The Hidden Costs and Lasting Legacies of Violence on Education: Evidence from Colombia

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Abstract

This paper uses the massive escalation of violence and terrorism in Colombia as a natural experiment to examine the medium and long term effects of prenatal to age six exposures to violence on educational outcomes. Exposure to violence is measured using homicide rates and merged to Census data using the municipality and year of birth for each individual. Results indicate that high levels of violence experienced around birth significantly reduce the likelihood of school attendance for children, and exposure around childhood has a significant and negative impact on the number of years of education for young adults. These findings do not seem to be driven by exposure to violence at other stages in life (late childhood, adolescence, etc.), selection bias on fertility, survival, mobility, or any other time varying factors at the regional level. Results hold when comparing siblings within the same family. The effects found in this study can be interpreted as conservative estimates of the causal effect of violence.

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1 Introduction

Since 1960 many countries, particularly poor nations in Africa, Asia, and Latin America, have suffered from internal armed conflicts, of which one fifth have lasted a decade or more (Blattman & Miguel, 2010). The impacts that these conflicts entail to societies are catastrophic. Wars devastate life, create poverty and suffering, destroy infrastructure, displace populations, and destabilize institutions, and so they represent a major obstacle for economic, social, and political progress. Warfare also diminishes human capital as violence deters investments in this sector by destroying the schooling and health service systems and lowering a household's income and well-being, thereby depresssing the returns on education. War's impacts on human capital are often persistent. Recent evidence on the effects of wars on an individual's human capital have shown that exposed cohorts to warfare events take long decades to recover from the shock. Looking at effects of war on education is important because education promotes economic development and helps individuals to overcome poverty traps. In addition, examining the link between war and education enable us to entirely account for the net (social and economic) costs of violent conflicts.

This study examines the long term impacts of early exposure to violence, from in-utero to age six, on individual's education. Exploring the impacts of violence experienced early in life is important given that a growing body of economic literature has shown that prenatal, infancy, and early childhood developments play a key role for subsequent health and cognitive development (Barker, 1972; Cunha & Heckman, 2007; Currie, 2009), and so any shock experienced during these early stages can have long term consequences on the wellbeing of individuals (Almond & Currie, 2011a; 2011b). While the research on armed conflicts and education has identified significant loses on an individual educational outcomes (e.g., Shemyakina, 2011; Akresh & De Walque, 2011; Chamarbagwala & Moran, 2011), most of the existing studies have estimated the impacts of war during the school-age period (when an individual is among the ages of 7 to 17) and less is known about about whether exposures experienced earlier (in-utero, childhood) in life are more pronounced or persistent. Accordingly, this study aims to connect these two bodies of research – the early influences with the contemporaneous effects of exposure to armed conflicts on education – to explore the long term effects of exposure to violence[1] at early stages in life on future-life educational attainment. In particular, the paper looks at the following

[1] For the purpose of this paper, exposure to violence refers to living in a place with a high level of violence, measured by homicide rate, and early stages refers to the period of time from in utero to age six, the age at which a child enters school.

specific question: What are the effects of exposure to violence from in utero to age 6 (age at which the child enters school) on future education (school enrollment, years of education, etc.)?

In addition to contributing to both bodies of research, this paper uses an improved measure of violence compared to previous studies. Violence is measured with homicide rate at the municipality (equivalent to a US county) and year levels, and it overcomes many problems faced in existing studies of violence and its effects on individuals given that violence is modeled by victims self-reports of damages and experiences. In addition, this paper is able to identify the impacts of violence in each year of an individual's early life on education rather than by stages (Leon, 2012).

The paper examines the case of Colombia, a country that has suffered from a long history of high violence explained by the emergence and expansion of the illegal drug industry and the intensification of its armed conflict. This very unfortunate and complex scenario offers a unique opportunity to explore the effects of violence on education in a context where both urban areas (that where initially hit by the massive escalation of the drug cartels) as well as rural areas (particularly hit by the guerrilla and paramilitary terrorist actions) have suffered from systematic violence.

I link data on homicide rate at the municipality and year level, obtained from Vital Statistics death records, to the Census-2005 based on the place and date of birth for each individual. I identify the levels of violence to which individuals were exposed to both prior to birth and after birth (during infancy and early childhood), and test whether the effects of high homicide rate exposure are persistent years or even decades after the exposure. Extending the period of exposure to violence to the whole lifecourse (from in utero to current age), this paper finds that early-life influences of violence have the most pronounced effects on future-life educational outcomes. In particular, the findings from sibbling comparisons indicate that high violence observed at the municipality and year of birth are associated with significant reductions in educational attainment for both children, who experienced a reduction on school enrollment by 1.7% and an increase in the likelihood that a child is behind grade by 2% for each year of exposure to high violence. Young adults face a decline in years of schooling by 0.2 years for each year of exposure to high violence in early childhood. These results suggest that violence effects do not vanish over time. These findings are of particular interest since high homicide rates are not a condition uniquely associated with Colombia; hence, the results are informative to other settings with high crime and violence. I find that early influences due to violence are robust to subsequent exposure to violence meaning that the strongest and persistent

effects occur while the individual is in utero or in childhood. Additionally, no placebo effects of homicide rates experienced three years prior to birth are observed on educational attainment, providing support for the validity of the identification strategy. The findings are conditional on survivorship and on individuals remaining in the country, however they do not seem to be driven by selection on mobility, survival, fertility, or other unobserved time variant factors associated with violence that could affect educational attainment.

The remainder of the paper is organized as follows. Section II presents the theoretical predictions and a review of the existing literature that describes the effects of exposure to violence on human capital. Section III describes the context of violence in Colombia. Section IV presents the data, descriptive statistics, and the empirical strategy. Section V, shows the results and provides some robustness tests to show that results can be interpreted as lower bound estimates of the causal impact of violence. The last section (VI) concludes and discusses the main findings.

2 Literature Review

2.1 Things that happen before age five have persistent long term effects

A growing body of literature argues that the prenatal and childhood periods are critical for subsequent health and cognitive development (see Almond & Currie, 2011b for a recent survey). Due to a child's rapid growth in these stages, development is more sensitive, and so any disruption that alters the normal process of the fetus (or the child) can exert permanent damage that in turn would have consequences for future outcomes (Almond & Currie, 2011b). For instance, prenatal exposure to high violence is associated with worse birth outcomes (Camacho, 2008; Valente, 2011; Mansour & Rees, 2011). Since health at birth is a commonly used predictor for a non-trivial portion of adult indicators, such as educational attainment (Currie & Hyson, 1999; Almond & Currie, 2011b), violence exposure while in-utero should also exert negative impacts on the long term educational attainment of affected cohorts. Also, in early childhood the child develops his/her core capabilities, such as motor, cognitive, and social skills that directly affect later performance. If these skills are not adequately developed, the skills that build on those previously attained skills will be poorly developed in adolescence and adulthood, even with good interventions later in life (Cunha & Heckman, 2007).

2.2 Armed conflict and education

A number of studies have found that individuals exposed to armed conflicts experience a significant reduction in educational outcomes and that this reduction may persist over time. By exploiting the geographical and temporal variation in cohorts exposed to violent actions previous research has found that school-age children (children and adolescents among the ages of 6 to 17 years of age) exposed to war episodes are less likely to complete their mandatory education and are more likely to attain fewer years of education. For example Shemyakina (2011) examined the variation in the 1992-1998 Tajik civil war measuring exposure to violence with the number of household reports of damages to dwellings. She found that affected individuals were significantly less likely to be enrolled (7% in the case of girls and little effect on boys) and less likely to complete their mandatory education by age seventeen (12.3% compared to girls not exposed). Akresh and de Walque (2011) studied the effects of Rwanda's 1994 genocide on schooling. Using a difference-in-difference approach in which they compared school-aged children exposed to the genocide with those not exposed, they found that affected individuals experienced a decline in years of schooling by 0.5 years and a decrease in the probability of being enrolled in 3rd and 4th grade by 15 percentage points. Chamarbagwala and Moran (2011) for the case of Guatemala's civil war also employed a difference-in-difference strategy and found that years of schooling fell by 23% during the most violent period of the conflict.Rodriguez and Sanchez (2012) for the case of Colombia's armed conflict used an instrumental variables approach to correct for the possible endogeneity between low human capital and armed conflict and found that increases in the number of violent attacks perpetrated by the irregular groups reduced the years of education by half a year and increased the joint probability of school drop-out and child labor by 13% for affected children.

A recent study by Leon (2012) provides evidence regarding exposure to violence in-utero, childhood, school age, and adolescence, on future education. Using the case of Peru's armed conflict, the author links data on human rights violations at the district level with Census data based on the district and year of birth, and examines the impact of violent events at different stages in life on the number of years of education. Results indicated that being exposed in early childhood and during preschool age decreases the years of education by 0.14 and 0.09 respectively, and that these impacts were the most pronounced among the effects of exposures at other stages in life. Results also indicated that if children were affected by violence after they had entered school (age 7 or above), they were able to catch up with the lost years of education; whereas if they were affected prior to age 7, the effect was likely to remain persistent. While these results show that

exposure to violence during the early stages matter for an individual's future educational attainment, more research is still needed to understand the long term impacts that these conflicts entail to individuals.

