Borradores de ECONOMÍA

Assessing the Link between Adolescent Fertility and Urban Crime

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Núm. 594

2010

BANCO DE LA REPÚBLICA
COLOMBIA

Assessing the Link between Adolescent Fertility and Urban Crime[♣]

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May 3, 2010

Abstract

We use data of neighborhoods of Bogotá to assess the causal relation between their adolescent fertility and their homicide rates. We find that neighborhoods with high adolescent fertility rates, and that have low secondary enrollment and high crime rates at the moment the children of their teen mothers become teenagers, are more likely to have higher homicide rates in the future, when those children reach their peak crime ages, estimated to be between 18 to 26 years old in violent cities of Colombia. We did not find evidence of a positive effect on crime when the adolescent fertility rates are either isolated, or only coupled with low school enrollment, or high crime rates. We also find that increases in the secondary school enrollment always reduce the homicide rate. The results are robust to various specifications, including measurement error corrections, and the modeling of the spatial autocorrelation of homicides.

Keywords: Crime, Illegal Behavior, Law Enforcement, Adolescent Fertility, Spatial Econometrics

JEL Codes: K40, K42, R21, J13, C21

[♣] We thank Christian Posso and Jorge Eliécer Giraldo for assistance. We are the solely responsible for any errors. The opinions expressed here are those of the authors and not of the *Banco de la República de Colombia* nor of its Board.

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I. Introduction

Colombia is one of the countries in Latina America and the Caribbean with homicide rates among the highest in the region, with more than 50 murders per 100,000 inhabitants, during most of the last 25 years, while in countries like Argentina, Chile and Uruguay it has been below 10, and only followed closely by El Salvador and Guatemala.[1] Colombian cities are as well among the most violent of the region, with homicide rates in Medellín and Cali, its most violent cities, that often go beyond 100 murders per 100,000 inhabitants, while cities like Santiago and Buenos Aires have usually been below 10 murders per 100,000 inhabitants.[2] While violence in rural Colombia has been substantially reduced, its most violent cities hardly observe homicide rates below 30 murders per 100,000 inhabitants, evidencing the structural effects of the presence of organized crime.

The high and persistent levels of crime have taken place under an increasing trend of adolescent fertility rates in the country, which have grown constantly from 9.5 percent in 1990, to 16.2 in 2005.[3] As previous Colombian literature affirms that Colombian violence has been highly promoted by the drug business, the international literature has emphasized the causal link between children born from adolescent mothers and their future propensity to get involved in crime.[4] Since the most violent cities of the country have developed a criminal structure that is highly embedded in those cities, it becomes relevant to study whether their high adolescent fertility rates are being complementary to the means of those criminal structures, facilitating the pursuit of their goals, and preventing the incorporation of many of youths in those cities to their formal economy.

In this paper we assess the causal link between adolescent fertility and crime using cross section and longitudinal data of Bogotá at the neighborhood level. We find that when there are neighborhoods with adolescent fertility rates, that also have low secondary enrollment rates and relatively high crime rates, their future homicide rates become significantly higher than that of neighborhoods without the concurrence of those characteristics. The result is consistent with abundant anecdotic evidence according to which urban criminal groups takeover the control of some of the poorest neighborhoods in those violent cities, and get nurtured by recruiting adolescents of their own neighborhoods. Adolescents on their part are often bound to attend school and get locked in their houses while not at school, or rather socialize and risk to be recruited, or threatened for not complying with their neighborhoods gangs' commands.[5]

This paper is organized as follows. The next section presents a revision of the relevant literature. Then we put forward some hypotheses consistent with a causal relation from

[1] See Krug et al. (2002).
[2] See Llorente and Rivas (2005).
[3] See Flórez and Soto (2007).
[4] The Colombian case is described by Gaitán (1995) and Rubio (2007) among others, while for the international one we provide various references in the next section.
[5] Documentaries like "The City of God" for the *favelas* of Rio de Janeiro, and "*La Sierra*", "Rodrigo D: No Future", and "The Rose Seller" for poor neighborhoods of Medellín respectively, illustrate the reality of lives by youths in violent neighborhoods of those cities. See also Salazar (1993, 2002), and Vallejo (1998).

adolescent fertility and homicides, to proceed to describe the patterns of crime in Colombia and Bogotá, before we present our identification strategy, empirical results, and conclusions.

II. Literature Review

Research on economic theory of crime and its empirical validity, has risen substantially since Becker's (1968) seminal paper. The traditional approach has focused in the crime reducing effect of deterrence variables, by measuring the impact of different policies that attempt to raise the expected cost of crime and disabling the power of action of criminal, on crime. Usually this studies use the arrest per capita and incarceration rate as deterrence variables.

The empirical validity of this hypothesis has become the focus of attention of many research agendas, due to the variety of results that the literature has found[6]. On the one hand there is large literature that found that a higher probability of arrest, measured by arrest per-capita, should trigger decreases of crime[7]. Another typical variable that is used in deterrence models, as quoted by Dills et al. (2008), is the size of the police force. In this case the main hypothesis is that an increase of police enforcement should increase the probability of arrest, and in consequence reduce crime, although, this implication is not immediate. Dills et al (2008) argue that the standard crime model identifies as deterrence variables, the probability of arrest and conviction, along with the expected punishment and "if these are held constant, police per se should have no additional impact". In fact, a long literature has found that this is not a straightforward relationship, and it is not always possible to conclude that more police means less crime.[8][9]

However there are two novel papers that provide a new evidence of the effect of police on crime, using the fact that terrorist attacks can induce exogenous variation in the allocation of police resources that can be used to estimate the causal impact of police on crime. The first one is the work by Di Tella and Schargrodsky (2004) who use as "quasi experiment" the terrorist attack to some religious buildings in July 1994, and the subsequent intensified on police presence around Muslim and Jewish buildings. They show that motor vehicle thefts fell significantly near to the place where terrorist attack occurred compared to the areas several blocks away where no extra police were deployed. The Second one is the paper of Draca et al. (2008) who look at the increased of security presence following the terrorist

[6] For literature related on deterrence models and empirical approaches, see Cameron (1988), Erlich(1973) Erlich (1996), Nagin (1997a), Levitt (2004), Lee and McCrary (2005).

[7] For papers that found a negative relation between crime and arrest per capita see Grogger (1991), Layson (1985), Johnson and Raphael (2006), among others.

[8] See for example Cover and Thistle (1988), Cameron (1988), Cornwell and Trumbell (1994) and Spelman (2000). On the basis of a series of criminological studies, Sherman and Weisburd (1995) state: "no matter how it is deployed, police presence does not deter". Eck and Maguire (2000) has similar conclusion based on empirical research on police and crime in economics.

[9] Levitt (1997) pins out the endogeneity and in consequence causality problem of the majority of the empirical research that have attempted to find a relationship between crime and police enforcement. He resolves this, using election years as an instrument for police in crime equation. Nonetheless, this work has been controversial for different reasons; McCrary's (2002).

bombs that hit London in July 2005. Access to police deployment data allows them to identify the magnitude of the causal impact of police on crime, who is negative and highly significant.[10] Circumstances under which these events took place were very atypical though, and thus, a relevant question is whether they resemble what actually happens under standard conditions.

Additional research focuses in alternative determinants of crime like the role played by young teen mothers and the abortion legalization, drug-taking prohibitions, guns laws and education in teen agers, have received significant attention in recent years. This new wave has been driven by the fact that United States and other countries, has experienced deeply and pronounces fluctuations on its crime rate, that can't be explained by the traditional facts. Specifically, since 1991 the United States has experience a widespread and persistent drop in crime, that have produce a explosion of new empirical hypothesis of this phenomenon.

One of the most revolutionary ideas was propose by Donohue and Levitt (2001), who argued that legalization of abortion in US in 1970 (in five states) and 1973 (nationwide), has an abrupt influence in the cohorts born in the wake of liberalized abortion, that might influence crime rates 15-20 years later. Donohue and Levitt (2001) argued that legalized abortion may lead to reduced crime in different ways: first, abortion legalization generate smaller cohorts after come into force, and this means that when that cohort reaches most prone age to commit crime, 18-24, there will be fewer young males in their highest-crime years, and thus less crime. Second, and more interesting, is that access to legal abortion allows women to optimize the timing of childbearing and in consequence to bring up children in environments less likely to produce future criminals. In other words, legalized abortion reduces the number of children born under adverse circumstances, which strongly signals their potential future criminality.

Donohue and Levitt (2001) presented empirical evidence consistent with the hypothesis that legalized abortion reduced crime fifteen to twenty years later. Moreover, their results suggest that an increase of 100 abortions per 1000 live births reduces cohorts' crimes by roughly ten percent. They also show that crime was almost 15-25% lower in 1997 than it would have been absent legalized abortion.

Several authors have disputed Donohue and Levitt (2001) conclusion. Joyce (2003) conclude that the relation between crime and abortion is not causal (more abortion less crime), and is product of the result of confounding changes in crack cocaine and handgun use and the growth in abortion. After having estimated different model specifications using teen fertility and abortion rates, controlling for state and year fixed effects, Joyce (2003) conclude that association between abortion and teen fertility rates is inconsistent with the story that states with higher abortion rates have lower rates of unintended childbearing. Joyce's analysis of homicide rates and arrest year by year of age, indicates that teens born between 1968-1973

[10] As Draca et al (2008) say, " a crucial part of identifying a causal impact in this type of setting is establishing the exclusion restriction which shows that terrorist attacks affect crime through the post-attack increase in police deployment, rather than via other observable and unobservable factors correlated with the attack or shock". Moreover, they found a crime-police elasticity of (-0.32) approximately.

in "repeal" states and who come of age between 1986 and 1991 experience similar or greater increases in crime that teens in non-repeal states.[11]

In line with the previous discussion, using individual-level victimization, socio-economic and demographic information from the four years of the International Crime Victims Survey, Hunt (2003) found that an increase in the share of young people born to a teen mother increases the assault rate. The relationship between crime and that share goes in the same fashion as Donohue and Levitt (2001) arguments; that is, a higher share of children born from teen mothers is linked to a higher crime rate. If children born from teen mothers are more likely to be unwanted than those born to older mothers, that would affect parenting quality and potentially crime. Another interesting argument stressed by Hunt (2003) is that children of poor teenage mothers are less likely to have been able to invest in education and that would trigger low probabilities of obtaining well paid jobs[12].

Krug et al. (2002) mention similar arguments and add two factors associated with violence in youths and teenage mothers, those are, poor attachment between parents and children and parental conflict in early childhood, since, teenage mothers are likely to be characterized by a family environment that includes these factors. Another important fact is the role played by social interactions developed in the neighborhood where teenage mothers lived, since they are more likely to live in neighborhood with high levels of crime.

Following the growing empirical evidence that higher wages reduce crime, Lochner (2004) developed a human capital framework to study crime. He studies the different possible relations between crime and human capital, defining the last as individual endowments (learning ability) and education. The main two channels through which human capital affects crime are: (i) the opportunity cost generated by engaging in crime is increased for individuals with high human capital levels due to the higher wage they would receive in the legal market, and (ii) more investment in skills and training increases the cost associated to incarceration, since they increase the cost of time spent in prison. This framework also suggest that the relationship between white collar crime and both age and education should

[11] "Repeal" states, are the 5 states where the legalized abortion was implemented first: New York, Washington, Alaska, California and Hawaii. See also Joyce (2007), Foote and Goetz (2008) and Dillls and Miron (2006) for other critiques to Donohue and Levitt (2001, 2004), and Donohue and Levitt (2008) for a response to Foote and Goetz (2008).

