, 1990–2010

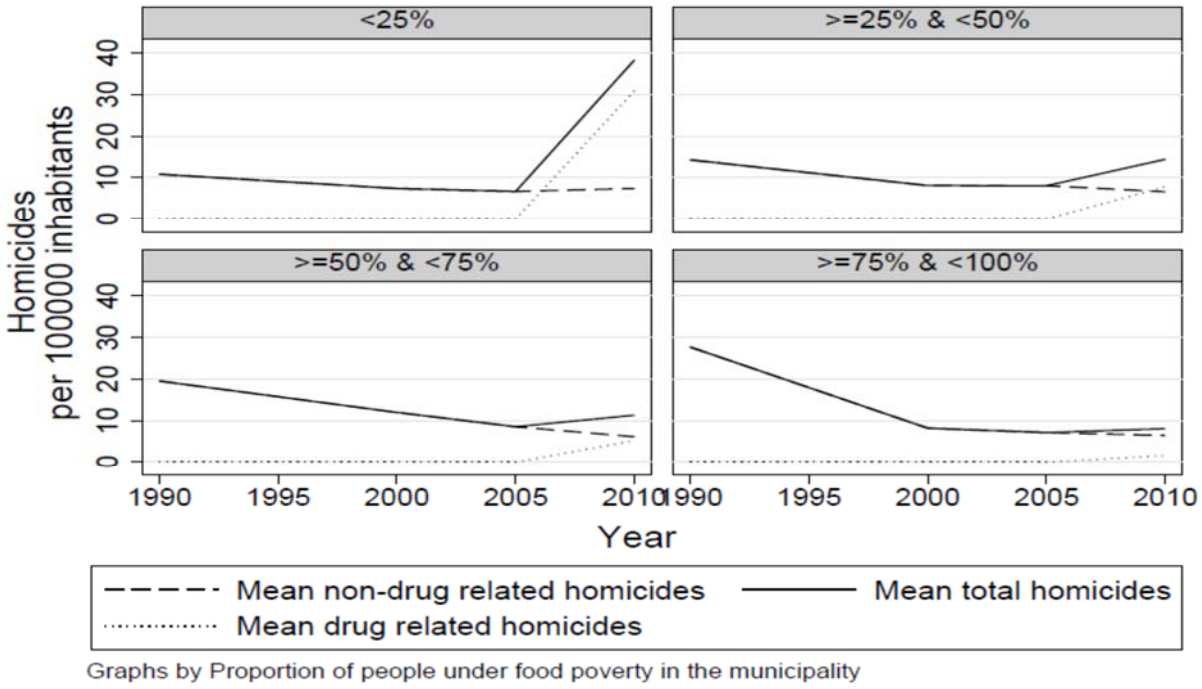
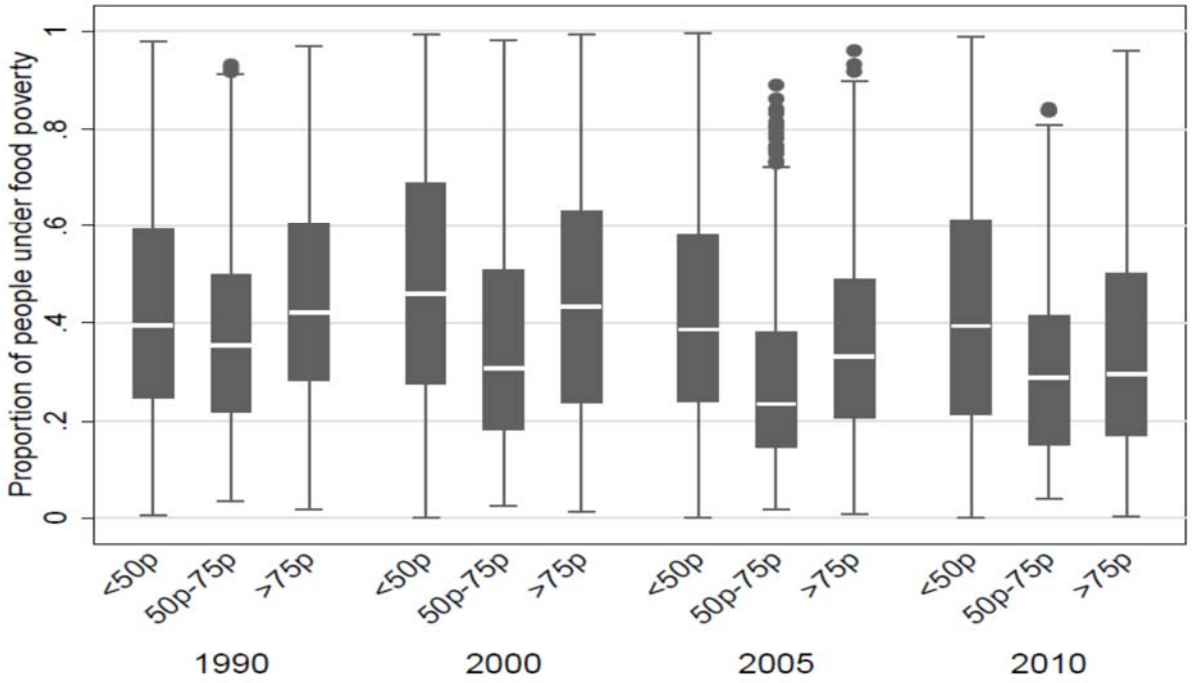