This paper contributes to the related literature in several ways. First, it will add to the research on the early influences and long term outcomes by exploring a relatively understudied environmental insult which are violent conflicts. Violent conflicts are distinguished from other adversities that affect human capital accumulation by their deliberately destructive nature. These conflicts tend to occur in the developing countries (Blattman & Miguel, 2010), countries for which less evidence exists on the link between early life conditions and future outcomes (Currie & Vogl, 2012). Second, this paper contributes to the research on the effects of violence on human capital by extending the period of analysis to the early stages (in utero, infancy, and early childhood). As shown by Leon (2012), early influences matter to explain the long term losses in future educational attainment. In addition, examining the long term impacts of warfare helps to account for the net social and economic costs of war since losses in human capital may take decades to recover. Third, this study uses an improved measure of violence with respect to previous literature, that helps to identify more precicely changes in violence and its effects on individuals. In particular this paper employs data on homicide rate at the municipality and year level. Homicides are the most common offense associated with a conflict since they effectively exert fear and control over the population (Kalyvas, 2000). Homicides are highly correlated with the occurrence of other terrorist actions such as attacks and kidnappings (Sanchez, 2007), and they are more reliable than other measures of crime that are not always registered by the police (Levitt and Vargas, 2000). Restrepo and Spagat (2004) indicated that homicides are the primary threat to the civilian population, whereas other forms of conflict, such as landmine explosions and oil pipeline attacks, are rarer, garner less coverage by the press and are difficult to track. Hence, using homicide rates to model the dynamics of violence in Colombia offers several advantages relative to other studies (Rubio, 1999; Echandia, 2001; Thoumi, 2002; Sanchez, 2007 Ed.). In addition this study uses data from the Vital Statistics Death Records and contrasts these numbers with homicide records from the National Police Department, thereby making the violence measure used here more reliable. Previous studies on the link between violent conflicts and education have used victims' self-reports to measure the intensity of conflicts (Shemyakina, 2011; Chamarbagwala & Moran, 2011; Leon, 2011). Considering that victims may self-select to report their own damages or stories, estimates of violence may suffer from bias if unobserved characteristics of people who report are correlated with

the probability of reporting. In that sense, the measure of violence used in this paper, homicide rate, overcomes many of the problems faced in existing studies of violence and its effects on individuals. Fourth, due to the relative importance of this period for human development and the advantages of the violence measure, this paper is able to identify the effect of each individual year of exposure to violence within the early stages. This means that for each year, starting 2 years prior to birth (t=-2) and ending at age 6 (t=6) when the child is about to enter school, this study will analyze the impact of homicide rates on an individual's future education.

2.3 Pathways of transmission

Violence may affect an individual's educational attainment through direct and indirect pathways. The direct pathways consist on killing, wounding, or witnessing, and the indirect compromise changes in the supply and demand for education.

From a demand side perspective, prolonged periods of exposure to violence can influence a household's investments in education through its effects on health and well-being, income and wealth, forced displacement, and by induding changes in a household's preferences and behavior.

Health and nutrition are affected during times of conflict due to the prevalence of famines, malnutrition, outbreaks of infectious diseases, post-war trauma, destruction of health facilities, and reduction of household's resources (Justino et al., 2011). In particular, stress due to violence plays an important role affecting children and parental health. The biomedical literature argues that chronic stress during pregnancy is likely to impact fetal and newborn health and cognitive outcomes through changes in the immune and/or behavioral systems (Denckel-Schetter, 2011). Foir instance, fetal exposure to excess cortisol –the hormones in charge of regulating fetal maturation– may lead to impaired development of the brain and spinal cord, and thereby diminish the mental and motor skills of infants (Yu et al. 2004; Huizink et al. 2003). Stress at later stages may comprise the family environment by affecting parental mental health and the family relationships, weakening parenting quality and affecting the child.

Violence can also increase the risk of malnutrition. Multiple evidence has shown that early exposure to war events reduces height-for-age (Valente, 2011; Akresh, Lucchetti, & Thirumurthy, 2012). Other studies have found that malnutrition in childhood is associated with delayed school enrollment, fewer grades attained, and lower probability of enrolling in school (Glewwe, Jacoby, & King, 2001; Bundervoet, 2012).

Widespread insecurity can also lower parental incentives to invest in a child's

human capital by disrupting the local economy and labor markets, thereby reducing the market returns for these investments, and also affecting a household's financial stability (Justino 2011, UNESCO 2011; Gupta, Clements, Bhattacharya, & Chakravarti, 2002; Barrera & Ibanez, 2004; Justino, 2011).

Another channel by which extreme violence affects children's outcomes is forced migration. Forced migration disrupts household's well-being in many ways, for instance, in the process of and after migration families face significant losses of income and wealth as they have to abandon their assets, and face poor employment opportunities in the places of destination. Displacement also causes household disintegration as some members are killed or recruited by armed groups, and women become the main breadwinners of the household. These conditions push children out of school to generate income (Ibanez and Moya, 2006). The actual process of displacement can also lead to health related difficulties, particularly for vulnerable groups such as children, women, and the elderly. Basic necessities like food, shelter, water, sanitation, and access to health care services might be scarce during the flight (Thomas & Thomas, 2004). In addition, displacement increases mental health problems. A number of studies have shown that refugees suffer from very high levels of depression and post-traumatic stress disorder (Porter & Haslam, 2001; Hermansson, Timpka, & Thyberg, 2002)

Household's preferences might also be affected. For instance, violence can increase the uncertainty of long term investments making the returns to education less foreseeable. As parents learn this, they can stimulate their children's future by making them less future oriented through investments in education which is a long term investment (Fuchs, 1982). Households modify their behavior in order to prevent victimization. For instance, students might avoid enrolling in schools located in high violence areas. Violence may also affect the quality of the relationship between parent and children as violence can affect parental economic stress and mental health, thereby influencing the incentives to child's investment in education.

From a supply-side perspective, violence can influence the school infrastructure (eg. destruction of school buildings, buses), reduce the quality of education (exodus of school teachers away from high violence areas), and limit public investment in education (eg. during wars there is a crowding out of resources away from education to military spending). Also, during periods of high violence, health facilities and infrastructure are destroyed, and health workers migrate away from war-related regions reducing the supply of health services. Additionally there is a crowding out of resources away from social services (eg. health) to military spending that limits even more the availability of health

care. To summarize, exposure to high violence is likely to have a negative and signficant impact on an individual's education which may persist over time.

3 Background: Colombia's Recent Violent History

Colombia's ongoing conflict is historically rooted in the 1950's, with a confrontation between the two main political parties and the assassination of a presidential candidate (Bushnell, 1993). Peace slowly came about in the 1960's when these two parties agreed to a peace treaty. However, the concentration of political power that came with this treaty influenced the formation of the communist guerillas, FARC (Revolutionary Armed Forces of Colombia) and ELN (National Liberation Army) (Pizarro, 2011), who initially fought against the government and local elites as they advocated for social justice and equal opportunities for all; it was only later that FARC and ELN became dangerous drug-terrorist groups (Bushnell, 1993; Rubio, 1999).

In the 1980's, Colombia experienced an unprecedented rise in its homicide rate, triggered by the emergence and consolidation of the drug cartels. By 1991, the country reached a peak in its level of violence, with more than a thousand Colombians killed and with the highest homicide rate in the region, more than ten times the rate in the US and three times that of other violent Latin American countries, such as Brazil and Mexico (Levitt & Rubio, 2000). (see Figures A1a, A1b). Violence in Colombia was particularly concentrated in urban areas, where the main drug cartels operated. For example, in the three most important cities, Bogota, Medellin, and Cali, which together represent 30% of the total population, homicide rates accounted for nearly 40% of the national rate (Levitt & Rubio, 1999), and at this time, Medellin became the most dangerous city in the world (Borrell, 1988).

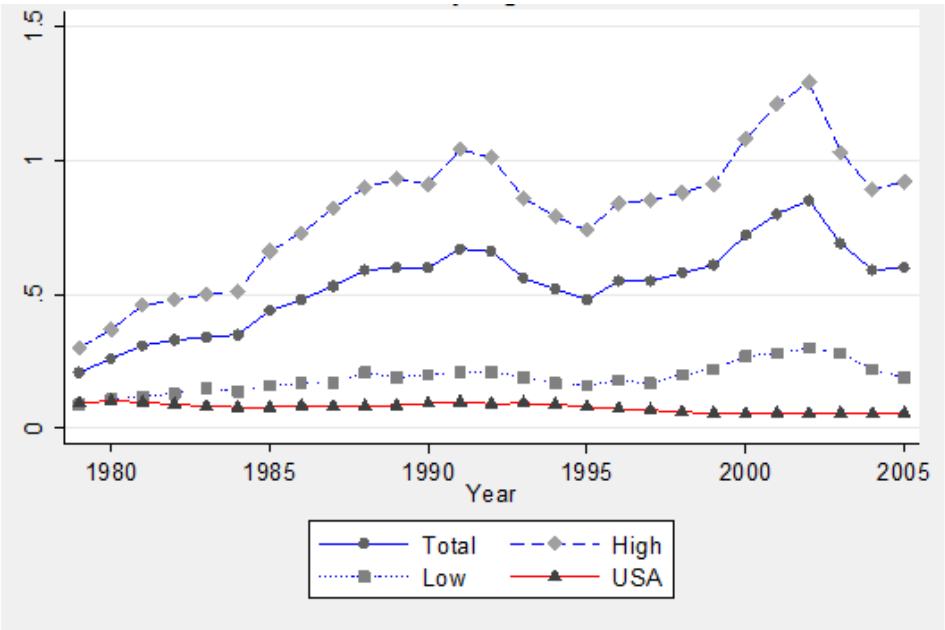
Three main factors help to explain this sudden increase in violence in the 80's and early 90's (Vargas, 1999; Levitt & Rubio, 2000; Bagley, 2001; Sanchez & Nunez, 2007). First, the increasing international demand for drugs, particularly coming from the US and to a less extent from Europe, played a key role, enhancing the drug industry in Colombia. Second, the breakdown of Colombia's criminal justice system offered incentives for criminals to commit more crimes, and third, the enormous profits derived from the drug-trade enabled the cartels to organize and equip private armies (paramilitaries) that were used to challenge the State through bribes, blackmail, terrorist attacks, and selective threatens to, or the actual killing of, political leaders (Diaz & Sanchez, 2004).