[12] Other studies supporting the relationship between teenage motherhood and their children's likelihood to commit crime in the future are Farrington (1998), Nagin et al (1997) and Sen (2002). This last one paper founds that lagged teen births rates affect sexual and physical assault rates, for Canada. On the other hand, there are other papers that have studied the effect of economic variables on crime using data from a single country. Broadly speaking what literature had found is that the relationship between wages and crime, and unemployment and crime is weak and in some cases insignificant (See Zeelenberg, Beki and Montfort [1999], Gould, Weinberg and Mustard [2002], and Raphael and Winter [2001]). Ayres (1998) argue that the fact that there is no direct causality does not mean that the two issues are unrelated; instead that data shows that violence is countercyclical (Homicide rates rise in periods of low economic activity), suggesting that unemployment has some effect in crime (quoted in Heinemann and Verner [2006]). On the other hand, Fajnzylber, Lederman and Loayza (1998, 2002a and 2002b) found that inequality increases crime. However, for Latin America, Heinemann and Verner (2006) stress that this relationship between inequality and crime is not straightforward; "Some countries have seen decreasing income inequality accompanied by an increase in violence such as Brazil and Venezuela, or a decrease in homicide rates accompanied by an increase in income inequality (Costa Rica and Mexico)" (Morrison, Buvinic and Shifter [2003])

differ from those for lesser-skilled crimes. All of this claims has as consequence that "violent and property crimes are mostly a problem among young uneducated men" (Lochner [2004]). Using data from the National Longitudinal Survey of Youth, and arrest data from the Uniform Crime Reports, Lochner (2004) found empirical support for this framework[13].

Lochner and Moretti (2004) also find that education reduces crime, and the probabilities of incarceration and arrests, due to a causal relation between education and criminal behavior. They highlight the fact that private returns to schooling could be increased between 14 to 16 percent due to its external effect on criminal activity, a very important result, mainly in developing economies in which private returns to secondary education are becoming negligible, making adolescents more likely to drop out of school. Education would make efforts to reduce crime much more cost effective than increasing the number of police officers, as pointed at by Heckman and Masterov (2007).

Heckman (2008) gives us additional elements to consider when analyzing the relationship between people's socioeconomic background, and their likelihood of engaging in crime later in life. First, he stressed that recent literature suggests "that a major determinant of child disadvantage is the quality of the nurturing environment rather than just financial resources available or presence or absence of parents", and we know that a less educated mother, and especially, teenage mothers, are determinants of a low quality of early environment. Moreover, he recalled that "those in less advantaged circumstances are much less likely to receive cognitive and socio-emotional stimulation and other family resources".

For Latin America, among others, De Mello and Schneider (2008) found that the age structure explain a significant part of the variation in homicides at the states of Sao Paulo during the period of 1990-2005. They also found that more high-school drop-out rates increase homicides. Although international evidence does not support this result[14], De Mello and Schneider (2008) argued that the relationship between crime and age structure would depend on the efficacy of the judicial system, law enforcement, and institutional development, among others. So, perhaps these kinds of differences between development cities and underdevelopment cities like Sao Paulo State, make that "the environment was ripe for demography to flourish as a cause of homicides" (De Mello and Schneider, 2008)[15].

Cohen and Rubio (2007) present some of the principal problems of "crime and violence" for a number of Latin-American countries, based on a survey that was conducted by the IDB for that project. They identified the following facts on "crime and violence" for Latin America: first, high incidence of crime;[16] second, high variance of homicide and violence rates[17];

[13] Specifically, he found a strong negative correlation between unskilled crime and cognitive ability and a negative effect of education on property and violent crime.
[14] De Mello and Schneider (2008) stress Levitt (1999) as an example against their arguments.
[15] Poner esta nota de pie de página el trabajo de Bonilla(2009b)
[16] Cohen and Rubio (2007) quote an estimate of the World Health Organization (WHO) who points out that the number of homicides committed with firearms in Latin America has reached three times the world average. Moreover, violence is the leading cause of death among Latin Americans between the ages of 15 and 44.
[17] There great different in the homicide rate in time and space across Latin America countries. Even in small geographical areas, like municipalities, "difference in the level of violence can be staggering" (Cohen and Rubio, 2007). This point is also stress out in Krug et al. (2002)

third, the problem of youth gangs and violence; fourth, is that most crime and violence in Latin America are committed by young men. They also found that youth gangs work with organized crime and that among young people, the most serious violence is perpetuated by gang members[18]; finally, they mentioned other risk factors for juvenile delinquency and gang membership. An important conclusion is that poverty is not the most significant factor to determine crime neither it is a necessary condition for gang membership. Dropping out of school seems to be a stronger risk factor.

Buvinic, Morrison and Orlando (2005) set out five reasons that explain high youth criminality in Latin America; drop out of high school or low school performance, high unemployment rates among formative years, weak law enforcement and poor efficacy of the judicial system on adolescent and early middle-age criminals, access to alcohol and drugs taking and the availability to a fire gun[19].

After a complete review of the recent literature and account for the main ideas and empirical findings on crime and violence in Latin America and the Caribbean, Heinemann and Verner (2006) stressed some risk factor for violent and criminal behavior, such as, inequality rather than the overall levels of development, lack of education, low social capital, unemployment and lack of opportunities, unruly urbanization and inoperative and inefficient criminal justice system (Heinemann and Verner, 2006).

Given the circumstances of violence in Colombia since late 60's, literature of definitions, determinants and cost of violence, among others, have been profuse[20]. Although, literature on the economics of crime for Colombia was scant until the late nineties. Gaitán (1995) was one of the first papers that tried to explain causes of violence under a different approach from the traditional focus, named by Sanchez et al. (2003) and Bonilla (2009) as "the objectives causes of violence". Bonilla (2009) mention the main findings of Gaitán (1995) which can be summarized as follows: first, Colombia has not always been a violent country; there have been different long periods of calm where the violence was in normal international standards. Second, the boom of violence in the late sixties and in the early eighties was promoted principally by the broken of the judicial system. Third, policies implemented by different governments have been poor, in reference with international patterns. Fourth, the excessive level of violence is not explained by the high rates of inequality and poverty, among others.

In recent years, research on economic of crime has been in agendas of many researches and academic institutions. Literature on crime in Colombia has found that weak law enforcement

[18] Another interesting issue sketched out by Rubio (2007), based on a self-report survey, and is that gang membership increase the probability to commit an offence. Moreover, gangs almost monopolize extreme violence among young people.

[19] For a complete description of crime stylized facts and policy implications for Latin America see Buvinic, Morrison and Orlando (2005)

[20] Referring Gaitán (1995), Bonilla (2009) stress out that there are many works previous to the former. See for example the report from de Commission of Violence Studies, who point out the main "*objective causes*" of violence.(Bonilla, 2009)

and poor efficacy of the judicial system are among the most important causes of crime[21]. It has also found that poverty and inequality have the same effects on violence than in other countries, in consequence, they are not the driving forces of violence. This argument is also supported by the fact that several of the richest municipalities have high homicide rates.[22]

The study most closely related to ours is the one by Gaviria et al. (2010), who assess the capitalization in house prices of their neighborhoods' violence. To do it, they used cross section data of households for Bogotá to estimate a hedonic regression that explained house prices as a function of control variables at the household and census sectors levels, including among the later the homicide rate. To correct the endogeneity of the homicide rate of the census sector, they separately consider two instrumental variables related to adolescent fertility: the age difference between the mother and her oldest co-resident child, as a proxy for defining a household as having had at least one child born from an adolescent mother, and the rate of adolescent mothers in the census sector.

Notice first, that while the age difference instrument is a proxy for the lagged effective adolescent fertility rate, it is not actually telling us the average adolescent fertility rate of any specific age cohort currently inhabiting the census sector, since the child that was born from an adolescent mother in a specific household might be currently someone of any age, and does not necessary belong to the peak ages for violent crime, estimated by Donohue and Levitt (2001) around 18-24 for the US, and by Giraldo et al. (2010) between 18 and 30 for the case of Medellín. Although it is still true that all children born in a household, in which there was at least one child born when his mother was adolescent, share some common characteristics, and that according to a wide literature some of those characteristics are likely to make them more likely to become criminals, in this study we additionally attempt to link the effective adolescent fertility rate of the cohorts more likely to commit crime, to current crime rates.[23]

In addition, we use information at two points in time separated by 12 years, which allows us to control for unobservable variables invariant in time, while their results rely on cross sectional evidence. We also have 20 years lags of the adolescent fertility rate, and 10 and 20 years lags of the homicide rate, which allow us to assess the causal relation that goes from adolescent fertility to crime, and as we will explain it later, to instrument for measurement error problems. Our Population Census data allow us to include the share of migrants by census sector in Bogotá, which had not been accounted for previously. Not only with better information does this paper advances with respect to Gaviria et al.'s work, but also in accounting for the spatial autocorrelation of crime, a regularity widely robust within cities.

We now proceed to describe some mechanisms we consider that are behind the causal relation that goes from adolescent fertility to the homicide rate of the census sector.

[21] See Rubio (1999) and Montenegro, Posada and Piraquive (2000), Sanchez et al. (2003) and Echeverry and Partrow (1998).
[22] Bonilla (2009) stress that four previous papers, Echandía (1997), Cubides, Sarmiento y Becerra and Sánchez (2007) support this argument.
[23] For evidence showing that children born from an adolescent mother are more likely to become criminals see Farrington (1998), Hunt (2003), Krug et al. (2002), Morash (1989), and Nagin (1997).

III. Adolescent Fertility and Crime Within Cities

We do not know of any reason why a child born of a teen mother is more likely to become criminal per se. There are socioeconomic reasons why that might end up happening though.

We know that the opportunity cost of studying for a teen mother is higher, and so, it is more costly for them to become well educated. Teen mothers might not yet be mature enough to raise their child; they might not be married at the time of pregnancy, and might not have planned yet to have their child.

Donohue and Levitt (2001) report that abortion has a large effect on the fertility rate of teenagers, and on that of teenagers out of wedlock. If that is the case, it should be more likely that under abortion prohibition, as it is the case in Colombia, children born of teenage mothers were unwanted, which according to the literature previously mentioned, makes them more likely to be involved in crime. In particular, Donohue and Levitt (2001) report that teenage motherhood and single parenthood might have increased the homicide rate in the US from 8.9 percent to 12.5 percent; that unwantedness might have increased it from 12.5 percent to 18.5 percent; and point to the studies by Dagg (1991), David et al. (1998), and Posner (1992), according to which women who sought abortion and were denied that right, were less likely to nurture, hold, and breastfeed their children, and their children were more likely to be involved in crime and have poor life prospects

These results become particularly relevant in the case of Colombia, where Flórez and Soto (2007) show that out of the wedlock adolescent mothers have increased from 18.0 percent in 1990, to 22.4 percent in 2000, and 29.6 percent in 2005, for women never united.[24] Here again we also recall the negative consequences on labor force participation and poverty of unplanned unwed motherhood reported by Bronars and Grogger (1994).

In addition, teen mothers are not a random sample of the population, but rather, more likely to be among the worse off. Flórez et al. (2004) present evidence using data of women from Bogotá and Cali, according to which adolescent women from low socioeconomic strata have sexual relations and become mothers much earlier than those in the highest socioeconomic strata.

Not only teenage motherhood, single parent family, and unwantedness, has been found to increase the risk of violent crime for males, but Räsänen et al. (1999) also found that mother's low education was another key determinant.

Finally, we will show that precarious living standards often lead to adolescent fertility among the worse off in environments in which most of the previously mentioned elements coincide, but still they might happen in the absence of violence, as it is the case in several places within Colombia. Thus, we consider that at least for the case of Colombia, where there has been a history of organized crime, it is the presence of gangs and any sort of organized crime, what becomes key to promote crime by exploiting the precarious

[24] Beck et al. (1993) report that in 1991, 43 percent of prisoners reported having only one parent, 39 percent grew up with their mother and 4 percent with their father.

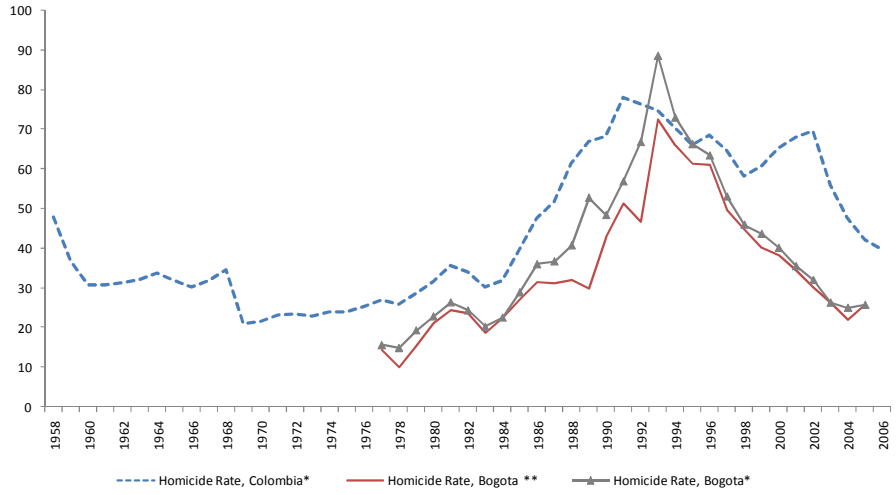
conditions existent in several neighborhoods of its cities, making it much easier for the increasing returns of crime, pointed at by Gaviria (2000), to prevail.