Figure 4 also illustrates the pattern in drug-related homicides. We may not need to be concerned about the possibility of confounding effects from the rise in drug-related violence during the last period of analysis. A first argument for this conclusion is that drug-related homicides have increased only since 2007. Thus, the analysis on the three periods covering 1990, 2000, and 2005 are free of a possible confounding effect from drug-related homicides. A second argument is that the increase in drug-related homicides is not observed in the poorest municipalities. Cofounding effects on the probability of falling into chronic poverty may be possible if the poorest municipalities experienced a relatively large rise in drug-related homicides. However, this is not the case. The municipalities in which fewer than 25 percent of the inhabitants are poor are the ones experiencing the largest expansion in drug-related homicides so that total homicides jumped from a little less than 10 per 100,000 population to almost 40 in 2005–10. In contrast, municipalities in which more than 50 percent, but fewer than 75 percent of the inhabitants were living in food poverty experienced an increase of less than 5 homicides per 100,000 in 2005–10. The rise is even smaller among municipalities in which more than 75 percent of the inhabitants are poor. Thus, municipalities that remained poor for consecutive periods—our definition of chronic poverty—experienced low levels of drug-related violence.

To avoid endogeneity, we take an additional step by noting how non–drug-related homicide rates enter econometric specifications through dichotomous variables. Dichotomous variables refer to a municipality's position relative to other municipalities in terms of annual rates of non–drug-related homicides per 100,000 inhabitants. While the number of non–drug-related homicides may be somewhat within the control of a municipality, relative performance depends on the performance of

other municipalities during the year. Figure 5 offers intuition on this point. It shows the distribution of the share of municipality inhabitants living in food poverty by the percentile group of non–drug-related homicides. In 1990–2010, the values corresponding to each percentile group range from 0 to close to 1. Likewise, we may observe that both poor and nonpoor municipalities exhibit differences in performance in terms of non–drug-related homicides. We may also observe that the average changes each year, which means that the threshold changes yearly. Because the average is calculated at the national level, the relative position of a given municipality is exogenous to whether the municipality is or is not chronically poor.