In the 1990's, the Medellin and Cali drug cartels were dismantled and the vacuum left by these big cartels was quickly filled with the proliferation of small cartels and irreg-

ular armed groups, guerillas and paramilitaries, who took over the drug businesses and expanded the industry to other regions (Bagley, 2001; Diaz & Sanchez, 2004). This shift lead to a dramatic increase in the homicide rate at the end of the decade, one that surpassed the previous peak reached in 1991 (Rubio, 2000). Paramilitary groups emerged to protect wealthy landowners and drug lords, and contest and restrain the expansion of the guerrillas who controlled vast regions of the country. By the mid-90's, the paramilitaries and guerrillas had already established themselves as dangerous terrorist armies in many regions of the country, committing massacres, abductions, land expropriation, forced displacement, income extortion (i.e., imposed taxes), destruction of public infrastructure, and other atrocities against civilians. Therefore, although by 1992 the homicide rate fell by more than 20% and a dramatic fall in violence was noted in the three main urban areas – 120 per 100,000 in 1991 to less than 80 in 1997–, the national homicide rate from 1991 to 1997 remained practically unchanged at 60 per 100,000 (Levitt & Rubio, 2000), which was due to the intensification of the armed conflict fueled by illegal profits from drugs (Rubio, 1999; Levitt & Rubio, 2000).

From 2002 to 2010, the dynamic of the conflict changed. After the failure of the peace dialogues with FARC in 2001, the government implemented new military strategies to combat the guerrilla and destroy their illicit crops (Pizarro, 2011). Many combatants from FARC quit fighting and the government gained control in many rural areas that were previously captured by this group. In 2003, Colombia also faced the demobilization of the paramilitaries. The drop in the homicide rate since 2002 gives evidence of this (see Figures 1 and A1a and A1b in the Appendix). After 2002, the homicide rate dramatically declined due to successful government interventions; however, by the end of the decade Colombia was still a violent country, it was ranked fifth in the world for the highest number of violent deaths per capita (Geneva Declaration, 2011).

Figure 1: Homicide Rate in Colombia by High and Low Violence Municipalities (hom /1000 inhab), 1979-2005



Source: Vital Statistics - Colombia (DANE) and the Bureau of Justice Statistics- U.S. (BJS)

4 Data

This study uses Colombian Census data for 2005 obtained from IPUMS- International[2]. The Census includes a representative sample of four million individuals that account for 10% of the total population. One virtue of using the Census is that it reports the municipality[3] and date of birth for each individual, plus the municipality where the mother lived while she was pregnant. This information will enable me to identify the level of violence to which an individual was exposed to in his/her early life.

Data on violence come from the Vital Statistics Records obtained from the Colombian National Statistics Department (DANE) and include all deaths in each of the 1,100 municipalities in Colombia since 1979. Homicide rates are constructed by counting the number of homicides in each municipality j and then dividing this number by the total population in municipality j for each year t, and then, multiplying this number by a factor

[2]Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 6.0 [Machinereadable database]. Minneapolis: University of Minnesota, 2011.

[3]Colombia has 1,100 municipalities from which less than half of the municipalities have a population with less than 20,000 inhabitants. The Census groups together those municipalities with low population into larger areas. The total number of municipalities in the Census is 532. The combination of municipalities into larger areas does not represent a problem for data analysis since each municipality in the grouped areas is clearly identified.

of 1,000. The homicide[4] rate is defined as total homicides per every thousand inhabitants in each municipality and year.

The outcome of interest in this study is educational attainment. Three measures will be considered:

(i) **Years of education:** discrete variable that indicates the total number of completed years of education that an individual has achieved. This outcome will be measured for adults between the ages of 19-23.

(ii) **School enrollment:** dummy variable that takes the value of one when a child is reported to be attending an academic institution and zero otherwise. This outcome is measured for children between the ages of 14-18.

(iii) **Child is behind grade:** dummy variable that takes the value of one when a child's age minus the years of education is over six, age at which by Law[5] all children must be enrolled in first grade of primary education; and zero otherwise. This outcome will reflect that a child is not on track in the school cycle. It is measured conditional on being enrolled in school, for children between the ages of 14-18.

The Census provides some information on the health status of individuals. The battery of questions included in the data asks about specific disabilities, such as: blindness, deafness, muteness, and disabilities affecting upper extremities, lower extremities, personal care, mobility, mental health, or psychological limitations. Using these extreme conditions, I construct a health measure that aggregates all of them:

(i) **Permanent disability:** dummy variable that takes the value of one if the individual suffers from at least one kind of permanent disability.

Using this measure as an additional outcome will allow me to test whether early exposure to violence has also an effect on an individual's future health. Multiple studies have shown that early exposure to conflict reduces nutritional status (height-for-age z-scores) (Valente, 2011; Akresh, Lucchetti, & Thirumurthy, 2012). Hence, if this study finds that early exposure significantly increases the probability of having a permanent disability, this could suggest on the one side that violence may also be causing a negative impact on less severe health outcomes, and on the other, that violence is affecting future education through health.

[4] Homicide rates are usually measured as the total homicides per 100,000 inhabitants; however, for easier interpretability of the coefficients I use a lower scale.

[5] General Education Law (115) of 1994.

5 Methods

To examine the relationship between violence and education, this paper uses two empirical models. The first one estimates the following reduced form model:

$$\mathbf{Y}_{i,2005} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_t \mathbf{Violence}_{jt} + \boldsymbol{\beta}_2 \mathbf{X}_{imt} + \boldsymbol{\beta_2} \mathbf{Z_{jt}} + \mathbf{Trend}_d + \boldsymbol{\alpha}_j + \boldsymbol{\alpha}_t + \boldsymbol{\varepsilon}_{imjt} \qquad (1)$$

where the subscript i refers to an individual, m to the mother, j municipality of birth, d department (equivalent to a state in the U.S.) of birth, and t year of birth. The variable Y denotes the educational outcome. The term Violence represents the homicide rate observed in each municipality j and year t of an individual's life. The subscript t takes the value t=-2,-1,..., 6. The period t=-2 will capture the effects of a violence shock experienced prior to conception on mother's health or on household's welfare, which in turn may affect health during pregnancy (Camacho, 2009; Leon, 2011). X is a matrix of individual (gender, race, and an indicator for whether the household is urban versus rural) and maternal (race, age, education, and marital status) characteristics. Z is a vector that includes municipality and department[6] controls (GDP per capita at the department level[7] and a measure of the average years of education[8] for the adult population –population expected to have completed their investments in education (e.g., individuals of 27 years of age) – in each municipality and year). These regional measures help to account for the differences in economic development and educational investments observed across municipalities. The term Trend indicates a department specific cubic time trend. This term is intended to capture differences in long term development across departments. $\boldsymbol{\alpha}_j$ and $\boldsymbol{\alpha}_t$ are municipality and year of birth fixed effects, and $\boldsymbol{\varepsilon}$ is the disturbance term. Errors are clustered at the year and municipality level. The coefficient of interest is $\boldsymbol{\beta}_t$, and it will be measured relative to zero exposure to violence.

To identify the level of violence to which an individual was exposed to at birth, this paper associates each individual's municipality and year of birth with the homicide rate observed at that place and time. For earlier periods like in utero, the Census include information on whether the mother lived in the municipality of birth during pregnancy. Mothers not living in the same municipalities where they gave birth were excluded (8.2% of the sample). For later years (ages 1, 2, etc.), I assume that the individual did not migrate from his/her place of birth, and, therefore, I use the homicide rate observed

[6] In Colombia there are 1100 municipalities distributed in 33 departments.

[7] Unfortunately the GDP per capita is only available at the department level.

[8] This measure will try to capture differences in investment in education across municipalities.

at that particular year and municipality j. The assumption of no mobility is carefully explored in the Robustness Checks section.

This study also examines whether sharp increases in homicide rates are linked to reductions in educational outcomes, which could provide further evidence on the hypothesis that there exists a causal relationship between violence and long term education. One possible way to identify sudden increases in violence is by constructing measures (dummy indicators) that take the value of 1 when the homicide rate in a given municipality j and year t, increases more than 1 (or 2) standard deviation with respect to the mean level of homicide rate in that municipality j, for the period 1979-2005. The identifying assumption here, to asses the causal impact of violence on education, is that these measures of violence shocks should be orthogonal to the error term after controlling for a broad set of fixed effects and trends (as shown in Equation 1). The intuition for this is that, individuals who live in a region with relatively modest changes in violence endogenously incorporate these conditions in their expectations, and therefore adopt strategies to cope with the regular level of violence. Whereas an unexpected and exogneous rise in the criminal activity may induce changes in an individual's investments in education.

The second model used in this study is described by the following Equation:

$$\mathbf{Y}_{i,2005} = \boldsymbol{\beta}_0 + \sum \boldsymbol{\beta}_t \mathbf{Violence}_{jt} + \boldsymbol{\beta}_i \mathbf{X}_{imjt} + \mathbf{Trend}_d + \boldsymbol{\alpha}_j + \boldsymbol{\alpha}_t + \boldsymbol{\varepsilon}_{imjt} \qquad (2)$$

The only difference with respect to Equation 1 is that Equation 2 conditions the exposure to violence at time t on previous and subsequent exposures to violence. Including the different exposures to violence simultaneously in the model allows testing for the presence of serial correlation in the homicide rates. This model is estimated using both the homicide rates and the 1 SD shocks in violence.

6 Results

6.1 Descriptive statistics

Figure A2 in the Appendix shows the proportion of children enrolled in school in Colombia. By law, the age for school entry is six and all children must complete at least until 9th grade. As shown in the figure, young children are more likely to be enrolled in school (93%) compared to older children (67%) who face higher drop-out rates. Given the small percentage of young children out of school (less than 7%), this could suggest that early school drop-out is not be a mechanism by which violence affects education.

For older children on the other hand, violence could play a more significant role on their education given their relatively low school enrollment.