IV. Patterns of Crime in Colombia and Bogotá

In this section we describe the evolution of crime in Colombia and Bogotá, and present main statistics of the variables employed in this study, which are those associated with the hypotheses set out by the economic literature on crime. Our sources for the empirical exercises are the 1973, 1985, 1993 and 2005 Population Census, provided by the Administrative Department of National Statistics (DANE, by its acronym in Spanish), and Police statistics for Bogotá. We use data at the census sector level for all variables.

Figure 1 shows the evolution of the homicide rate in Colombia and Bogotá, over the period 1980-2008. At the national level, homicide rates began to rise in the early-1980s and continued increasing until early-1990s, when it began a temporal decline until late 1990s, when homicides rates begin to climb again at levels of late 1980s. After the peaking in the late 1990s and early 2000, homicides rates presented a persistent decline reaching levels not seeing since late seventies. For Bogota the behavior is similar to national rates, except that for that city, the downward trend of the homicide rate has been constant since its peak in 1993.[25]

Figure 1. Homicide Rate in Colombia and Bogotá, 1980-2007[26]



Source: (*) Took from Melo (2008) who used data from National Police Department, (*Dirección Central Policía Judicial*) (**) Took from Sánchez et al. (2007) who used data from National Police Department[27].

[25] The increase in homicide rate, experienced in late nineties in Bogota is associated with the increase in the use of guns as method of attack, see Figure A1. Krug et al. (2002) stress similar arguments at national level. In fact Krug et al. (2002) stress that for the period 1985-1994, "youth homicides increased by 159%, from 36.7 per 100.000 to 95 per 100.000, with 80% of cases at the end of this period involving guns".

[26] For the purpose of this study, we understand homicide as the activity by which one person kills another (Art 323 Penal Code). We define the homicide rate as number of homicide for every 100.000 habitants.

[27] Melo (2008) highlights possible reasons for the little different presented in both series of homicide for Bogota

Figure 1 shows two interesting episodes of crime in Colombia; the first one is a period of very high homicide rates, and it goes from the late eighties to early 2000s. This high homicide rates are attributed to the boom of Medellin drug cartel, and it's declaration of war to the government and other illegal groups.[28] The second one, and the most interesting, is the persistent decline in the homicide rate observe since early 2000's, attributed to the strengthening of law enforcement since President's Uribe came into power.[29]

Let us now analyze the evolution of the adolescent fertility rate in Colombia. Figure 2 shows its evolution at the national and urban levels, and for Bogotá. The curves illustrating the national and urban trends were estimated from the Demographic Health Survey, DHS, by Flórez and Soto (2007). Those curves show a similar U shape pattern for the national and urban levels, with a peak in the late 1960s, lowest levels from mid 1970s to mid 1980s, and a subsequent increase until mid 1990s, where it remains stable until 2005. Notice that the increase of adolescent fertility rates from mid 1980s until mid 1990s follows the pattern of the homicide rate in Bogota shown in Figure 1. This fact might be picking other relationship that goes from crime to adolescent fertility: as violence increases in city's neighborhoods, more males involved in gangs are sought by their female partners to have a child of them. These women, afraid of losing their partners in the city's war, become eager to have a child of them, no matter their circumstances.[30] Thus, we expect the relationship from crime to adolescent fertility to operate contemporary, while that from adolescent fertility to crime with a lag of as many years as it might take males of the specific place to reach the peak ages for violent crime.

There are two curves that illustrate the adolescent fertility rate in Bogotá: one of them presents the estimates obtained from the 1973, 1985, 1993 and 2005 Colombia Population Census, and the other estimated by Flórez (2009), who uses the 2005 DHS and Population Census, to present a corrected figure for that year. As it is argued by Flórez (2009), there are biases in the figure gotten from the 2005 census, which highly underestimates its actual magnitude. Once the figure is corrected the result shows that adolescent fertility in Bogotá would have remained stable between 1993 and 2005.[31]

We now proceed to study the variation in homicide rates within Bogotá. We have fertility and homicide rates at the census sector level from the population census and police records

[28] In 1993, the year in which Pablo Escobar, the leader of the Medellín Cartel, was murderer, the homicide rate in Medellín was around 310 murders per 100,000 inhabitants. In 1991, the year in which the indicator peaked in Medellín, it reached 360 murders per 100,000 inhabitants.

[29] Although national homicide rate present a persistent decline in recent years, Sanchez and Nuñez (2007) recall that the evolution of homicides rates has been heterogeneous across states, since they respond to different factors like drug trafficking routes, guerilla and paramilitary interventions, etc.

[30] The famous documentary "La Sierra", shows how members of gangs use to date several women simultaneously, each of them wanting to have a child of him as a mean to keep him for them, and to assure having his heir before he gets murdered.

[31] Flórez (2009) highlights different problems presented in the 2005 Population Census, specifically, arguing that "the quality of data on children ever born in the 2005 Population Census presents deficiencies that underestimates the levels of teenage fertility indicators". Flórez (2009) estimated in nearly 7.5 percent the adolescent fertility rate in Bogota for women between twelve and nineteen years, versus a figure of less than 5 percent according to the 2005 Population Census. This controversy is not relevant for the purposes of our empirical work below because we use the 20 years lagged adolescent fertility rate.

respectively. The city has nearly 600 census sectors with an average of around 10,000 inhabitants per sector. Census sectors register a wide range of variation of both socioeconomic characteristics and homicide rates.

We seek to relate lagged adolescent fertility to current crime. Since we need both information on crime and socioeconomic data at the census sector level, we use for the former the census of homicides of Bogotá, and for the later, the 1973, 1985, 1993 and 2005 Colombian Population Census. To have a reasonable lag period between both figures, we study crime in 1993 and 2005 as a function of adolescent fertility in 1973 and 1985 respectively, that is, with a 20 year lag between them.

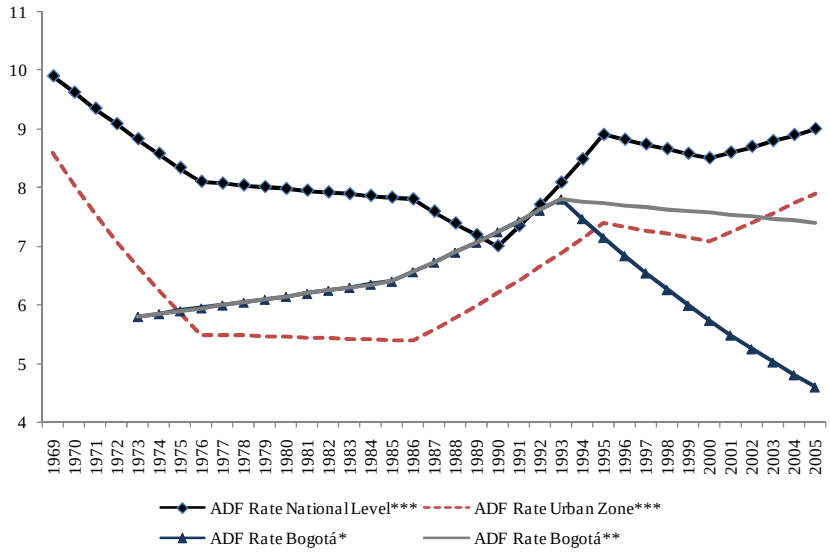
Figure 3 has two graphs that illustrate the relationship between the change in homicide rate between 1993 and 2005, and the change in the adolescent fertility rate with a 20 year lag on the left, and in the same period on the right. In both cases, graphs show that there is a positive relation between crime and adolescent fertility rate. As we argued above, the figure on the left, the one of interest for this study would represent a relation that goes from adolescent fertility to crime, while that on the right a relation on the opposite direction.

Figure 4 presents the relation across census sectors between homicide rates in 1985 and 2005 for the left panel, and in 1993 and 2005 for the right panel. The figure illustrates the large persistency of crime at the census sector level along time. This regularity is in line with previous findings by Llorente and Rivas (2005), and by Sánchez et al. (2003). In particular, Llorente and Rivas (2005) conclude that violent crime in Bogotá is concentrated in certain places which proved to be roughly the same over time. Violence in those places would expand or contract according to the wave of crime experienced by the city at the moment.

Figure 5 shows that the levels of the homicide rate had increased substantially by 1993, and that rather than increasing in just a few census sectors, the whole distribution shifted rightwards, consistent with the hypothesis of Llorente and Rivas according to which violent places are the same over time, their crimes just fluctuate with the conjuncture. It is also consistent with previous findings presenting evidence of spatial autocorrelation in crime rates, under which it is unlikely for a few census sectors to jump rightwards in the distribution in an isolated fashion.[32] This characteristic can also be appreciated in Map 1.

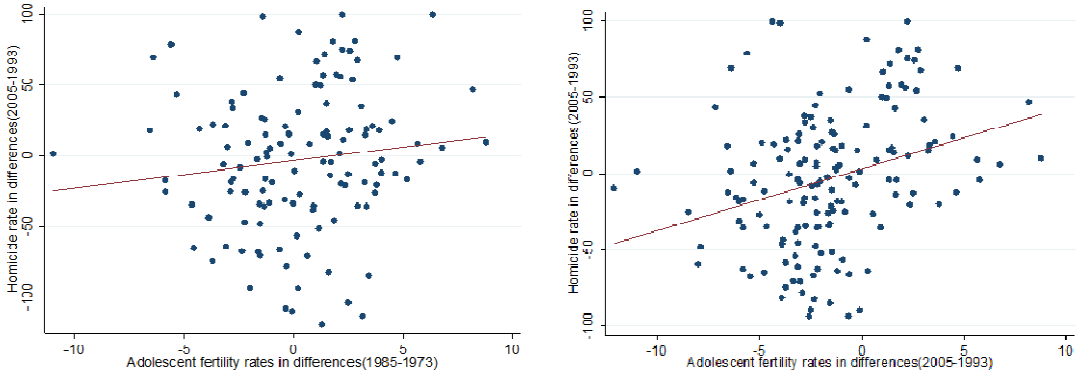
[32] For evidence of spatial autocorrelation see Núñez and Sánchez (2001), Sánchez and Núñez (2001), and Sánchez et al. (2003).

Figure 2. Adolescent Fertility Rates in Bogotá



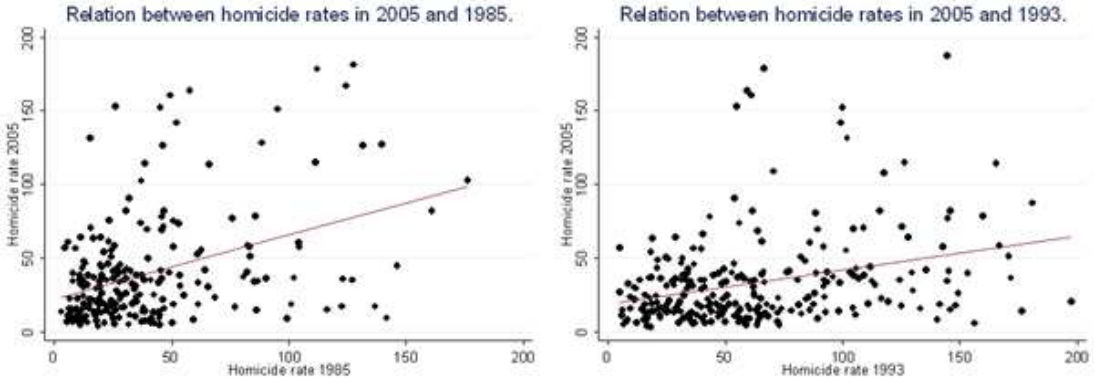
Source: (*) 1973, 1985, 1993 and 2005 Population Census, provide by DANE. (**) Flórez (2009). (***) Flórez and Soto (2007) based on DHS.