Figure 5. Inhabitants Living in Food Poverty, by Non–Drug-Related Homicide Percentile, Municipalities, 1990–2010



Given the binary nature of the dependent variable and the panel availability of the data, we have obtained parameter estimates from nonlinear panel models. Specifically, we have estimated a mixed effect logit model. The model allows the intercept to behave as a random variable that may or may not depend on other variables. Based on the argument that the intercept may be correlated with the error term, fixed effect models are usually preferred. Fixed effects, however, require sufficient heterogeneity in the dependent variable. As illustrated in table 1, there is a lack of social mobility in municipalities; the condition of poverty has not changed in 51 percent of municipalities. This implies that the estimation of fixed effect specifications would sacrifice many degrees of freedom. Allowing the intercept to behave as a random coefficient that depends on other variables represents an alternative to controlling for the possible correlation between the intercept and the error term (see Cameron and Trivedi 2005).

5. Results

Table 3 reports the results of logit specifications on chronic poverty. A municipality is chronically poor if the share of its inhabitants living in food poverty remains above the national average during two consecutive periods.[11]

Table 3. Logit and Mixed Logit Specifications on Chronic Poverty

Explanatory variables, lagged one period, municipality		*Mixed logit*[d]		*Logit*[d]		
Homicides, per 100,000 inhabitants	*Average household income*	*Homicides*		*Full range of homicides*		
		Full range	*< 117*	*2000*	*2005*	*2010*
Below the median	Below 25th percentile	Reference category				
	25th percentile–median	−2.393***	−2.401***	−1.413***	−2.184***	−2.826***
		(0.17)	(0.17)	(0.24)	(0.22)	(0.23)
	Median–75th percentile	−6.242***	−6.255***	−4.834***	−4.738***	−7.434***
		(0.31)	(0.31)	(0.40)	(0.33)	(0.67)
	Above 75th percentile	−10.111***	−10.150***	—	—	−8.775***
		(1.19)	(1.19)	—	—	(1.20)
Median–75th percentile	Below 25th percentile	0.612	0.611	0.428	—	—
		(0.41)	(0.41)	(0.41)	—	—
	25th percentile–median	−2.284***	−2.294***	−1.287***	−1.968***	−2.785***
		(0.26)	(0.26)	(0.31)	(0.33)	(0.37)
	Median–75th percentile	−7.083***	−7.088***	−4.673***	—	−6.313***
		(0.49)	(0.49)	(0.61)	—	(0.58)
	Above 75th percentile	−9.169***	−9.176***	—	−7.394***	—
		(1.10)	(1.09)	—	(1.12)	—
Above 75th percentile	Below 25th percentile	0.659*	0.674*	0.973**	0.587	0.506
		(0.28)	(0.29)	(0.36)	(0.39)	(0.51)
	25th percentile–median	−1.920***	−1.917***	−1.030***	−1.832***	−2.319***
		(0.23)	(0.23)	(0.30)	(0.30)	(0.30)
	Median–75th percentile	−5.606***	−5.642***	−4.117***	−5.058***	−5.485***
		(0.34)	(0.34)	(0.48)	(0.46)	(0.41)
	Above 75th percentile	−9.573***	−9.544***	—	—	−8.070***
		(1.17)	(1.17)	—	—	(1.09)
Atkinson inequality index		8.250***	8.416***	6.319***	3.983***	10.091***
		(0.76)	(0.76)	(1.53)	(1.02)	(1.28)
Over-5-year-olds speaking an indigenous language, %		2.096***	2.057***	1.951***	0.506	1.119***
		(0.26)	(0.26)	(0.28)	(0.27)	(0.27)
Political party different from the president's party		0.504***	0.510***	0.542*	0.008	0.001
		(0.14)	(0.14)	(0.22)	(0.21)	(0.20)
Intercept		−4.206***	−4.239***	−1.835	1.569	−2.762*
		(1.18)	(1.18)	(1.29)	(1.13)	(1.18)
Intercept, standard deviation		1.109***	1.083***	—	—	—
		(0.14)	(0.14)	—	—	—
Chi²		790	779	1048	1654	1554
P-value chi²		0.00	0.00	0.00	0.00	0.00
Pseudo R²		—	—	0.48	0.47	0.58
n		6,852	6,779	1,582	1,654	2,010

Note: A municipality remaining below the national average food poverty rate during two consecutive periods is defined as chronically poor. All specifications control for time and state fixed effects. Five states are excluded from the analysis because no municipalities in these states are classified as chronically poor during the period of analysis: Aguascalientes, Baja California, Baja California Sur, Coahuila, and Colima.
Significance level: * = 10 percent, ** = 5 percent, *** = 1 percent.