Table 1a shows descriptive statistics for all outcomes stratified by the level of violence (high versus low) experienced in-utero, at birth, and at age 5. All municipalities are classified as either high or low violence for a given year, based on a comparison between a municipality's homicide rate in that year t and the national median (0.43 homicides/1,000 inhabitants) for the period 1979-2005. In general, Table 1 a indicates that educational outcomes in low violence municipalities are higher than in the high violence ones. In particular, the difference in years of education is 0.3 years, and children among the ages of 14 to 18 are around 2 percentage points more likely to be enrolled in school in the peaceful areas. The fact that the proportion of children behind grade in low violence places is between 2.5-6.5 percentage points higher than in the high violence municipalities may suggest positive selection in the violent areas. This is possible given that the outcome is constructed for those who are enrolled in school and therefore excludes those not attending school. The proportion of individuals among the ages of 10 to 22 with a permanent disability is XXX.

Table 1a: Sample Statistics by Low vs. High Violence

[TABLE 1A HERE]

All differences are statistically significant at the 95% CI

SE in parenthesis

Table 1b shows maternal characteristics stratified by the level of violence (high versus low) in three different moments: while she was pregnant, at the birth of the child, and when the child was five years of age. The sample of mothers included in Table 1b are those mothers who still live with the child (for whom information on their parents is available in the Census). In general, slight differences are observed on maternal age, mothers in low violence municipalities are 0.3 years older than those living in high violence municipalities. Mothers in high violence are also more educated, more likely to be married, and less likely to cohabitate. While some of these differences are significant at the 99% level, the magnitudes are small, and they suggest a positive sorting in high violence places which would in any case underestimate the causal impact of violence on children's education.

Table 1b: Maternal Characteristics by Low vs. High Violence

[TABLE 1B HERE]

SE in parenthesis

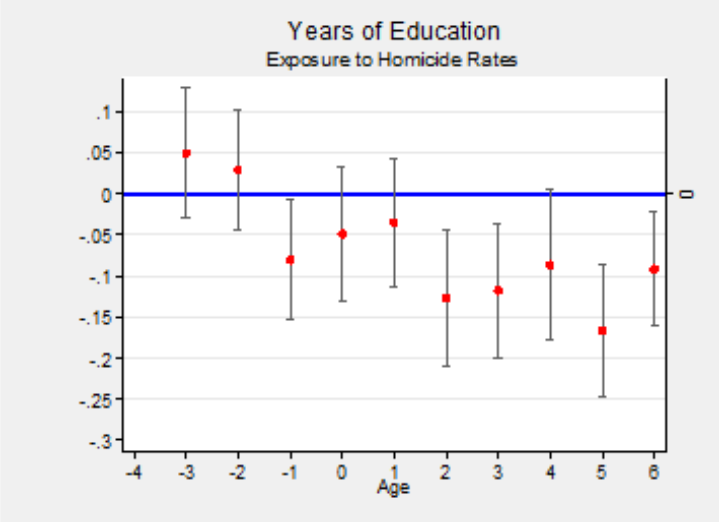
6.2 Long term effects of violence

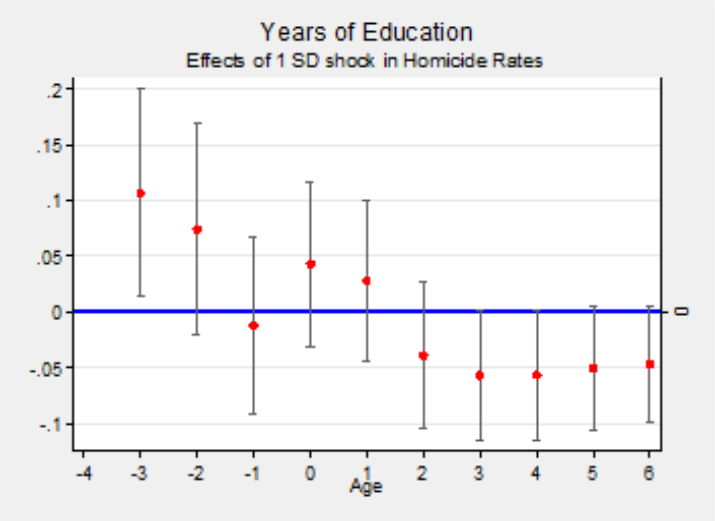
Figures 4 through 7 show the effects of violence on education. Each red dot in the figures represents the individual effect, β_t, of the homicide rate observed at age t, starting from t=-2 to t=6, controlling for all covariates, fixed effects, and trends as described in Equation 1. Hence, each graph presents the results of eight separate regressions. The 95% confidence intervals are depicted by the black standard error bars. In addition to the effects of violence during the period of interest (in-utero to age 6), the figures include the impact of the homicide rate three years before birth (t=-3) which serves as a placebo test for the identification strategy. No significant effect of violence at t=-3 should be observed on an individual's future educational attainment.

6.2.1 Years of Education

Figure 4a shows the effects of exposure to violence on the years of education for individuals between 19 to 23 years of age. These indicate that those exposed to high homicide rates while in utero (t=-1) and from age two to six (t=2, t=3, ..., t=6) have lower educational attainment compared to those who were not exposed to violence at early stages. Due to an increase of 1 standard deviation in the homicide rate in childhood (Figure 4b), years of schooling decrease by 0.2. If the individual is consistently exposed to 1-SD shocks for more years during his/her childhood, the effects in the long term would imply a reduction of approximately 0.8 years of education.

Figure 4: Outcome Years of Education,
Ages: 19-23
A and B





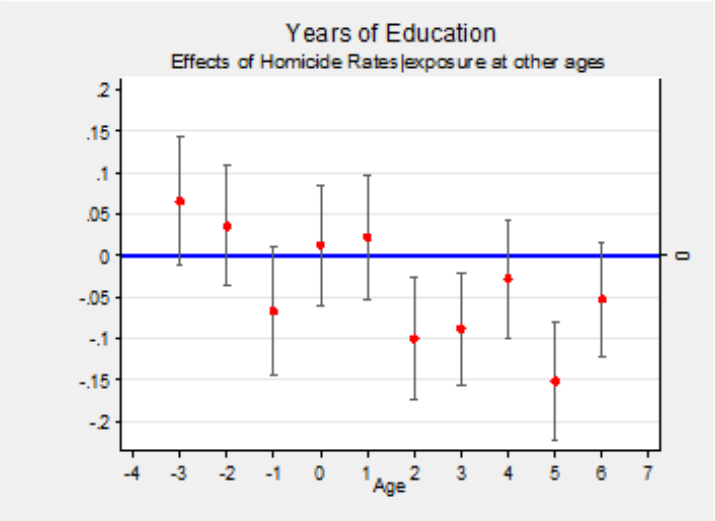
Figures c and d show the effects of violence on years of education using Equation 2, that simultaneously includes each of the exposures to violence experienced in each year during the early stages (period from in-utero to age 6). Results are consistent with the findings shown in Figures 4a and b where the effects of violence were estimated using separate regression models. The fact that results from Equation 1 and Equation 2 are similar suggests that there is little serial correlation in the homicide rates.

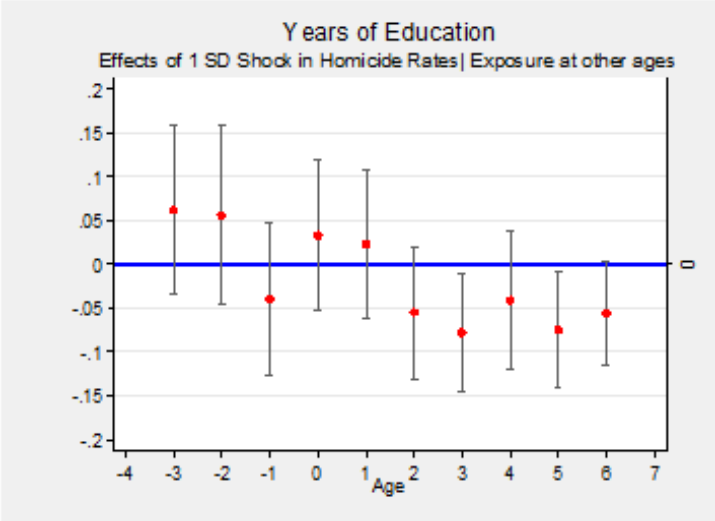
Figure 4

Outcome Years of Education,

Ages: 19-23

C and D

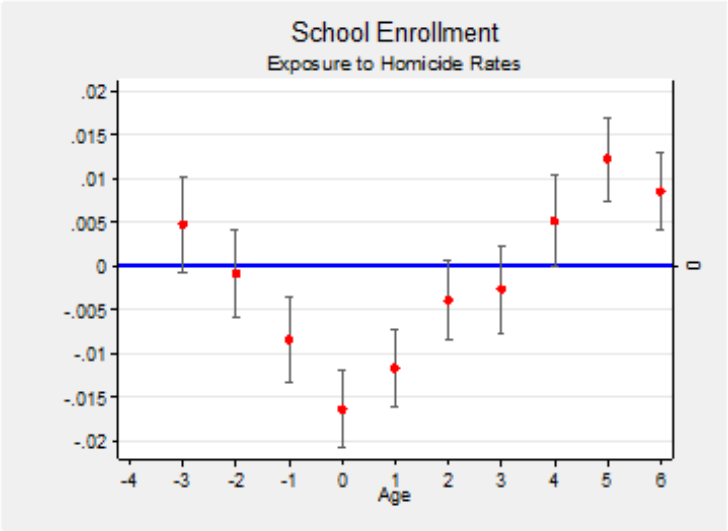


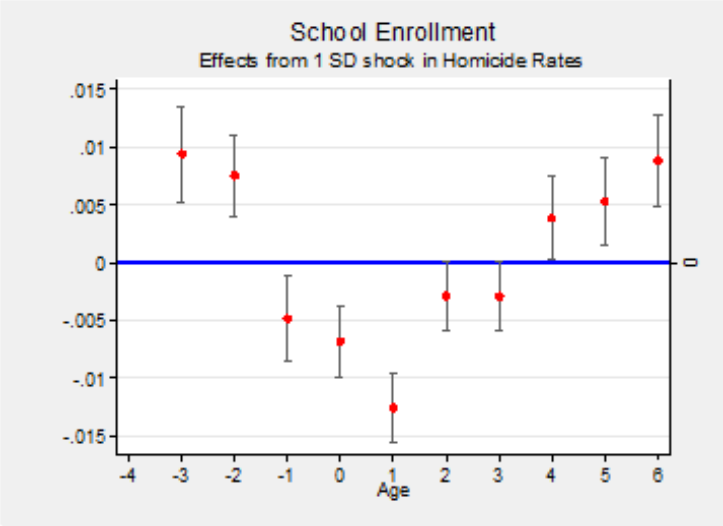


6.2.2 School enrollment

Results in Figures 5a-d show the impacts of violence on school enrollment for children among the ages 14 to 18. Figure 5a indicates that exposure to violence from in utero (t=-1) to age 3 (t=3) reduces school attendance. The largest effect occurs at birth, where school attendance decreases by approximately 1.7% due to an increase of 1 standard deviation shock in violence for a given year around birth.