Figure 3. Relation between Adolescent Fertility Rates and Crime



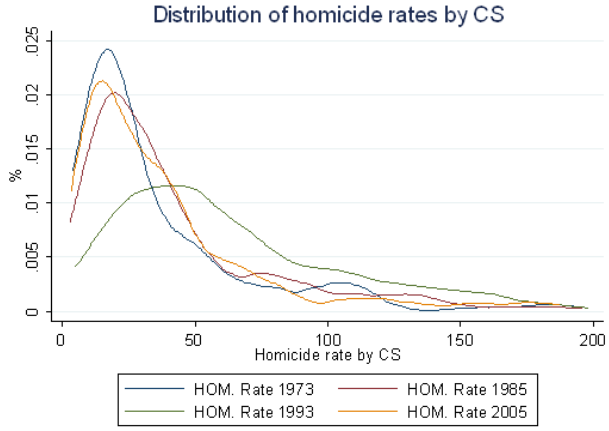
Source: 1973, 1985, 1993 and 2005 Population Census, and National Police-Dijin.

Figure 4. Persistency of the Homicide Rate across Census Sectors. Bogotá, 1985-2005.



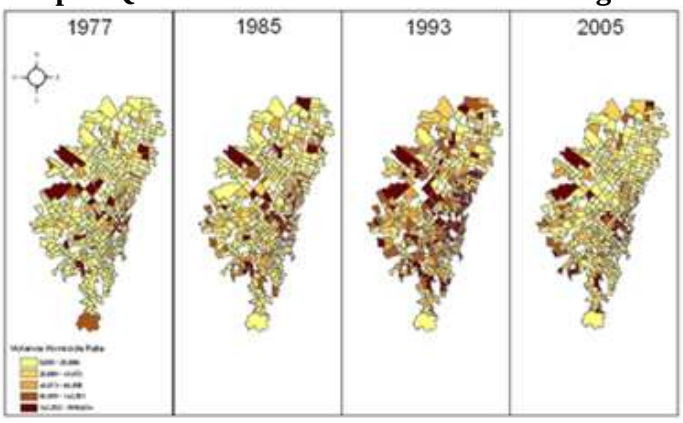
Source: 1993 and 2005 Population Census, and National Police-Dijin.

Figure 5. Distribution of the Homicide Rate by Census Sector in Bogotá.



Source: National Police-Dijin

Map 1. Quintiles of the homicide rates in Bogota[33]

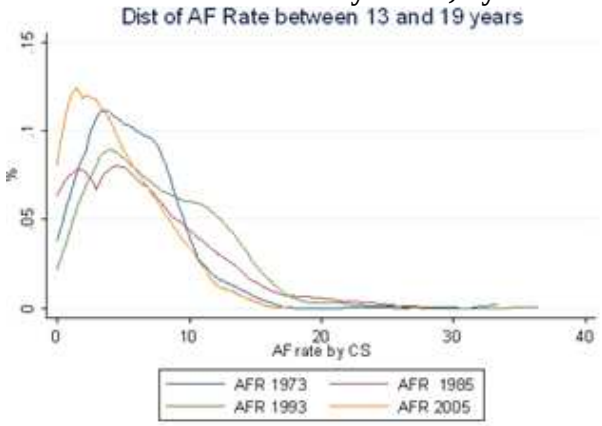


Source: National Police-Dijin

In order to deeply explore the role of the adolescent fertility on crime, figure 6 shows the adolescent fertility rates kernel densities by census sector for different years. It can be observed that although adolescent fertility rates increased substantially during 1980s and 1990s, this phenomenon was intensified in almost the same census sectors, due to the fact that census sector with high adolescent fertility rates remain nearly the same along time.

[33] Quintiles are normalized with 1993 as the baseline year.

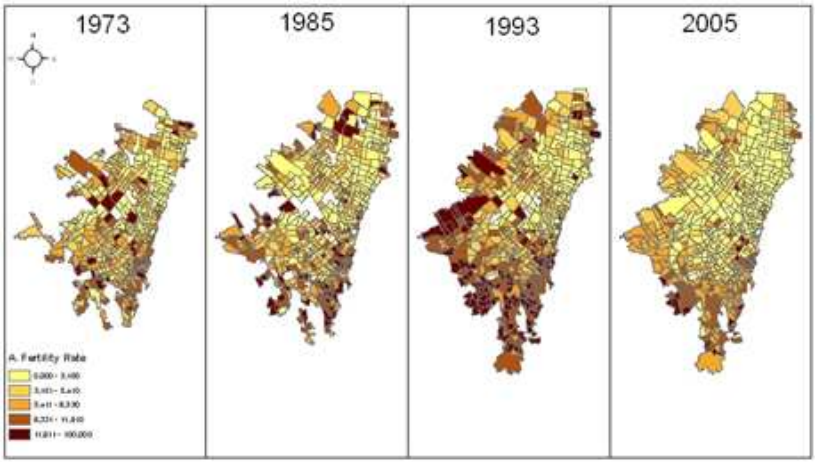
Figure 6. Distribution of Adolescent Fertility Rates, by Census Sector in Bogotá.



Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map 2 shows the spatial distribution of adolescent fertility rates and it stands out the high spatial correlation with homicides rates for the last three years presented in both maps, although for 1973 this contemporaneous correlation is less evident. As we mentioned it before, the work by Gaviria et al. (2010) had previously detected this relationship for Bogotá, and used the adolescent fertility rate at the census sector level as an instrumental variable for crime in a hedonic prices regression, showing cross sectional evidence that they were significantly correlated.[34] Here again, the contemporaneous relation should go from crime to adolescent fertility, while we are interested on the causal relationship going from lagged adolescent fertility to crime.

Map 2. Quintiles of Adolescent Fertility Rates.



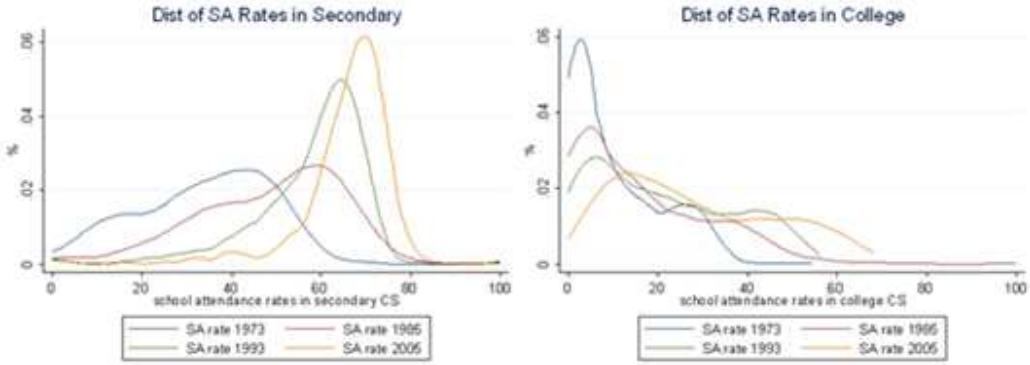
Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

[34] They also found a spatial autocorrelation between the homicide rate and the age difference between the youths in each census sector and their respective mothers (their proxy variable for youths born from a teenage mother, or lagged fertility rates), of 0.044, and statistically significant.

Another important variable that is associated with crime, especially for Latin American countries, is the school attendance in secondary and college. Figure 7 shows that school attendance rates in secondary have improved substantial during the analyzed period. Although there is a persistent increase in the college attendance rate from the 1970s to the late 1990s, the progress is modest if we compare it with secondary attending rates.

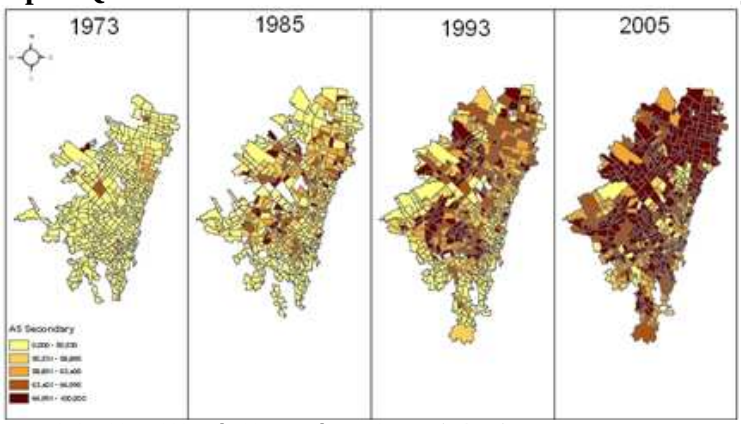
This can be confirmed if we compare map 3 and map 4, which sows the spatial distribution of school attendance in secondary and college. Map 3 shows that the big jump of secondary attendance rates started by the mid 1980s, and during all decade of the nineties this tendency pronounced. An important issue that it is appreciated from Map 3 is that by the end 2005 school attendance had increased in most areas of Bogotá, including the poorest zones located at the southwest of the city[35].

Figure 7. Distribution of School Attendance Rates in Secondary and College, by Census Sector in Bogotá



Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map 3. Quintiles of School Attendance Rates in Secondary



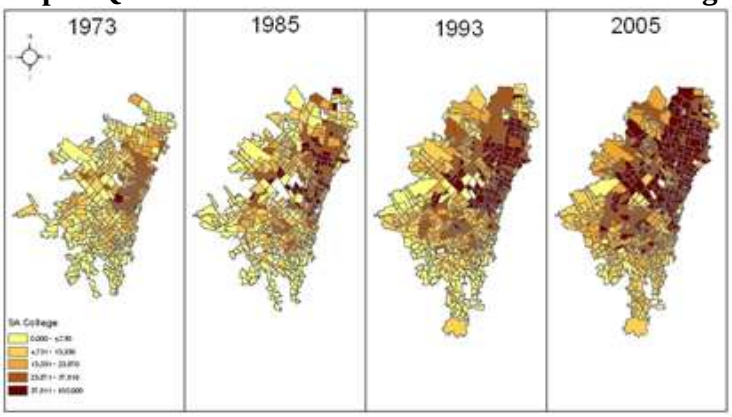
Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map 4 sets what we establish in the last paragraph. Although school attendance rates in college have improved during the last two decades, the progress has settled in the northeast zone of Bogota, while the marginalized sectors at the southwest still have low attendance

[35] See Maps 3 and 5.

rates. The two different zones distinguished in the map, the one at the northeast and the other at the southwest, represent the existence of two types of cities within Bogotá, that of the better off and the worse off respectively, as it is found by Medina et al. (2008).

Map 4. Quintiles of School Attendance Rates in College

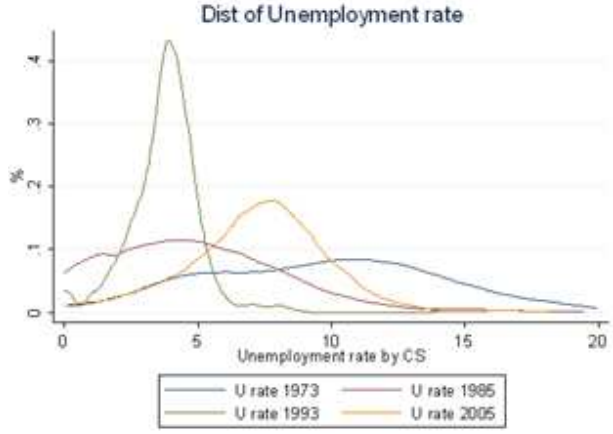


Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

One of the most controversial economic explanations trying to explain crime argues that it is more likely to emerge under high unemployment rates. As we reviewed above, the empirical literature testing that hypothesis has found that the relationship is weak, and in some cases insignificant. Figure 8 is in line with this result; while unemployment rate was at the lowest levels in the early 1990s, the homicide rate reached its highest level in 1993. The opposite situation took place in 2005, when the homicide rate was at 1980s level, but unemployment rate was at a significant superior level than 1993.