[11] As a robustness check, we have also carried out specifications using an alternative definition of chronic poverty. The alternative definition classifies a municipality as chronically poor if 50 percent or more of the inhabitants are living in food poverty. The results are similar to those discussed in this section. Annex table A.1 shows the results of these specifications.

The results of the mixed effect logit specifications reported in the middle of table 3 allow the intercept to behave as a normally distributed random parameter that is uncorrelated with observed heterogeneity.[12] Random intercepts can be imagined as the combined effect of omitted municipality-specific covariates that cause a municipality to remain chronically poor.

The column in table 3 headed by the term full range presents a mixed logit specification on the full range of the observed homicide rates. The specification in the next column in table 3 excludes municipalities in which the number of homicides per 100,000 inhabitants was less than 117. This exclusion represents 1 percent of the observations and is meant to test whether the results are driven by municipalities with large homicides rates. All specifications control for time and state fixed effects (not reported in table 3). All specifications exclude states in which no municipalities are classified as chronically poor during the entire period of analysis. These states are Aguascalientes, Baja California, Baja California Sur, Coahuila, and Colima.

The two columns in the panel on the left side of table 3 refer to the interaction of two sets of dichotomous variables. These variables relate, respectively, to a municipality's relative position in terms of non–drug-related homicide rates across municipalities and in terms of average household income.[13] With respect to the homicide rate, a municipality is classified as below the annual national median, between the median and the 75th percentile, or above the 75th percentile. With respect to average household income, a municipality is classified as below the 25th percentile, between the 25th percentile and the annual national median, between the median and the 75th percentile, or above the 75th percentile.

The direction of the impact of the interaction variables has been interpreted with respect to municipalities below both the median homicide rate and the 25th percentile of average household income. This reference category defines a group of municipalities that exhibit both low average household income and low homicide rates. All but two interactions decrease the probability of remaining in poverty with respect to the reference group. The two exceptions correspond to two groups of municipalities in which the homicide rates vary, but average income does not: (a) municipalities below the 25th income percentile and between the median homicide rate and the 75th percentile and (b) municipalities below the 25th income percentile and above the 75th homicide