Figure 5
Outcome: School Enrollment,
Ages: 14-18
A and B

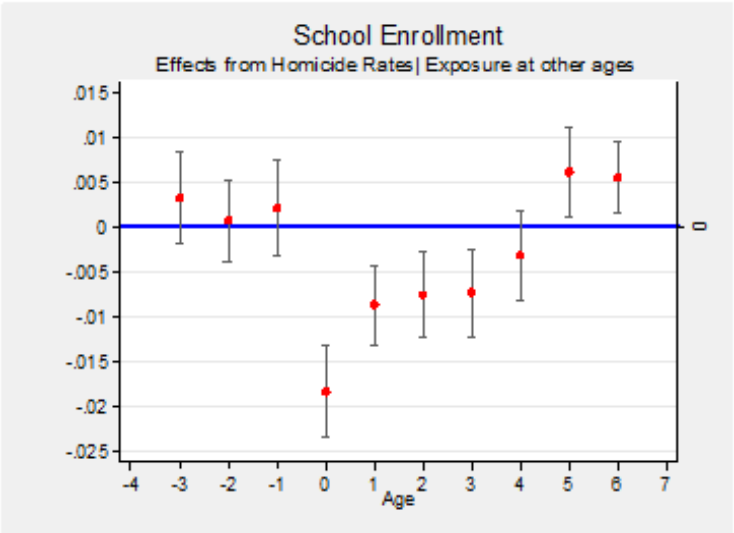


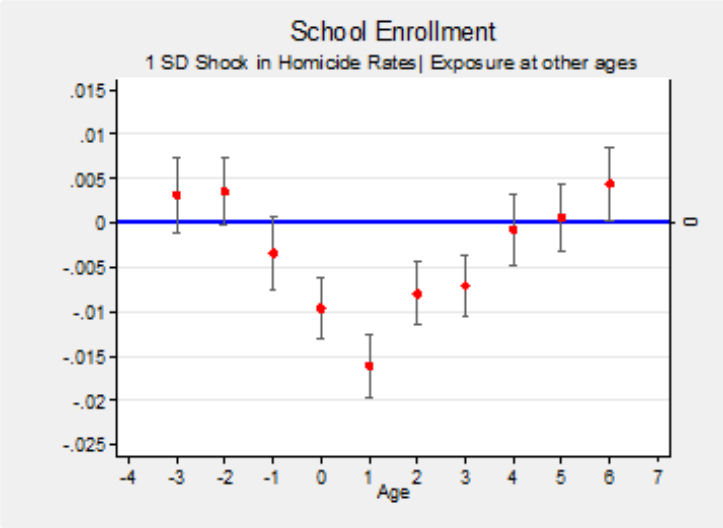


The last two Figures, c and d, indicate that when the exposure to violence (measured by homicide rates or shocks) is conditional on the exposure at other ages, the significant effect around birth is robust and consistent to the 1.5% decrease in the probability of school enrollment.

Figure 5
Outcome: School Enrollment,
Ages: 14-18

C and D



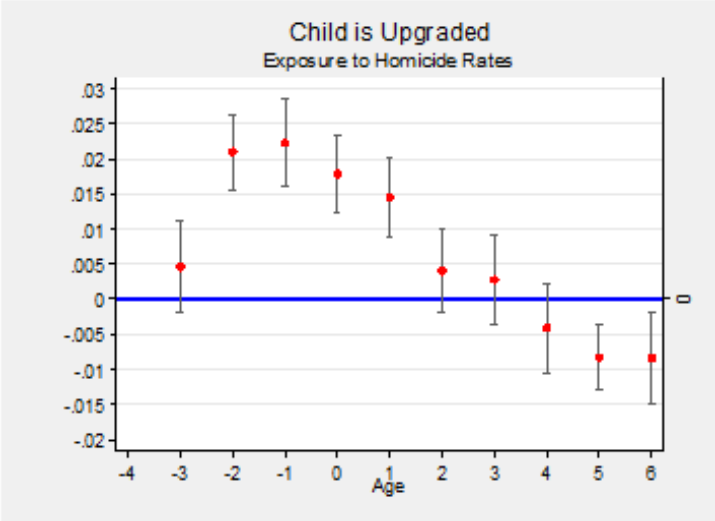


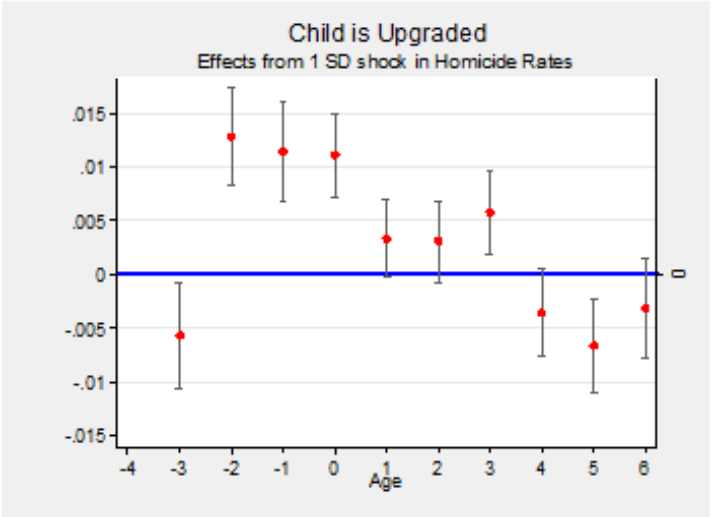
6.2.3 Child is behind grade conditional on school enrollment

Figures 6a-d show the impacts of violence on the probability that a child is behind grade conditional on being enrolled in school. The findings show that violence increases the likelihood that a child is behind grade when exposure occurs in the prenatal period, at birth, and at year 1, suggesting that mother's health could be a significant mechanism by which violence affects human capital (Leon, 2011). The impacts of violence on for those currently enrolled in school, which could be interpreted as a milder (negative) effect of violence onchildren compared to school drop-out (not enrolled in school). The fact that the effect of exposure to violence at conception (t=-2) is significant and not for school enrollment might reflect some sort of selection resulting from conditioning the outcome on those currently enrolled in school.

Figure 6: Outcome Child is Behind Grade | Enrolled in school, Ages: 14-18

A and B

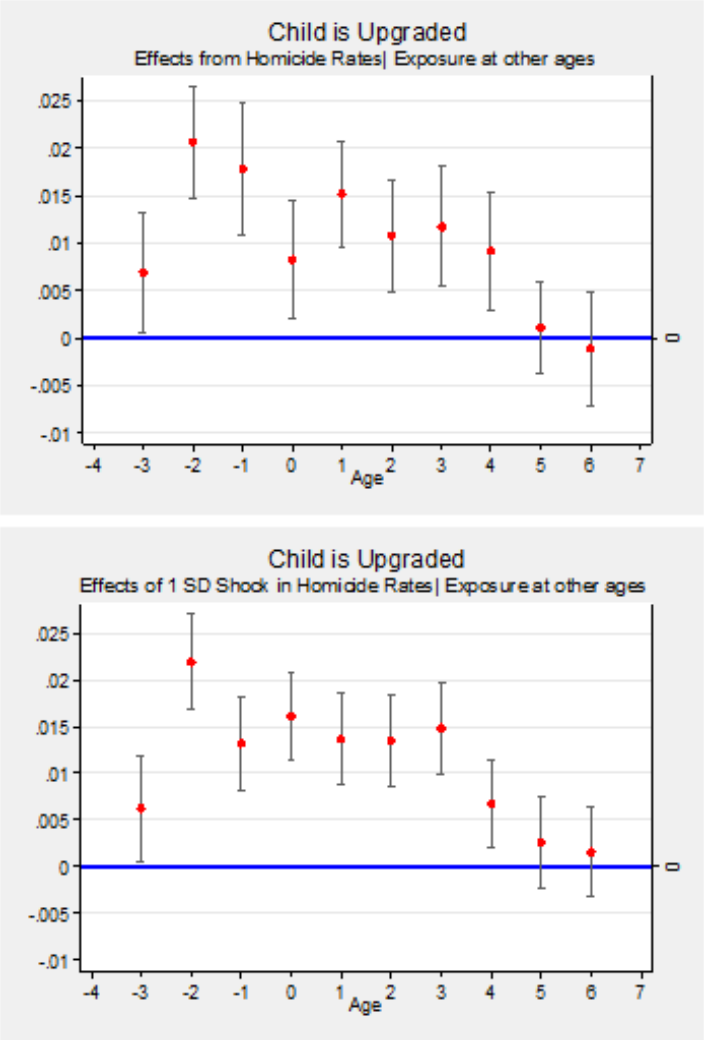




As observed in Figures 6 b, c, and d, the effects are highly consistent. An increase of 1 standard deviation in the homicide rate prior to conception, increases the probability that the child is upgraded by 2%.