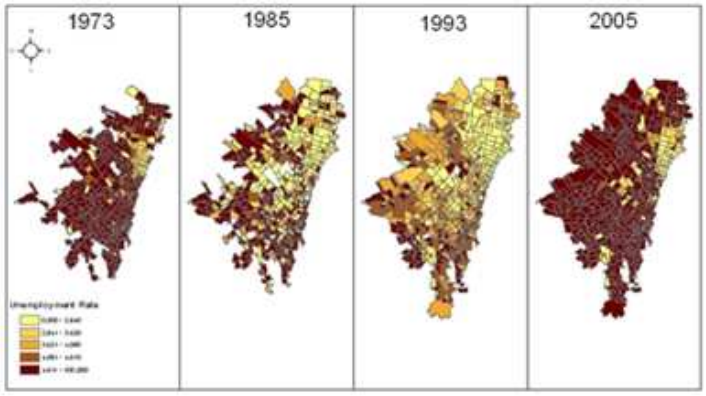
Map 5 shows an interesting regularity, and it is that even though we saw that the homicide rate follows a different dynamic than the unemployment rate, the unemployment rate could have a similar spatial pattern to crime. A reason could be that young men respond to the economic returns of crime, and these returns will be perceived as relatively larger if legal employment and resources become scarce. However, international literature have found that unemployment is not related to extreme violent crime like homicides, rather unemployment is related to less violent crimes like robbery.

Figure 8. Distribution of the Unemployment Rate by Census Sector in Bogotá



Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map 5. Quintiles of the Unemployment Rate



Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

On the other hand it is worth to note that several socioeconomic variables have reported a constant improvement in Bogotá, like those included in the so called index of Unsatisfied Basic Needs, (*NBI* for its acronym in Spanish), which accounts for changes in the access to housing, water and sanitation, education among others (See figure A1). Nonetheless, family structure has experienced important changes, as it can be observed in figure A2, where the increase in the share of female headed households becomes clear.

A topic in the literature of economic crime that has not been studied deeply is the relationship between crime and migration from other regions of the country to the different neighborhoods of a specific city. There are some studies that account for the effect of migration between countries or between states within a country though. Bianchi et al. (2008) set out some endogeneity problems that could be presented in the estimations that link immigration and crime, as result of unobserved "demand-pull" factors that are correlated with the location choice of immigrants within the destination country and crime. Once endogeneity is taken into account total criminal offenses as well as most types of crime are not related to the size of immigrant population. Butcher and Piehl (1998a) find that current U.S. immigrants have lower incarceration rates than natives. Moreover, when controls are

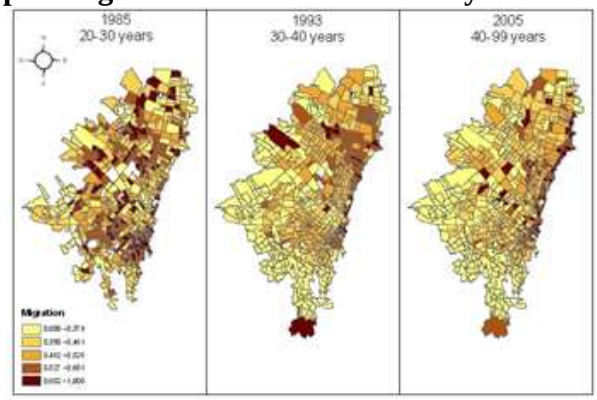
included for characteristics correlated with the labor market opportunities and criminal justice enforcement, incarceration rates are much lower for immigrants that for natives. In addition, Butcher and Phiehl (2007) suggests that deportation and deterrence of immigrants' crime from the threat of deportation are not driving the result of lower incarceration rates for immigrants: "Rather, immigrants appear to be self-selected to have low criminal propensities and this has increased over time" (Butcher and Phiehl, 2007). Butcher and Piehl (1998b) look at a sample of U.S. metropolitan areas over the 1980s and conclude that new immigrants' inflows had no significant impact on crime rates. See also Hagan and Palloni (1999) for comparisons of border to non-border cities with larger immigrant populations, and Lee, Martinez and Rosenfeld (2001) for an analysis of the influence of immigrants (Latinos and African Americans) to crime. In both cases immigration is not associated with higher levels of homicide.

On the other hand, Alonso et al. (2008) find that both immigrants and natives have contributed to the recently increase in the crime rate in Spain. "This result is partly explained by the fact that immigration has contributed to the main increase of the collective of males aged 20 to 50, which are responsible for most offences and by differences in socioeconomic opportunities between migrants and natives (Alonso et al. 2008). Moehling and Piehl (2007) describe similar patterns for immigrants in the early 1900s in U.S. where foreign born between 18 and 19 years old were disproportionately represented among prison commitments for major offenses. This would be suggestive evidence that "adjustment" and "culture conflict" issues were a factor in this period (Something interesting here is that, almost half of the foreign born between18 and 19 years old, were rent arrivals in the U.S.

In the last twenty years Bogotá has received large flows of people proceeding from other zones of the country. This phenomenon was intensified in the late 1980s and early 1990s. Map 6 shows migration from other regions to Bogotá, by the same cohort. In particular, we follow individuals who were 20-30 years old in 1985, 28-38 in 1993 and 40-50 in 2005; dark sectors represent people born in Bogotá, while light sector are those who were born outside the capital. Notice that 20-30 years old migrants arriving in Bogotá in 1985 are relatively disperse, while by 1993 and 2005 they are much clustered towards the southwest, and the west of the city. People born in Bogotá on their part, cluster in the central-northeast zone. This shows a similar spatial pattern between migrants and crime, with places in which migrants live being the most violent of the city.

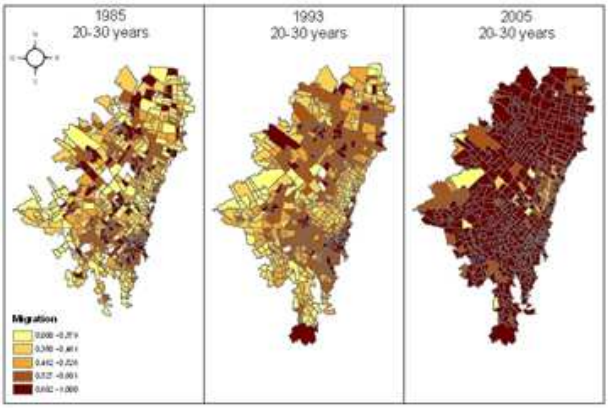
In Map 7 we can appreciate that the phenomenon of large flows of migrants from other regions started in the decade of eighties and continue during the nineties; by the early 2000s this tendency was sharply moderate.

Map 6. Migration from Other Cities by Generation



Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map 7. Migration from Other Cities to Bogota, by the Same Generation



Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Maps A1, A2, A3 and A4, show that migrants to Bogotá come from Antioquia, the Central Zone, the Pacific and Atlantic Zones, respectively. These are the zones with the larger shares of total migrants.

V. Identification Strategy and Results

In this section we present the empirical strategy to identify the causal relation between adolescent fertility and crime, and the results of different model specifications that include the control variables most related to crime according to the economic literature. We exploit the cross section and longitudinal variation at the census sector level, of crime and key socioeconomic variables, for Bogotá.

We present a baseline model from which we get cross section estimates for 1993 and 2005, estimates of the pooled sample, and difference-in-differences estimates. We first get these estimates using the contemporaneous relation between a set of socioeconomic variables, including adolescent fertility, and the homicide rate. Although we are aware that there should not be any causal contemporaneous relationship from adolescent fertility to

homicides, but maybe the other way around, we present the results in order to compare them with previous work.

Then we proceed to estimate the pooled and difference-in-differences baseline model using the lagged adolescent fertility rate of the census sector, which we construct as the effective adolescent fertility rate. We also introduce interactions of the effective adolescent fertility rate to explore potential mechanism under which adolescent fertility ends up affecting homicide rates. First, we iterate it with an inverse measure of secondary enrollment of the census sector about ten years ago, that is, at the time individuals currently in their peak crime ages were about entering adolescence; secondly, we introduce a triple interaction with the same enrollment variable, and the homicide rate of the census sector about ten years ago.

Finally, we estimate a model that accounts for spatial autocorrelation, and present several robustness checks.

1. Baseline Model

We begin estimating cross section models for years 1993 and 2005 of the following form[36]

$$h_{it} = \alpha_i + \theta AFR_{it} + \gamma SE_{it} + u_{it} \quad (1)$$

Where h_{it} is the homicide rate, AFR_{it} is the adolescent fertility rate, and SE_{it} is a vector of socioeconomic variables for census sector *i* like the unemployment rate of the sector, a quality of life indicator denominated Unsatisfied Basic Needs, *NBI*, school attendance rates in primary, secondary and college, *SAR(Primary), SAR(Secondary), and SAR(College)* respectively, the share of ethnic minority, *Minority ethnic rate*, educational attainment of people 25 and older in the census sector, *Education level 25*; the share of residents between twenty and thirty years old who have lived for more than 5 years in that census sector and were born in one of eight different regions outside of Bogotá, *Share Residents (Born in Atlántico), Share Residents (Born in East Zone), Share Residents (Born in Central Zone), Share Residents (Born in Pacific Zone), Share Residents (Born in Antioquia), Share Residents (Born in Valle), Share Residents (Born in San Andres and Providence Islands), Share Residents (Born in Orinoquía Zone)*, and the share of female headed households of the sector, *HH women*.[37]

Our model has the implicit assumption that children born of an adolescent mother about 20 years ago commit crime in the census sector they currently live. Giraldo et al. (2010) show that when we exclude the homicides committed in down town, 49% of the total homicides were committed 1.5 neighborhoods of distance to the centroid of the census sector where the criminal lived.[38] This fact gives support to our implicit assumption.

[36] We use robust standard errors in all of the specifications.
[37] See Table A3 for details in the construction of variables.
[38] A neighborhood in this case, has a similar size to a census sector, that is, about 10,000 inhabitants in the case of Bogotá.

The 2005 Population Census allows us to determine whether a household lived 5 years ago in the same place it currently lives, and the 1993 Population Census allows us to determine whether it lived 5 years ago in the municipality it currently lives. We use this information to restrict our 2005 (1993) sample to households who live today in the same census sector (municipality) they lived 5 years ago. We did this basically because we wanted to capture the structural relationship between adolescent fertility and crime. We are not focused on the type of criminal who moves from one place to the other, but on the one that grows up at least since his adolescence, in a place with key characteristics we can control for, that help to determine and explain his current decision to have engaged into criminal activities. We expect individuals who frequently move within the city to have grounds that lead them to commit crime, weakly linked at the most, to the socioeconomic conditions of the place in which they currently reside, thus, although they are as well important to account for the levels of crime in their neighborhoods, controlling for them might prevent us from, rather than help us to, identify the relationship between adolescent fertility and crime.

Tables 1 and 2 present the results of estimating equation (1) using two specifications for the years 1993 and 2005. For 1993 we have 443 census sectors in our sample while for 2005 we have 451. Each set of results contains OLS estimates using robust standard errors. Table 3 presents the results of estimating equation (1) using pooled data for both years. In this case we have 894 census sectors in our sample.

The estimation for 1993 shows that there is no significant relation between adolescent fertility and homicides, although those for 2005 do at the 10 percent level, and the pooled estimates are again positive, and in that case, they are also statistically significant.

Table 1. OLS Estimates for Bogota, 1993.

Variable	Cross1993a		Cross1993b		Cross1993c	
	coef	p-value	coef	p-value	coef	p-value
Adolescent Fertility Rate (AFR)	7.923	0.365	10.750	0.323	9.800	0.345
Unsatisfied Basic Needs (NBI)	-0.150	0.974	0.501	0.910	2.248	0.585
School Attendance Rate (Primary) (SAR(Primary))	-2.666	0.485	-1.617	0.691	3.232	0.530
School Attendance Rate (Primary) (SAR(Secondary)	-0.217	0.931	0.078	0.976	-0.584	0.887
School Attendance Rate (Primary) (SAR(College))	2.806	0.324	-0.378	0.861	5.042	0.206
Household Head Women (HH Women)	10.186***	0.003	10.597***	0.026	17.715**	0.052
Illiteracy Rate	37.407	0.157	42.163*	0.125	38.229	0.233
Unemployment rate	-29.961*	0.133	-22.807	0.372	-22.621	0.330
Minority ethnic rate	-0.848	0.654	-1.108	0.556	-2.009	0.312
Education level 25			26.421	0.452	119.624**	0.084
Schooling Rate			9.845	0.864	-248.185**	0.088
Share Residents (Born in Atlantico)					-1.940	0.779
Share Residents (Born in East Zone)					-1.037	0.395
Share Residents (Born in Central Zone)					9.246	0.153
Share Residents (Born in Pacific Zone)					-3.195	0.801
Share Residents (Born in Antioquia)					1.886***	0.047
Share Residents (Born in Valle)					8.249	0.520
Share Residents (Born in S. A and P) (i)					-166.958***	0.047
Share Residents (Born in Orinoquía Zone)					2.240	0.904
Share pop. 0-10					-30.634*	0.121
Share pop. 11-20					-17.760	0.278
Share pop. 21-30					-0.517	0.950
Share pop. 31-40					6.413	0.685
Difference Men-Women 0-10 years					26.255	0.201
Difference Men-Women 11-20 years					29.057*	0.136
Difference Men-Women 21-30 years					29.977**	0.082
Difference Men-Women 31-40 years					29.758**	0.075
_cons	-48.950	0.887	-458.551	0.480	626.334	0.517
Number of observations	443		443		443	
R2	0.126		0.131		0.242	
r2_0						
r2_b						
r2_w						
Log-Likelihood	-3,066.17		-3,064.93		-3,034.62	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Table 2. OLS Estimates for Bogota, 2005.