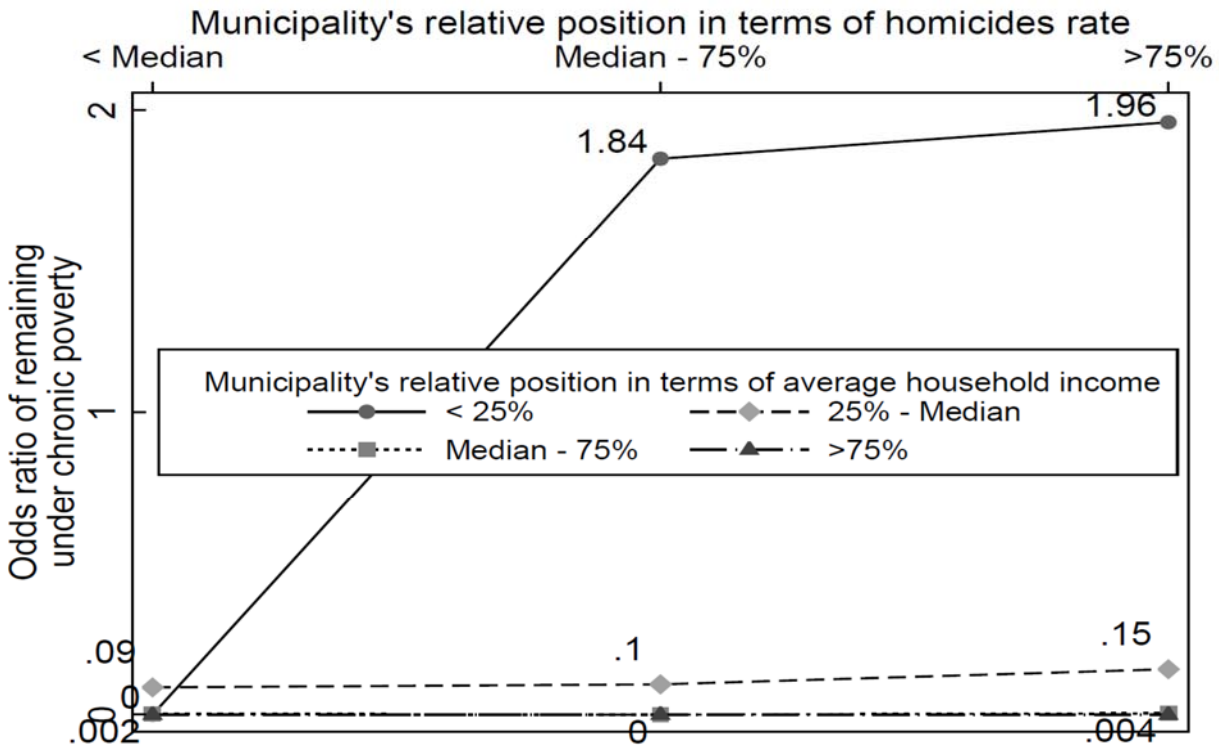
[12] Specifications allowing correlation between the intercept and observed heterogeneity act as a test for the presence of omitted variables. If omitted variables generate this type of correlation, the parameter estimates are inconsistent. Specifications allowing for correlation have been estimated. These specifications yield results similar to those reported here if one does not control for state fixed effects. (The results are available upon request.) Once state effects are included, the correlated specifications show convergence problems. We interpret this pattern as evidence that the inclusion of state fixed effects is sufficient to control for omitted variables that provoke correlation between the intercept and observed heterogeneity. See Train (2009) for details on specifications that allow correlation.

[13] Specifications considering public expenditure instead of household income have also been carried out. The sign of the coefficient of this variable is, however, sensitive to the specification. We believe changes in the sign of the expenditure coefficient may derive from the fact that public expenditure is directed to poor communities, and a possible endogeneity issue may thus be in play. Household income has been preferred because of the consideration that the linear correlation between income and expenditure is around 0.90, and no sensitivity in the coefficient of income has been observed.

rate percentile, that is, among municipalities in the lowest income category in which an increase in non–drug-related homicides raises the probability of remaining in chronic poverty.

For the rest of the municipality income categories, a way to interpret the impact on probability is as follows: for a given income category, an increase in the homicide rate decreases the negative impact of income on the probability of remaining chronically por. Because the relative magnitude of the coefficients cannot be interpreted as marginal effects, this interpretation may be illustrated more clearly through figure 6, which shows the odds ratios of remaining chronically poor if the income category is kept fixed.[14]

Figure 6. Odd ratio of remaining under chronic poverty



Odds ratios indicate the odds that a municipality will remain chronically poor if its homicide rate changes across categories. The largest impact is observed in the poorest municipalities. In the group of municipalities below the 25th income percentile, those with homicide rates between the median and the 75th percentile are 1.84 times more likely of remaining in chronic poverty. The odds ratio increases to 1.96 among municipalities above the 75th homicide rate percentile. The impact of the homicide rate declines if income increases. This can be seen by noting the modest rise in the odds

[14] Odds ratios are obtained through the exponentiation of the regression coefficients. Odds ratios must be interpreted conditionally on the random intercept and, in contrast to odds ratios derived from conventional logit specifications, are often referred to as conditional or subject-specific odds ratios. For an explanation, see Rabe-Hesketh and Skrondal (2012).

ratio among municipalities between the 25th income percentile and the median. The increase in the odds ratio becomes indistinguishable from 0 among municipalities with income above the median.