Figure 6: Outcome Child is Behind Grade | Enrolled in school, Ages: 14-18

C and D



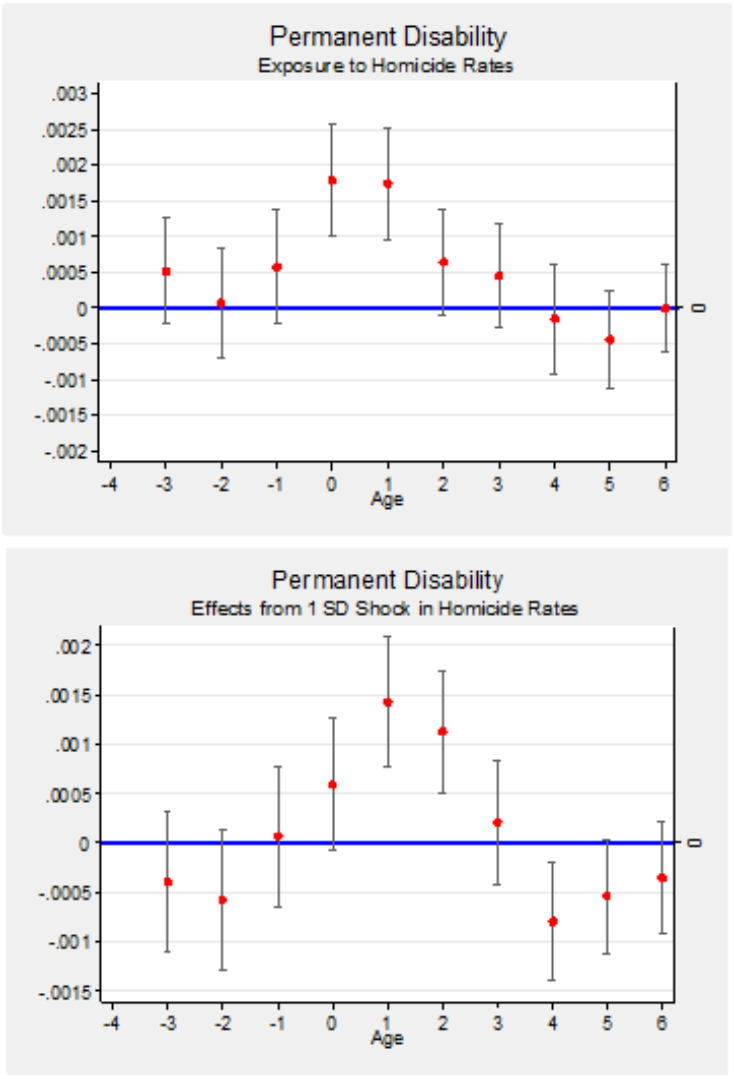
6.2.4 Permanent disability

Figure 7a presents the impacts on the likelihood of having a permanent disability (of any kind) for individuals between 10 and 22 years of age. Violence experienced at birth and during the first year of age exerts a harmful and statistically significant effect on this outcome (0.2%).

Figure 7: Outcome Permanent Disability,

Ages: 10-22

A and B

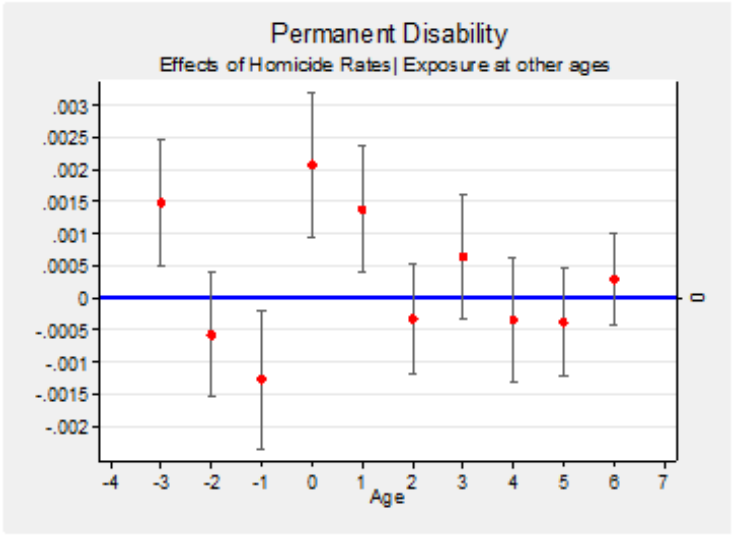


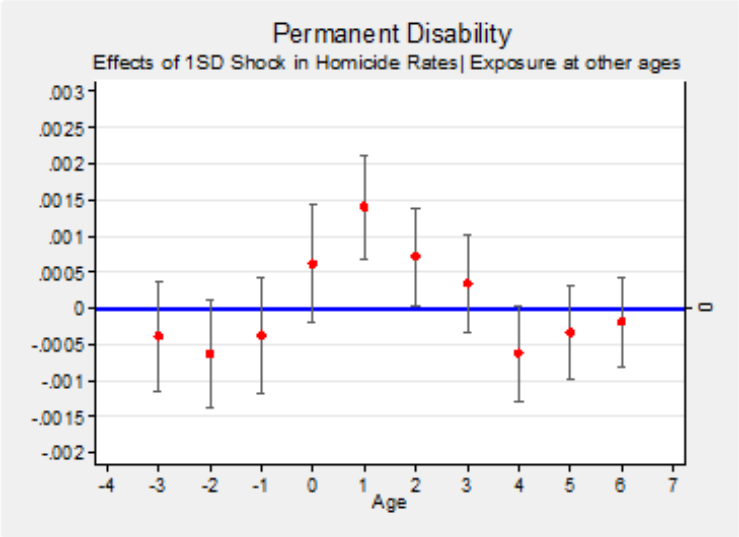
Figures b, c, and d confirm the results observed in Figure 7a, exposure to violence around birth exerts a negative impact on having an extreme health limitation. In a separate analysis not shown here, I tried testing whether these effects were driven by mental health/psychological problems versus physical limitations which are more likely to be affected by childhood shocks than in utero insults (Almond & Currie, 2011b). Unfortunately, due to the very few cases reporting these limitations (<1%), the standard errors were too large to capture any effect.

Figure 7: Outcome Permanent Disability,

Ages: 10-22

C and D





6.2.5 Placebo test

As shown in Figures 3 through 6, the coefficient accompanying homicide rate at t=-3 was non-significant in almost all cases, providing support for the validity of the identification strategy.

7 Robustness Checks

7.1 Identifying assumption

The main identifying assumption needed to consistently estimate the causal effect of violence on education is that, after controlling for a broad set of characteristics, municipality and year fixed effects, and department cubic time trends, violence should be strictly orthogonal to the error term. This assumption is violated if for instance, violence is correlated with "something else" that could affect education, such as, the incidence of poverty which in turn (poverty) affects educational attainment.

To test if violence is correlated with poverty, I explore how homicide rates are associated with income. Hence, I regress the homicide rates in each department on the GDP per capita, and department and year fixed effects as well as department linear trends. Results are shown in Table A1a in the Appendix section. They indicate that after controlling for fixed effects and linear time trends, the GDP per capita is not significantly associated with homicide rates (column 5), suggesting that changes in violence are not directly correlated with changes in income (or poverty).

Violence could also be correlated with low investments in education, which in turn could affect the educational outcomes. In order to test this hypothesis, I regress the homicide rates in each municipality on the average years of schooling for those who are 27 years of age, which serves as a proxy for the investments in education, and I include municipality and year fixed effects as well as municipality linear trends. Table A1b in the Appendix section shows the results. They are consistent with the hypothesis that changes in violence are not driven by changes in the growth of investments in education as shown in column 5.

Additional evidence also suggests that the dramatic increase in violence during the decades of the eighties and nineties (period of interest) in Colombia was not driven by the incidence of poverty. Rubio (1999) indicated that those municipalities with the highest homicide rates were actually the ones with the lowest poverty indicators in the country.

7.2 Sources of selection bias

To correctly estimate the causal effect of exposure to violence on education, this paper examines three potential sources of selection bias due to violence, that are, selection on survival, selection on fertility and selection on mobility.

Exposure to violence in utero can have both scarring and selection effects on survivors. Valente (2011) showed that pregnant mothers exposed to high conflict in Nepal had higher probabilities of miscarriage, and suggested that, if these pregnancies had been carried full term, those children would have been at more in risk of worse health outcomes. Hence, if violence reduces the share of frailer babies, the surviving population would be relatively healthier and the long term effects of early exposure to violence on education would be biased towards zero.

Being exposed to high violence may also reduce the incentives to fertility. If however, the response is differential across maternal socioeconomic characteristics, for instance, more educated mothers tend to have fewer pregnancies under high violence, then, the effects of violence may be overestimated.

In order to test for the presence of these two potential sources of selection bias, survival and fertility, I perform two tests. The first one consist on examinining whether violence has differentially affected fertility decisions by female characteristics of those in the fertile age (12-50 years of age). I perform a set of regressions akin to Akresh et al. (forthcoming) and Miniou and Shemyakina (2012) where I regress female characteristics, particularly age and education for those in fertile age for the whole period (1979-2005), on a set of covariates that include: a dummy variable for being born in a high violence municipality, having a child during the most violent years of the period (1990-2003, see Figure 1), their interaction and fixed effects and trends as in Equation 1. Table A2 shows the results. They indicate that there are no systematic differences in fertility behavior by female characteristics in low versus high violence municipalities. An important consideration here is that these results are conditional on child and mother surviving, and children living in the household with their mothers.