Variable	Cross2005a		Cross2005b		Cross2005c	
	coef	p-value	coef	p-value	coef	p-value
Adolescent Fertility Rate (AFR)	4.925	0.388	8.394*	0.116	3.954	0.396
Unsatisfied Basic Needs (NBI)	0.619	0.625	0.502	0.715	-0.878	0.543
School Attendance Rate (Primary) (SAR(Primary))	-8.003	0.167	-7.739	0.178	-6.948	0.188
School Attendance Rate (Primary) (SAR(Secondary)	-0.247	0.847	0.004	0.997	-0.084	0.972
School Attendance Rate (Primary) (SAR(College))	0.452	0.601	-0.915	0.535	1.269	0.207
Household Head Women (HH Women)	-2.796**	0.065	-2.814***	0.028	-0.970	0.434
Illiteracy Rate	-4.297	0.399	-3.974	0.428	-3.638	0.313
Unemployment rate	9.418	0.439	12.202	0.363	15.443	0.210
Minority ethnic rate	-0.001**	0.060	-0.001**	0.074	-0.000**	0.074
Education level 25			38.326	0.407	36.818	0.226
Schooling Rate			-27.912	0.560	-26.211	0.348
Share Residents (Born in Atlantico)					0.319	0.659
Share Residents (Born in East Zone)					-1.211	0.469
Share Residents (Born in Central Zone)					8.743***	0.001
Share Residents (Born in Pacific Zone)					-1.068	0.797
Share Residents (Born in Antioquia)					-2.077	0.273
Share Residents (Born in Valle)					8.826***	0.009
Share Residents (Born inS. A and P) (i)					-25.199	0.707
Share Residents (Born in Orinoquía Zone)					-10.147	0.346
Share pop. 0-10					0.221	0.977
Share pop. 11-20					10.091	0.213
Share pop. 21-30					-4.505**	0.087
Share pop. 31-40					7.865**	0.051
Difference Men-Women 0-10 years					1,722.792*	0.103
Difference Men-Women 11-20 years					1,850.532***	0.031
Difference Men-Women 21-30 years					786.856	0.250
Difference Men-Women 31-40 years					611.797	0.271
_cons	757.192**	0.096	593.854*	0.126	181.719	0.431
Number of observations	451		451		451	
R2	0.123		0.136		0.371	
r2_0						
r2_b						
r2_w						
Log-Likelihood	-2,860.19		-2,856.88		-2,785.15	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Homicide increases with the share of female headed households and with the shares of migrants, between twenty and thirty years old, from Antioquia and San Andrés for 1993, and the Central zone and Valle for 2005. The former result is not supported with the pooled data, as it is shown in table 3. Homicide rates increase with the share of migrants, between twenty and thirty years old, from Antioquia, Valle, San Andrés, the Central zone, and additionally, from the Atlantic zone. They also increase with adolescent fertility rates, and lastly, and surprisingly, with high school attendance rates in colleges. This surprising result disappears once we estimate the fixed effects model, as it can be seen in Table 4. In that table, adolescent fertility is again positively a significantly related to homicides, and so is the share of female headed households. In this estimation we control for the age structure of the population by census sector (*Share pop. 0-10, Share pop. 11-20, Share pop. 21-30 and Share*

pop. 31-40).[39] On the other hand, the homicide rate decreases in sectors with the share of middle-aged residents of the census sector, specifically, for those twenty to forty years old.

In short, we find similar results to those found by Gaviria et al. (2010) when using the contemporaneous adolescent fertility rate, that is, a positive and significant relation between the contemporaneous adolescent fertility rate, and the homicide rate. In particular, although our cross section estimates do not provide a robust relationship between these variables, which might be due to the fact that we have less control variables than Gaviria et al. (2010), our pooled and fixed effect estimates allow us to get to a similar result.

Table 3. OLS Estimates for Bogota, Pooled.

Variable	Cross_ALLa		Cross_ALLb		Cross_ALLc	
	coef	p-value	coef	p-value	coef	p-value
Adolescent Fertility Rate (AFR)	14.221***	0.015	15.083***	0.031	16.316***	0.020
Unsatisfied Basic Needs (NBI)	0.319	0.866	0.290	0.876	0.416	0.811
School Attendance Rate (Primary) (SAR(Primary))	-2.830	0.362	-2.895	0.342	-2.047	0.544
School Attendance Rate (Primary) (SAR(Secondary)	-1.574	0.237	-1.061	0.457	-1.174	0.576
School Attendance Rate (Primary) (SAR(College))	1.724*	0.147	2.340***	0.032	3.557***	0.007
Household Head Women (HH Women)	1.827	0.316	3.266**	0.076	3.798	0.157
Illiteracy Rate	0.069	0.983	1.009	0.740	-0.173	0.953
Unemployment rate	-6.167	0.460	-3.506	0.729	-5.367	0.588
Minority ethnic rate	-0.001	0.208	-0.000	0.285	-0.001*	0.143
Education level 25			30.404	0.276	37.083	0.164
Schooling Rate			-39.084*	0.132	-61.878***	0.046
Share Residents (Born in Atlantico)					1.344	0.347
Share Residents (Born in East Zone)					-2.019***	0.041
Share Residents (Born in Central Zone)					8.726***	0.021
Share Residents (Born in Pacific Zone)					-0.450	0.895
Share Residents (Born in Antioquia)					1.700***	0.036
Share Residents (Born in Valle)					9.178***	0.034
Share Residents (Born in S. A and P) (i)					-88.468**	0.091
Share Residents (Born in Orinoquía Zone)					-0.689	0.954
Share pop. 0-10					-3.301	0.589
Share pop. 11-20					1.092	0.836
Share pop. 21-30					-0.941	0.758
Share pop. 31-40					7.469**	0.079
Difference Men-Women 0-10 years					13.858	0.341
Difference Men-Women 11-20 years					11.745	0.420
Difference Men-Women 21-30 years					7.696	0.435
Difference Men-Women 31-40 years					5.861	0.472
_cons	274.088	0.309	196.390	0.452	95.510	0.809
Number of observations	894		894		894	
R2	0.083		0.088		0.167	
r2_0						
r2_b						
r2_w						
Log-Likelihood	-6,032.40		-6,029.82		-5,989.20	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

[39] *Share pop. 0-10*, *Share pop. 11-20*, *Share pop. 21-30* and *Share pop. 31-40* measure the share of the total population between 0-10 ten years, 11-20 years, 21-30 years and 31-40 years old, respectively. The intuition behind this variables is that census sector with a young structure population, specifically sectors with high shares of teen agers, are sector more prone to have higher homicide rates.

Table 4. Panel with FE for Bogotá

Variable	PANELa		PANELb		PANELc	
	coef	p-value	coef	p-value	coef	p-value
Adolescent Fertility Rate (AFR)	12.029**	0.071	11.522**	0.072	14.586***	0.031
Unsatisfied Basic Needs (NBI)	-0.020	0.992	0.270	0.883	-1.805	0.405
School Attendance Rate (Primary) (SAR(Primary))	1.476	0.574	1.183	0.650	1.711	0.478
School Attendance Rate (Primary) (SAR(Secondary)	-0.662	0.689	0.281	0.865	-0.736	0.690
School Attendance Rate (Primary) (SAR(College))	-5.907***	0.003	-2.869	0.189	-3.499*	0.124
Household Head Women (HH Women)	6.325***	0.001	9.159***	0.000	8.457***	0.000
Illiteracy Rate	-6.962***	0.036	-5.172	0.167	-5.348*	0.143
Unemployment rate	2.848	0.606	5.505	0.296	5.413	0.354
Minority ethnic rate	0.000	0.793	0.000	0.579	0.000	0.587
Education level 25			18.139	0.461	14.933	0.574
Schooling Rate			-43.302**	0.052	-40.040	0.162
Share Residents (Born in Atlantico)					-0.351	0.775
Share Residents (Born in East Zone)					-1.155	0.311
Share Residents (Born in Central Zone)					5.261	0.161
Share Residents (Born in Pacific Zone)					3.644*	0.139
Share Residents (Born in Antioquia)					1.074	0.237
Share Residents (Born in Valle)					-4.476	0.347
Share Residents (Born in S. A and P) (i)					-7.005	0.899
Share Residents (Born in Orinoquía Zone)					-5.302	0.649
Share pop. 0-10					2.248	0.692
Share pop. 11-20					1.854	0.712
Share pop. 21-30					-9.205***	0.030
Share pop. 31-40					-6.738**	0.099
Difference Men-Women 0-10 years					5.579	0.553
Difference Men-Women 11-20 years					12.276	0.183
Difference Men-Women 21-30 years					-2.936	0.646
Difference Men-Women 31-40 years					-2.889	0.632
_cons	-78.109	0.783	-120.334	0.620	185.683	0.638
Number of observations	894		894		894	
R2	0.223		0.244		0.307	
r2_0						
r2_b	0.000		0.000		0.003	
r2_w	0.223		0.244		0.307	
Log-Likelihood	-5,353.69		-5,341.59		-5,302.68	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

2. Identifying the Causal Relation Between Adolescent Fertility and the Homicide Rate

As we have argued so far, the contemporaneous relation between adolescent fertility and the homicide rate would work from homicides to adolescent fertility rather than the other way around.

To identify the causal relationship we are interested in, we define the effective adolescent fertility rate, as the twenty years lag of the adolescent fertility rate of each census sector adjusted for migration, closely similar to what Donohue and Levitt (2001) do. So, we determine the municipality of birth for all individuals in crime peak ages living in Bogotá at the moment the population census was collected, and we use the adolescent fertility rate of

those municipalities, to calculated the effective adolescent fertility rate of each census sector as the average of those fertility rates, weighted by the number of individuals of that specific census sector that were born in each municipality.[40]

Table 5 and 6 presents pooled OLS and difference-in-differences estimates of equation (1) respectively, using the effective adolescent fertility rate. Aside the non significance of the effective adolescent fertility rate, in both cases we obtain similar results from what we found in the previous estimations. At this point, we also perform some sensitive analysis excluding some census sectors, and what we find is that these results are not robust and the significance of parameters varies substantially.

Table 5. OLS Estimates with EAFR for Bogotá, Pooled

Variable	CrossEf1993a		CrossEf1993b		CrossEf1993c	
	coef	p-value	coef	p-value	coef	p-value
Effective Adolescent Fertility Rate (EAFR)	5.601*	0.119	5.601*	0.121	3.065	0.393
Unsatisfied Basic Needs (NBI)	0.398	0.931	0.822	0.857	2.806	0.488
School Attendance Rate (Primary) (SAR(Primary))	-2.165	0.548	-1.426	0.715	3.783	0.455
School Attendance Rate (Primary) (SAR(Secondary))	-0.874	0.717	-0.828	0.732	-1.338	0.733
School Attendance Rate (Primary) (SAR(College))	1.739	0.342	-0.520	0.808	4.759	0.228
Household Head Women (HH Women)	11.313***	0.001	11.575***	0.011	17.730***	0.047
Illiteracy Rate	38.875	0.168	42.637*	0.142	40.135	0.231
Unemployment rate	-33.746**	0.061	-29.880	0.161	-28.149	0.162
Minority ethnic rate	-0.894	0.634	-1.034	0.580	-1.927	0.325
Education level 25			12.537	0.680	127.835**	0.061
Schooling Rate			10.798	0.845	-274.785**	0.057
Share Residents (Born in Atlantico)					-2.861	0.686
Share Residents (Born in East Zone)					-0.909	0.478
Share Residents (Born in Central Zone)					9.135	0.156
Share Residents (Born in Pacific Zone)					-3.384	0.791
Share Residents (Born in Antioquia)					2.037***	0.048
Share Residents (Born in Valle)					11.186	0.420
Share Residents (Born in S. A and P) (i)					-171.602**	0.051
Share Residents (Born in Orinoquía Zone)					3.665	0.846
Share pop. 0-10					-32.432*	0.107
Share pop. 11-20					-20.565	0.210
Share pop. 21-30					-0.298	0.971
Share pop. 31-40					5.028	0.751
Difference Men-Women 0-10 years					25.150	0.223
Difference Men-Women 11-20 years					30.142*	0.114
Difference Men-Women 21-30 years					26.586*	0.119
Difference Men-Women 31-40 years					30.452**	0.065
_cons	-35.653	0.909	-271.275	0.582	893.587	0.351
Number of observations	443		443		443	
R2	0.124		0.126		0.237	
r2_0						
r2_b						
r2_w						
Log-Likelihood	-3,066.54		-3,066.07		-3,035.95	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

[40] In the case when the young teen mother born in Bogota we use the adolescent fertility rate of the census sector in which she reside.