To put these figures in context, consider a chronically poor municipality in 2005 in which average household income is below the 25th percentile in 2000 (Mex$323,000 expressed in constant 2010 prices). If this municipality showed 10.47 non–drug-related homicides per 100,000 inhabitants (the 75th percentile in 2000), its chances of remaining chronically poor up to 2005 were almost double the corresponding chances of an identical community with 0 non–drug-related homicides, the national median in 2000.

Variables in the bottom-left panel of table 3 control for (a) inequality through the Atkinson inequality index calculated with a sensitivity parameter of 2, (b) the indigenous condition through the percentage of over-5-year-olds speaking an indigenous language, and (c) political institutions through a dichotomous variable indicating whether the municipality is ruled by a political party different from the president's political party.[15] The direction of the impacts of these variables is intuitive. Wider income inequality and a larger share of indigenous people in the population increases the probability of remaining in poverty. A municipality governed by a party different from the president's political party is more likely to remain in chronic poverty. This variable attempts to control for the quality of institutions. In this sense, the presence of a political party different from the president's is intended to reflect, among other conditions, that resources may be flowing at a slower pace to these municipalities and that this is reflected in the quality of municipal institutions.

The last three columns on the right in table 3 report the results of cross-sectional logit specifications. These specifications provide information on whether a particular period governs the mixed logit results. Most of the estimates rely on information on the three periods under analysis. Two exceptions are (a) the coefficient of the variable reflecting political institutions, which is driven mostly by 2000 data, and (b) coefficients among the group containing municipalities above the 75th income percentile, which is driven mostly by 2005 and 2010 data.

6. Conclusions

This study finds evidence supporting the hypothesis that crime increases the likelihood of observing chronic poverty in municipalities. Putting our results in context, consider a chronically poor municipality in 2005 in which the average household income is below the 25th percentile in 2000. If this municipality exhibited a non–drug-related homicide rate of 10.47 (the 75th percentile in 2000), its chances of remaining chronically poor up to 2005 were almost double the corresponding chances of a municipality with identical mean household income but with zero non–drug-related homicides, the national median in 2000. Although this scenario of completely eradicating non-drug related violence at the municipal level seems highly unlikely, this comparison emphasizes the dramatic impact of crime on the poorest municipalities. As shown above, there is a non-linear effect of the effects of crime on chronic poverty. While the effect is the largest on the poorest municipalities, the rest of the

[15] The share of people speaking an indigenous language is highly correlated with the share of the population living in rural areas. Thus, rural residence is excluded from the specifications.

municipalities hardly experience an impact --e.g. the odds of remaining chronically poor almost double for a municipality below the 25th percentile in terms of income, these odds only increase by 0.1 for a municipality between the 25th percentile and the median in terms of income.

These results have important implications for public policy since these suggest that policies to enhance citizen security may be instrumental in reducing persistent poverty. As illustrated by using the non–drug-related homicide rate as a measure of violence, even violence that implies no loss in infrastructure has long-run impacts on the incidence of poverty.

Finally, the analysis highlights the need for further study, particularly the identification of potential mechanisms that may explain how violence impacts the probability of observing chronic poverty. On one hand, one extension would be to test the potential psychological effect of witnessing violence which could translate into reductions in good health, school graduation rates, labor market participation, and, ultimately, human capital accumulation. This causal mechanism is a type of behavioral poverty trap that has been put forward in recent studies to explain chronic poverty more effectively than well-established theories have been able to do. Another possible extension would involve studying the effects of violence on persistent poverty through its impact in the local economy. Of particular interest would be to further analyze how violence could affect the probability of a municipality to experience chronic poverty through several factors such as reduced private investment and employment prospects because of uncertainty, diversion of public resources from poverty reduction strategies in order to address citizen security, or out migration of the better off which could in turn increase poverty rates (composition effect).