The second test to evaluate if violence has has differentially affected the probability of survival is based on a comparison of sex ratios for those born in high versus low violence municipalities as in Miniou and Shemyakina (2012). Figure A3 shows that the sex ratios for those eighteen or younger, in both high versus low violence municipalities, are above one and behave relatively similar, however, after age eighteen sex ratios decline dramatically in both regions and the largest drop is observed in places where the violence is higher. This surprising result suggests that men are departuring from home once they become eighteen which might indicate that if anything, violence is increasing the chances of departuring at age eighteen rather than differentially affecting the probability of survival by gender which in turn could bias the results.

The third potential source of bias is related to endogenous mobility due to violence. Internally forced displacement in Colombia has been one of the most dramatic consequences of violence. Recent estimates indicate that the total displaced population is over 3.2 million which is equivalent to 7.6% of the total population (Lozano-Gracia et al., 2010). These groups are characterized for having very low socioeconomic indicators, including educational attainment, and be highly vulnerable.

Identifying internally displaced populations (IDP) in the Census 2005 is only possible for recent migration episodes, since the Census asks questions about migration within the last 5 years[9]. Therefore, since I cannot observe previous IDP's, a simple test to examine how large is the endogenous response due to violence, I compare the observable characteristics of the mover and non-mover population in high versus low violent municipalities. Table A3 shows these results. They indicate that on average, movers in low and high violence municipalities, and non-movers in low and high violence municipalities, have very similar age, education, race, and marital status. This suggests that migration is not particularly driven by violence.

Summing up, the results presented in Figures 4 through 7 are not driven by selection on survival, fertility, or migration, and if anything, the bias will make the coefficients conservative.

7.3 Exposure to violence over the life cycle

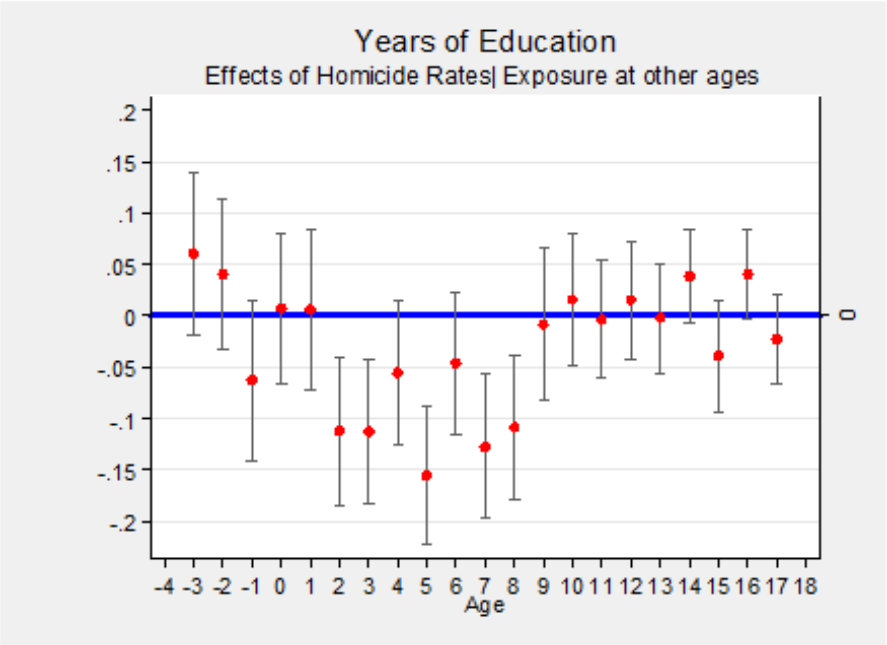
So far, the years on which exposure to violence has been considered in this study are from t=-2 to t=6. One question that arises is whether the effects found are robust to the inclusion of additional exposures to violence over the life course (t > age 6). To test this, I extend the period of analysis from t=-2 to two years prior to year 2005, moment at which the Census was collected. Figures 8 a, b, c and d show the effects of exposure to violence on years of education, school enrollment, child is upgraded, and probability of having a permanent disability, respectively. Results indicate that even after extending the ages of exposure to violence, that is, including primary school age and high-school age exposures, does not affect the previous results observed in Figures 3 through 6. For instance, the years of education are still affected by exposure to violence experienced in childhood. This suggests that the period in the life-course were effects of violence are more pronounced are the early stages: in-utero and childhood.

[9] Descriptive statistics indicate that 5% of the recent migrants in Census 2005 were IDPs.

Figure 8 - The Effect of Violence over the Life-course

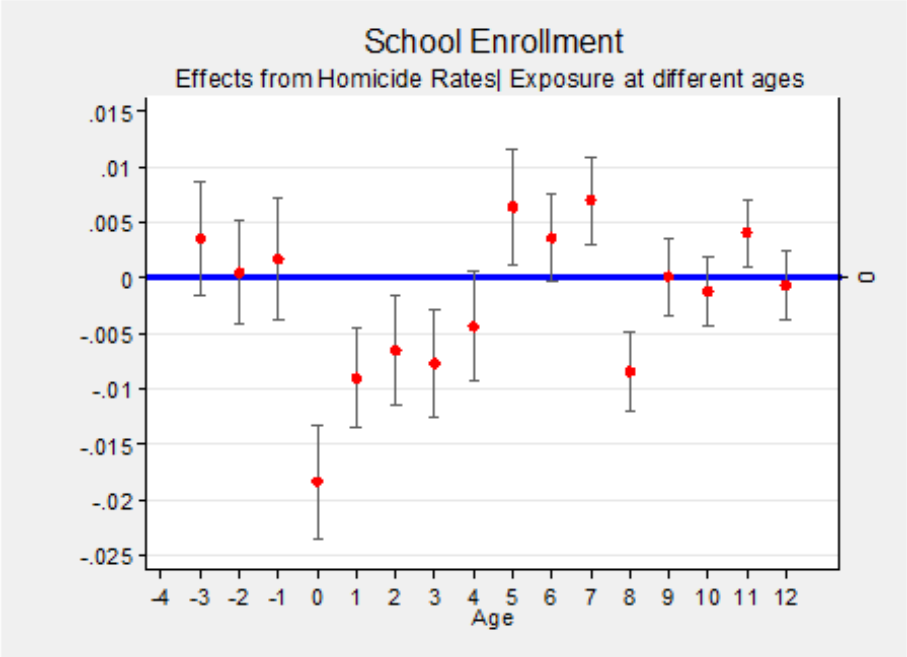
A. Years of Education

Ages: 19-23



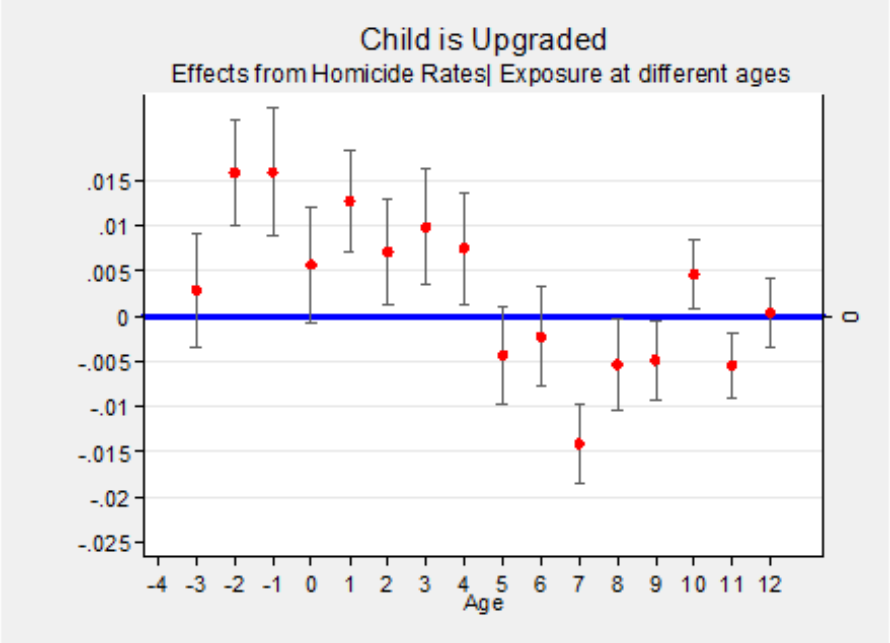
B. School Enrollment

Ages: 14-18



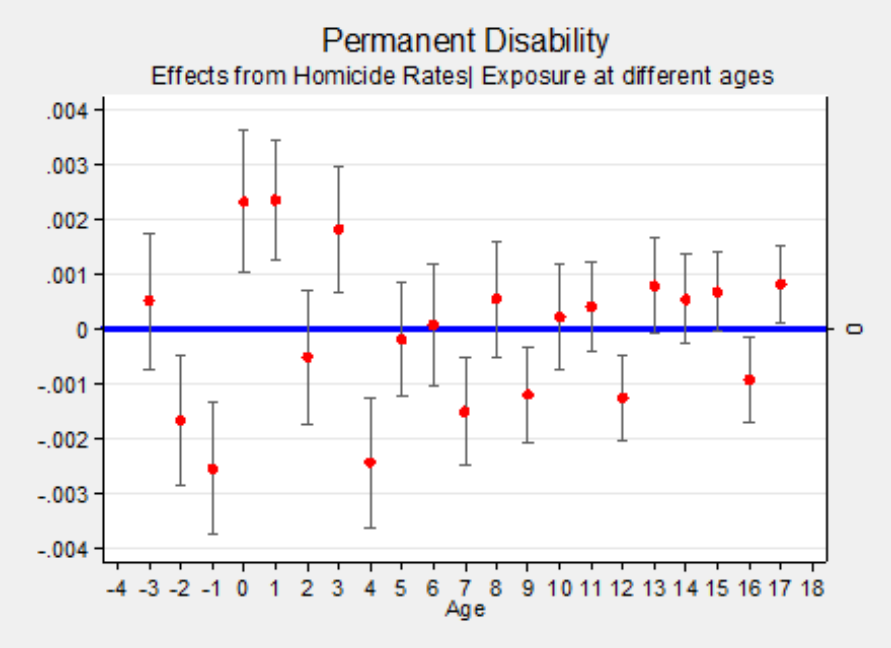
C. Child is Upgraded | Enrolled in School