Table 6. Panel with FE and using EAFR for Bogotá

Variable	PANELEfa		PANELEfb		PANELEfc	
	coef	p-value	coef	p-value	coef	p-value
Effective Adolescent Fertility Rate (EAFR)	-2.429	0.252	-3.856**	0.082	12.088**	0.058
Unsatisfied Basic Needs (NBI)	0.871	0.687	0.992	0.613	-7.446**	0.056
School Attendance Rate (Primary) (SAR(Primary))	2.015	0.503	1.425	0.632	11.448***	0.017
School Attendance Rate (Primary) (SAR(Secondary)	-1.339	0.448	-0.063	0.973	-10.446***	0.009
School Attendance Rate (Primary) (SAR(College))	-7.056***	0.003	-3.518*	0.140	-3.849*	0.141
Household Head Women (HH Women)	6.115***	0.002	9.004***	0.000	12.932***	0.004
Illiteracy Rate	-8.015***	0.018	-5.899*	0.135	-5.026	0.277
Unemployment rate	-0.055	0.991	2.663	0.603	8.279	0.294
Minority ethnic rate	0.000	0.802	0.000	0.680	0.000	0.675
Education level 25			8.630	0.746	104.751***	0.033
Schooling Rate			-39.920**	0.092	-146.413***	0.014
Share Residents (Born in Atlantico)					-2.018	0.272
Share Residents (Born in East Zone)					-0.947	0.460
Share Residents (Born in Central Zone)					5.739	0.153
Share Residents (Born in Pacific Zone)					6.194**	0.067
Share Residents (Born in Antioquia)					0.584	0.623
Share Residents (Born in Valle)					-3.331	0.474
Share Residents (Born in S. A and P) (i)					-8.250	0.918
Share Residents (Born in Orinoquía Zone)					6.176	0.605
Share pop. 0-10					-9.751	0.360
Share pop. 11-20					-20.238*	0.113
Share pop. 21-30					-14.065***	0.017
Share pop. 31-40					-23.174***	0.013
Difference Men-Women 0-10 years					18.448	0.226
Difference Men-Women 11-20 years					11.359	0.342
Difference Men-Women 21-30 years					-7.365	0.452
Difference Men-Women 31-40 years					-8.358	0.453
_cons	52.997	0.854	67.432	0.783	892.838	0.218
Number of observations	895		895		901	
R2	0.204		0.230		0.340	
r2_0						
r2_b	0.002		0.002		0.011	
r2_w	0.204		0.230		0.340	
Log-Likelihood	-5,369.98		-5,354.99		-5,751.91	

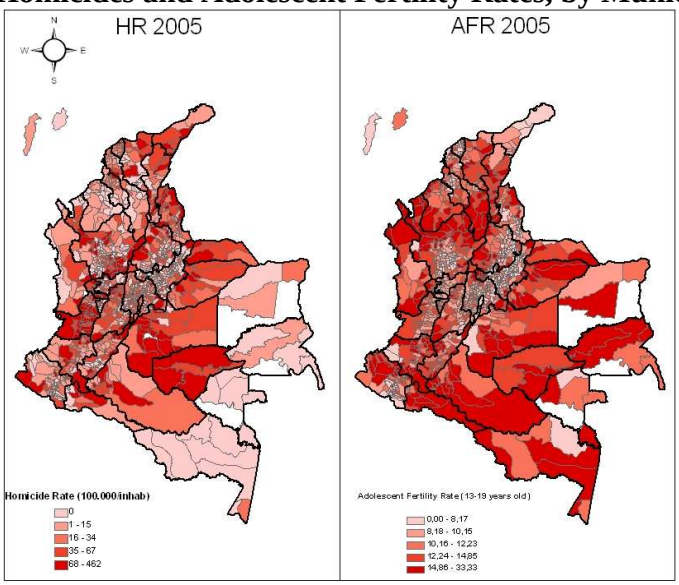
notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Although the lack of significance of our *EAFR* variable seems surprising, let us remember that it should not, per se, be linked to crime, but only as some specific conditions hold.

Map 8 presents homicide rates and adolescent fertility rates for all of the 1104 municipalities of Colombia. The map shows that there are municipalities with high adolescent fertility rates, and still, low homicide rates. This can be mainly appreciated in the Caribbean and Pacific zones. Notice that both variables are contemporaneously measured, but in this case it is important to bear in mind that they present a high persistency in long periods of time, which is not consistent with a positive causal effect from adolescent fertility to crime. That is, if adolescent fertility under the conditions existent in those regions, were to increase

crime, crime should have picked up at some point, which never happened. Thus, there must other elements that are required to, coupled with adolescent fertility, propel crime among children of teen mothers, and increase crime in the future.

Map 8. Homicides and Adolescent Fertility Rates, by Municipality.



Source: 2005 Population Census (DANE)

There is previous work that sought to identify the causal relation between adolescent fertility per se, and some outcomes of interest, but could not do so. Geronimus and Korenman (1992) estimated the effects of teen young mother on long term socioeconomic status, controlling for race, age, urban/rural status, and the most important, family background characteristics.[41] They find that adding the last controls, the observable family background characteristics, the socioeconomic differences associated with a teen birth are much smaller when compared with what traditionally the literature has found.[42] Using the "twins-first" approach proposed by Rosenzweig and Wolpin (1980), Bronars and Grogger (1994) estimated that for black unwed women the effects of unplanned births had large and persistent negative effect, while for whites there is only a negative effect in the short run of unplanned births reflected on labor force participation and poverty.

Now we proceed to explore potential channels through which the *EAFR* might become linked to the homicide rate.

3. Identifying the Channel Through Which the EAFR Affects the Homicide Rate

Previous paragraphs give us support to the argument that teen young mother is not a necessary and sufficient condition to think that her children would be criminals in late teens

[41] Large Decreases in the socioeconomic differences associated with a teen birth appear, specially, when Geronimus and Korenman (1992) compared sisters who time their births at different ages, in this case is when "the estimated effects of a teen birth on most indicators of socioeconomic status narrow further"

[42] Some of the works that have found large negative effects of teenage childbearing are Trussell (1988) and Jencks (1989). Hoffman, Foster and Furstenberg (1993) found also similar results.

and twenties. There might be channels through which adolescent fertility affect the homicide rate, and one such channel might be the lack of opportunities children born from an adolescent mother my face. Although the better off adolescent women might not be prevented from pursuing their former goals, and simultaneously, be able to care for their child, the possibility that those worse off could do so depend on the opportunities they and their children face. In order to assess whether children with lack of opportunities born from an adolescent mother are more likely to become criminals, we construct an interaction variable with effective adolescent fertility rate and one minus the secondary school attendance rate lagged ten years, by census sector. Our hypothesis at this stage is that high adolescent fertility rates twenty years ago adjusted by migration coupled with low enrollment rates in secondary ten years ago (when the children of young teen mother reach teen age), have negative effects on current homicides rates.[43]

It is important to notice that school attendance is not only limited by the availability of supply of schools, but also by potentially precarious care from mothers to their children. Krug et al. (2002) argue that "Poor monitoring and supervision of children by parents and the use of harsh, physical punishment to discipline children are strong predictors of violence during adolescent and adulthood". Hawkins et al. (2000) analyzed studies related to "risk and protective factors and the development of serious and violent juvenile offending careers" and conclude that poor family management practices and child maltreatment are good predictors of youth violence.[44]

Table 7 presents the difference-in-differences estimation of equation (1) using the effective adolescent fertility rate interacted with one minus secondary school attendance rate lagged ten years (*EAFR*[1-SAR(Secondary)_L10]*) and controlling for the difference between men and women average age by cohorts of ten years (*D1, D2, D3 and D4*), excluding individual with more than fifty years.

Results in Table 7 show that census sectors with higher school attendance rates, in secondary and college, and with higher proportion of adults in middle-ages, have lower homicide rates. On the other hand, homicide rates increase with the share of migrants from the Pacific and Antioquia zones, between twenty and thirty years old. The results also show that the interaction variable is not significant in any of the specifications, leading us to consider alternative, or complementary, channels.[45]

[43] This argument is in line with previous works that relate homicides and criminal activities with early dropping out of school by young teens. See the Literature Review section.

[44] Brook et al. (2007) present a psychiatric study that aim to explore the interrelation of domains of personality, familial, peer and ecological variables associated with violence, base on a survey to 1151 male adolescents selected from the Colombian cities. They found that low parental involvement and monitoring, negatives influences from their peer group, and environmental risks, are related to violent activity.

[45] We performed some robustness check (not reported here) that tested wheter results changed once we dropped some census sectors located in downtown Bogotá. Results did not change.

Table 7. Panel with FE and Interactions (Education), for Bogotá

Variables	PANEL_INTERAC_AVGe1		PANEL_INTERAC_AVGf1		PANEL_INTERAC_AVGg1		PANEL_INTERAC_AVGh1	
	coef	p-value	coef	p-value	coef	p-value	coef	p-value
Effective Adolescent Fertility Rate (EAFR)	6.768	0.202	6.429	0.226	6.267	0.238	6.291	0.239
Unsatisfied Basic Needs (NBI)	-3.331*	0.109	-3.544**	0.092	-3.694**	0.080	-3.728**	0.078
School Attendance Rate (Primary) (SAR(Primary))	0.648	0.667	0.640	0.679	0.853	0.578	1.067	0.492
School Attendance Rate (Primary) (SAR(Secondary))	-2.899***	0.032	-2.747***	0.040	-2.846***	0.035	-3.026***	0.021
School Attendance Rate (Primary) (SAR(College))	-2.011***	0.043	-2.026***	0.039	-2.398***	0.017	-2.756***	0.014
Unemployment rate	0.855	0.818	1.047	0.781	1.522	0.686	1.887	0.620
Minority ethnic rate	0.000	0.273	0.000	0.278	0.000	0.199	0.000*	0.128
Schooling Rate	-39.036**	0.058	-13.834	0.152				
Share Residents (Born in Atlantico)	0.211	0.782	0.400	0.601	0.557	0.469	0.609	0.432
Share Residents (Born in East Zone)	0.107	0.787	0.107	0.791	0.163	0.680	0.218	0.566
Share Residents (Born in Central Zone)	-0.345	0.752	-0.320	0.775	-0.340	0.764	-0.372	0.738
Share Residents (Born in Pacific Zone)	4.101***	0.039	4.086***	0.039	4.059***	0.039	4.041***	0.039
Share Residents (Born in Antioquia)	1.029***	0.018	1.057***	0.015	1.117***	0.009	1.161***	0.007
Share Residents (Born in Valle)	-3.419	0.313	-3.514	0.302	-3.507	0.306	-3.450	0.314
Share Residents (Born in S. A and P) (i)	18.939	0.679	13.603	0.764	12.391	0.786	14.083	0.758
Share Residents (Born in Orinoquía Zone)	-1.491	0.780	-1.211	0.820	-1.485	0.782	-1.908	0.725
Share pop. 0-10	1.814	0.569	3.600	0.265	5.454**	0.056	6.316***	0.009
Share pop. 11-20	-2.522	0.455	-1.874	0.581	-0.656	0.834	0.195	0.939
Share pop. 21-30	-6.563***	0.002	-6.548***	0.001	-6.466***	0.002	-6.393***	0.002
Share pop. 31-40	-8.525***	0.001	-7.662***	0.001	-7.263***	0.003	-7.337***	0.002
Difference Men-Women 0-10 years	-8.359	0.236	-9.281	0.174	-10.629*	0.114	-11.457**	0.093
Difference Men-Women 11-20 years	2.172	0.660	3.114	0.537	3.632	0.473	3.632	0.471
Difference Men-Women 21-30 years	-9.146***	0.041	-8.564**	0.055	-8.826**	0.051	-9.400***	0.038
Difference Men-Women 31-40 years	-12.824***	0.017	-12.332***	0.022	-13.351***	0.012	-14.622***	0.006
EAFR*[1-SAR(Secondary)_L10]	-0.179*	0.136	-0.173*	0.148	-0.165	0.165	-0.160	0.172
[1-SAR(Secondary)_L10]	0.161	0.852	0.058	0.947	-0.065	0.940	-0.130	0.876
Education level 25	24.162	0.182			-6.584	0.434		
Household Head Women (HH Women)	4.559***	0.000	4.475***	0.000	4.309***	0.000	4.191***	0.000
Illiteracy Rate	-1.513	0.320	-1.146	0.453	-0.989	0.512	-1.032	0.496
_cons	543.618***	0.015	504.781***	0.024	397.404***	0.044	312.575**	0.065
Number of observations	840		840		840		840	
R2	0.383		0.379		0.376		0.374	
r2_0								
r2_b	0.024		0.015		0.015		0.020	
r2_w	0.383		0.379		0.376		0.374	
Log-Likelihood	-4,489.50		-4,492.07		-4,494.54		-4,495.60	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Literature of risk of youth violence stress that peer influences and community factors in which young and adolescent live are important influence on their future criminal behavior. Krug et al. (2002) points that peer and community influence are important in shaping interpersonal relationships; "Having delinquent friends, for instance, is associated with violence in young people" (Krug et al., 2002). For the Colombian case, Brook et al. (2007) stress that among adolescents, the environmental and neighborhood risk, accompanying with negative influences from the peer group, are consistently with violent activity.[46]