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ANNEX

Annex A. Robustness Check

Table A.1 Econometric Specifications on an Alternative Definition of Chronic Poverty[a,b,c]

Explanatory variables, lagged one period, municipality		*Mixed logit*[d]		*Logit*[d]		
Homicides, per 100,000 inhabitants	*Average household income*	*Homicides*		*Full range of homicides*		
		Full range	*< 117*	*2000*	*2005*	*2010*
Below the median	Below the 25th percentile	Reference category				
	25th percentile–median	−2.926***	−2.928***	−2.115***	−1.887***	−4.430***
		(0.17)	(0.17)	(0.23)	(0.21)	(0.32)
	Median–75th percentile	−6.955***	−6.941***	—	−4.707***	—
		(0.58)	(0.58)	—	(0.54)	—
	Above the 75th percentile	—	—	—	—	—
		—	—	—	—	—
Median–75th percentile	Below the 25th percentile	0.391	0.382	0.395	0.385	0.383
		(0.30)	(0.30)	(0.36)	(0.38)	(0.52)
	25th percentile–median	−3.261***	−3.267***	−2.505***	−2.834***	−3.379***
		(0.29)	(0.29)	(0.35)	(0.42)	(0.46)
	Median–75th percentile	−7.422***	−7.423***	—	—	−6.585***
		(1.08)	(1.08)	—	—	(1.13)
	Above the 75th percentile	−7.338***	−7.336***	—	−5.486***	—
		(1.11)	(1.11)	—	(1.15)	—
Above the 75th percentile	Below the 25th percentile	0.638**	0.608**	0.792**	0.367	0.62
		(0.22)	(0.22)	(0.31)	(0.27)	(0.36)
	25th percentile–median	−2.447***	−2.432***	−1.944***	−1.742***	−3.704***
		(0.23)	(0.23)	(0.30)	(0.29)	(0.39)
	Median–75th percentile	−7.158***	−7.141***	—	−5.364***	—
		(0.80)	(0.80)	—	(0.79)	—
	Above the 75th percentile	—	—	—	—	—
		—	—	—	—	—
Atkinson inequality index		4.531***	4.550***	1.896	−0.559	7.230***
		(0.77)	(0.77)	(1.62)	(1.04)	(1.56)
Over-5-year-olds speaking an indigenous language, %		2.100***	2.055***	1.952***	0.780***	1.186***
		(0.23)	(0.23)	(0.26)	(0.23)	(0.27)
Political party different from the president's party		-0.108	−0.118	0.254	−0.095	−0.646*
		(0.15)	(0.15)	(0.22)	(0.22)	(0.26)
Intercept		−3.561*	−3.516*	−1.552	−1.976**	−3.745***
		(1.68)	(1.67)	(1.52)	(0.60)	(0.78)
Intercept, standard deviation		0.913***	0.878***	—	—	—
		(0.16)	(0.17)	—	—	—

	775	763	1015	1556	1450
Chi^2					
	0.00	0.00	0.00	0.00	0.00
P-value chi^2					
	—	—	0.46	0.45	0.51
Pseudo R^2					
	5,407	5,341	1,131	1,543	1,229
n					

Note: A municipality remaining below the national average food poverty rate during two consecutive periods is defined as chronically poor. All specifications control for time and state fixed effects. Ten states are excluded from the analysis because no municipalities in these states are classified as chronically poor during the period of analysis: Aguascalientes, Baja California, Baja California Sur, Coahuila, Colima, Morelos, Nuevo León, Sinaloa, Sonora, and Tamaulipas.
Significance level: * = 10 percent, ** = 5 percent, *** = 1 percent.

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