Ages: 14-18



D. Permanent Disability

Ages: 10-22



8 Discussion and Conclusions

This paper provides new evidence of the long run effects of exposure to violence on educational outcomes using the Colombian case as a natural experiment. Results indicate that early exposure to violence has the most pronounced impacts on future education compared to exposures at other stages. For instance, violence around age 5 reduces years of education by 0.2 years if the individual is exposed to a 1 standard deviation shock for at least one year in childhood. If the exposure occurs for a longer period, the effects of violence in the long term may reduce the years of education by 0.8 years. School attendance is significantly affected from exposure around birth. While these results – impacts on young adullts' years of education and impacts on children's school enrollment – are obtained from two different cohorts exposed to two different waves of violence (see Figure 1), the individual findings for children and adults can be reconciled. The estimated coefficient of the exposure to violence on school enrollment at birth (β_t=-2%) is equivalent to an expected loss in 0.1 years of education which is within the estimated effect of violence exposure around birth on an individual's future years of education.

Studies on the consequences of armed conflict on individuals have either examined the impacts of violence when the exposure occurs while in-utero and have measured the

effects on health at birth outcomes), or when the exposure occurs at school age (and its effects on later outcomes). This paper is one of the first studies (Leon, (2001) offered pioneer evidence) to investigate the continuous exposure to violence across the life-course for children and young adults, and the first one to being able to accurately measure year by year the individual effects of violent shocks. The evidence suggests that the period more sensible to violence exposure is from in-utero to childhood, which offers important insights for policy design.

While children can be permanently damaged at early ages, the literature indicates that damage can be efficiently remediated if appropriate interventions, from parents and society, are attempted at early enough ages, maybe while the mother is pregnant, or when the women is of child bearing age, or while the child is young (Cuhna & Heckman, 2007).

Future research should confirm these results in different environments of violence, exploring whether mild levels of homicide rates are also associated with costs in educational attainment or whether non-linearities exist. Channels of transmission still remain to be explored in depth, for instance one possible mechanism could operate via violence affecting single parenthood as suggested by the differential sex ratios across age groups.

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10 Tables and Figures - Appendix

Figure A1: Homicide Rates (homicides/ 1,000 inhabitants) in Colombia: 1990 and 2005

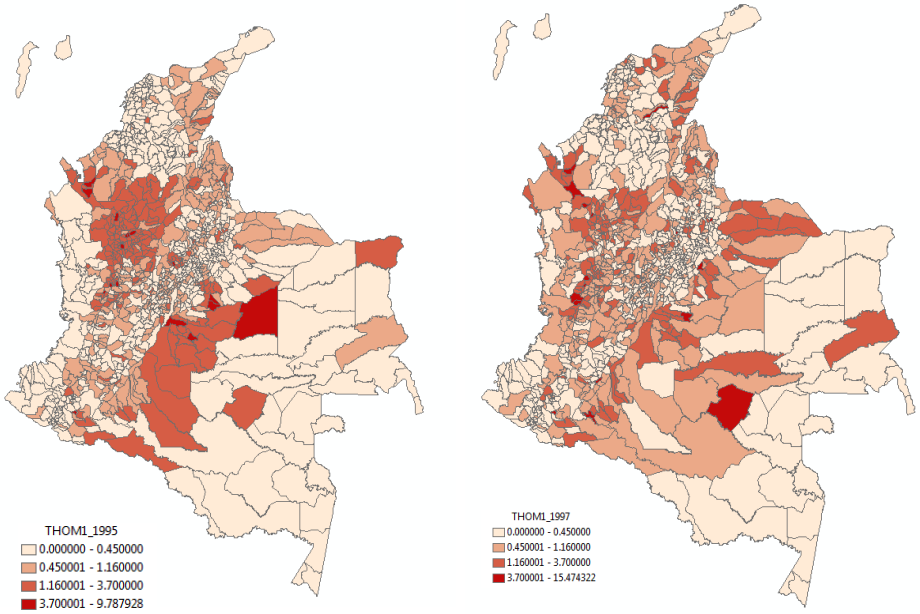

Figure A2: School Enrollment in Colombia (%), Ages 6-18

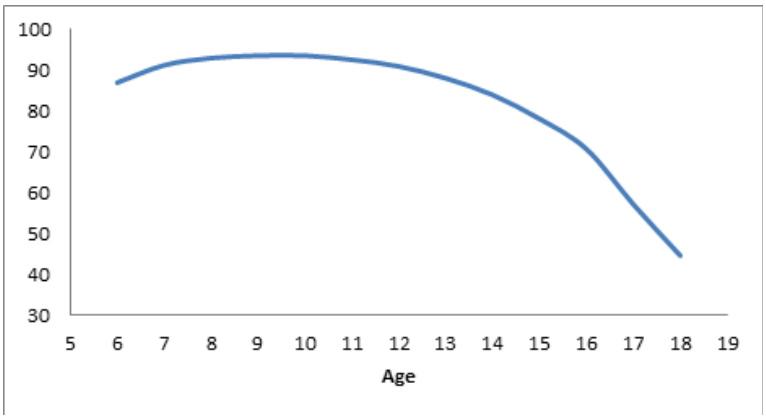

Figure A3

Table A1a: The Effect of GDP per capita (Lag and Lead) on Homicide rates by Department

	(1)	(2)	(3)	(4)	(5)
gdp_pc at the department level	**0.139****	**0.118****	0.02	-0.09	0.03
	[0.05]	**[0.06]**	[0.08]	[0.08]	[0.04]
Observations	768	768	768	768	768
R-squared	0.07	0.15	0.63	0.73	0.2
Lagged **gdp_pc at the department level**	**0.146****	**0.126****	0.023	-0.093	-0.003
	[0.05]	**[0.06]**	[0.08]	[0.08]	[0.04]
Observations	735	735	735	735	735
R-squared	0.08	0.15	0.66	0.75	0.81
Lead **gdp_pc at the department level**	**0.151*****	**0.128****	0.069	-0.044	0.06
	[0.05]	**[0.06]**	[0.07]	[0.07]	[0.05]
Observations	768	768	768	768	768
R-squared	0.09	0.18	0.6	0.72	0.79
Department FE	no	no	yes	yes	yes
Year FE	no	yes	no	yes	yes
Department linear trend	no	no	no	no	yes

Clustered errors at the department level
***** p<0.01, ** p<0.05, * p<0.1**
Each coefficient comes from a separate regression

Table A1b: The Effect of Average Yrs of Educ (Lag and Lead) on Homicide rates by Municipality

	(1)	(2)	(3)	(4)	(5)
Avg yrs of Educ	**0.027*****	-0.009	**0.09*****	-0.006	0.0015
	[0.009]	[0.01]	**[0.01]**	[0.01]	[0.005]
Observations	14359	14359	14359	14359	14359
R-squared	0.005	0.06	0.48	0.52	0.4
Lagged **Avg yrs of Educ**	**0.027*****	-0.009	**0.09*****	-0.007	-0.009
	[0.009]	[0.01]	**[0.01]**	[0.01]	[0.006]
Observations	14359	14359	14359	14359	14359
R-squared	0.006	0.06	0.48	0.52	0.65
Lead **Avg yrs of Educ**	**0.029*****	-0.006	**0.10*****	-0.001	-0.001
	[0.009]	[0.01]	**[0.01]**	[0.01]	[0.005]
Observations	13828	13828	13828	13828	13828
R-squared	0.006	0.07	0.49	0.53	0.66
Municipality FE	no	no	yes	yes	yes
Year FE	no	yes	no	yes	yes
Municipality linear trend	no	no	no	no	yes

Clustered errors at the municipality level
***** p<0.01, ** p<0.05, * p<0.1**
Each coefficient comes from a separate regression

Table A2: Characteristics of Women in Fertile Age who had a Child During High Violence

	Education			Age
	Primary	Secondary	University	
High violence	-0.04	**0.17**	0.83	**-0.367**
	[0.073]	**[0.034]**	[0.069]	**[0.07]**
Had a child during 1990-2003	**0.086**	**-0.083**	**-0.066**	**0.013**
	[0.003]	**[0.003]**	**[0.005]**	**[0.001]**
High violence **X** Had a child during 1990-2003	0.0018	-0.0044	0.006	0.0016
	[0.004]	[0.003]	[0.005]	[0.002]
Observations	1,236,909	1,236,909	1,236,909	1,236,909
R2	0.141	0.153	0.079	0.999
Municipality FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Department linear trends	Y	Y	Y	Y

Clustered errors at the municipality-year level

Table A3: Sample Statistics by Low vs. High Violence and Movers

	Census 2005					
	Non Movers			Movers		
	Low	High	Diff	Low	High	Diff
Maternal Characteristics						
N	*721,101*	*635,303*		*150,107*	*196,288*	
Age	40.14	39.89	*0.3***	40.47	41.43	*-1***
	[12.64]	[12.79]		[12.64]	[13.31]	
Less than Primary	30.60	33.68	*-3***	25.16	30.26	*-5***
	[46.08]	[47.26]		[43.40]	[45.94]	
Completed Primary	39.01	40.71	*-1.7***	43.08	43.24	*-0.2***
	[48.78]	[49.13]		[49.52]	[49.54]	
Completed Secondary	22.47	20.2	*2.3***	24.01	20.98	*3***
	[41.74]	[40.15]		[42.72]	[40.72]	