In order to capture the influence of the environment where young adolescent grew up, we construct a new interaction variable defined as: one minus secondary school attendance rate lagged ten years interacted with "effective adolescent fertility" and the homicide rate lagged ten years (*EAFR*[1-SAR(Secondary)_L10]*HR_L10*). In addition of the consequences of the

[46] For more on this topic see Brook et al. (2003).

simultaneous occurrence of adolescent fertility and lack of opportunities, with this variable we expect to control for the "environmental-peer effect". This approach seeks to capture the main hypothesis that literature has suggested of potential risk of youth violence. Those are: Secondary school attendance, children of adolescent mother, and negative "environmental-peer effect".

Table 8 presents the results of difference-in-differences estimation of equation (1) using our new interaction variable defined in last paragraph, and our pervious controls. In this specification we find that sectors with high school attendance rates in secondary and college, and with high proportion of adults in middle-ages, have lower homicide rates; and that homicide rates increase with the share of migrants from Antioquia, the Pacific and Central zones, between twenty and thirty years old. These results are similar to those found in our previous estimations. In this case, we additionally find that our new interaction variable is positive and significant in all of the specifications. Moreover, when we carry out some sensitive analysis as we made it previously, the coefficient of the interaction variable remain always significant at 5%.[47] It follows that it is not only adolescent fertility per se what implies a direct causal relation with crime, neither its jointly occurrence with lack of opportunities, as measured by school attainment, but their occurrence in an environment of crime, under which local criminals and gangs find it much easier to tempt teenagers to get involved in delinquency, leading them to become criminals. The result is robust and it is in line with what literature on youth violence have suggested.

Note that both the adolescent fertility rate and the 10 years lagged homicide rates have negative coefficients. The sign of the adolescent fertility rate is less worrisome to the extent that as the triple interaction is capturing a positive effect, the isolated variable would be explaining what happens in census sectors with high adolescent fertility rates, but in which there are not simultaneously both low school attendance rates and high crime rates.

Understanding the sign of the lagged crime rate is less straightforward, since we know that crime rates are very persistent in time. The negative coefficient of that variable might be biased due to measurement error though. Notice that since ours is a difference-in-differences estimation, the 1993 homicide rate appears both on the left hand side, when it is subtracted to the 2005 homicide rate, and on the right hand side, when we subtract to it the 1985 homicide rate. That is, our model has the form

$$h_{it}^{*} = \alpha_i + \theta AFR_{it} + \gamma SE_{it} + \beta h_{it-j}^{*} + u_{it} \qquad (2)$$

with

$$h_{it} = h_{it}^{*} + v_{it} \qquad (3)$$

where h_{it} is the true homicide rate, and h_{it}^{*} is the imperfect signal of the homicide rate that is actually observed, with measurement error v_{it}. In our case, *t* is either 2005 or 1993, and *t-1* is 1993 and 1985 respectively.

[47] See estimations presented in Table A2

Borjas (1980) shows what happens in this case taking as example the use of cross section data to estimate a labor supply function in which the log of hours of work is explained as a function of the log hourly wage, and the hourly wage is constructed as the ratio of the monthly wage and the hours of work, a model which perfectly resembles the characteristic of ours. Borjas shows that in that case, the coefficient of the log hourly wage, in our case, of the differenced homicide rate, is biased towards minus one as the measurement error becomes larger. In that case, the estimate becomes

$$\text{plim}\,\hat{\beta} = \frac{\sigma_h^2\beta - \sigma_v^2}{\sigma_h^2 + \sigma_v^2} \tag{4}$$

Where σ_h^2 is the variance of the true homicide rate, and σ_v^2 is the variance of the measurement error. Thus, in this setting, the estimate is a weighted average of the true coefficient and minus one. Levitt (1998) follows Griliches and Hausman (1986) to show that when the measurement error affects both the left-hand and right-hand side variables in a contemporaneous way, as it is our case, with panel data, the use of differentiation to remove the individual fixed effect makes the estimate to become

$$\text{plim}\,\hat{\beta}_j = \frac{\sigma_h^2\left(1-\rho^j\right)\beta - \sigma_v^2}{\sigma_h^2\left(1-\rho^j\right) + \sigma_v^2} \tag{5}$$

where the subscript j indicates that the panel model is estimated on the j^{th} differences, and ρ^j is the correlation between h_t and h_{t-j}. Here again, the estimate is a weighted average between the actual coefficient and minus one, although in this case the minus one is weighted more heavily for $0 > \rho^j > 1$.

In our case, the variable measured with error appears in both sides of the equation, but it is lagged j periods on the right side, in our case, about ten years. It is straightforward to show that in the more general case with serial correlation in the v_{it}'s and the u_{it}'s, so that $\text{Cov}(v) = \Sigma \otimes I_N$, and $\text{Cov}(u) = \Omega \otimes I_N$, $u_{it} = \rho u_{it-1} + \varepsilon_{it}$, where both Σ and Ω are T x T matrices with all diagonal elements assumed equal, the expression for the estimated β becomes in our case

$$p\lim\hat{\beta}_{dj} = \frac{\sigma_\varepsilon^2 \dfrac{1 + \dfrac{\beta}{(1-\beta)^2} + \rho^j + \dfrac{\beta}{K}}{\left(1-\beta^2\right)\left(1-\rho^2\right)}\beta - \dfrac{\sigma_v^2\left(1-r^j\right)^2}{2} - \sigma_\varepsilon^2 \dfrac{\left[\dfrac{1-\rho^j}{K} + \dfrac{\rho^{2j}}{\left(1-\rho^{2j}\beta\right)}\right]}{\left(1-\rho^2\right)}}{\dfrac{\sigma_\varepsilon^2}{\left(1-\beta^2\right)\left(1-\rho^2\right)}\left\{\left[1 + \dfrac{\beta}{(1-\beta)^2}\right] + \left[\rho^j + \dfrac{\beta}{K}\right]\right\} + \sigma_v^2\left(1-r^j\right)} \tag{6}$$

With $K = (1-\beta)(1-\rho^{2j}\beta)$. Here the bias has two main components, the first linked to the measurement error, v, and the second to the endogeneity of the lagged left hand side variable included on the right hand side of the equation, given the autocorrelation of the error term. The estimated coefficient, only under the presence of measurement error, would be again a weighted average, but in this case of the true β and minus $(1-r^j)/2$, where r^j is the correlation coefficient between v_t and v_{t-j}. Here in addition, we have another term that still biases more negatively the estimate.

Table 8 Panel with FE with Interactions (Education and Homicide Rate Lagged 10 Years), for Bogotá

Variables	PANEL_INTERAC_AVGc		PANEL_INTERAC_AVGd		PANEL_INTERAC_AVGe		PANEL_INTERAC_AVGf		PANEL_INTERAC_AVGg	
	coef	p-value	coef	p-value	coef	p-value	coef	p-value	coef	p-value
Effective Adolescent Fertility Rate (EAFR)	-5.633***	0.004	-5.760***	0.004	-5.507***	0.005	-5.605***	0.005	-5.522***	0.005
Unsatisfied Basic Needs (NBI)	-2.137	0.385	-2.160	0.381	-1.778	0.479	-1.886	0.458	-1.850	0.462
School Attendance Rate (Primary) (SAR(Primary))	4.419**	0.053	4.346**	0.060	3.214**	0.082	3.220**	0.082	3.268**	0.074
School Attendance Rate (Primary) (SAR(Secondary))	-2.771***	0.018	-2.584***	0.029	-2.975***	0.023	-2.868***	0.029	-2.944***	0.027
School Attendance Rate (Primary) (SAR(College))	-3.835***	0.018	-3.892***	0.018	-4.000***	0.018	-4.012***	0.018	-4.091***	0.012
Unemployment rate	-2.680	0.569	-3.361	0.480	-3.398	0.478	-3.315	0.489	-3.258	0.495
Minority ethnic rate	0.000	0.236	0.000	0.198	0.000	0.175	0.000	0.176	0.000	0.167
Schooling Rate	9.107	0.489	6.342	0.638	-9.918	0.615	5.558	0.674		
Share Residents (Born in Atlantico)	1.012	0.213	0.969	0.202	0.891	0.213	1.012	0.175	0.983	0.183
Share Residents (Born in East Zone)	1.034**	0.061	1.068***	0.047	1.068***	0.046	1.072***	0.047	1.085***	0.041
Share Residents (Born in Central Zone)	-0.443	0.680	-0.404	0.700	-0.473	0.641	-0.461	0.655	-0.477	0.642
Share Residents (Born in Pacific Zone)	3.288**	0.079	3.199**	0.077	3.413**	0.069	3.394**	0.069	3.392**	0.069
Share Residents (Born in Antioquia)	1.056***	0.047	1.046***	0.036	1.103***	0.032	1.117***	0.034	1.122***	0.032
Share Residents (Born in Valle)	-1.462	0.643	-1.222	0.678	-0.973	0.743	-1.029	0.731	-1.000	0.738
Share Residents (Born in S. A and P) (i)	-11.343	0.805	-12.863	0.774	-9.169	0.838	-12.415	0.783	-10.815	0.810
Share Residents (Born in Orinoquía Zone)	6.330	0.380	5.509	0.433	5.420	0.440	5.640	0.426	5.463	0.439
Share pop. 0-10	1.855	0.555	2.881	0.350	1.035	0.740	2.105	0.521	1.932	0.503
Share pop. 11-20	2.543	0.465	2.723	0.430	2.683	0.420	3.083	0.363	3.147	0.299
Share pop. 21-30	-6.304***	0.024	-5.674***	0.042	-5.892***	0.038	-5.850***	0.040	-5.834***	0.040
Share pop. 31-40	-2.873	0.261	-2.240	0.373	-2.637	0.328	-2.080	0.407	-2.291	0.349
Difference Men-Women 0-10 years	-6.134	0.392	-5.176	0.465	-4.199	0.559	-4.775	0.497	-4.794	0.503
Difference Men-Women 11-20 years	1.755	0.783	3.283	0.593	3.037	0.634	3.554	0.574	3.332	0.588
Difference Men-Women 21-30 years	-1.223	0.858	-0.098	0.989	-0.126	0.985	0.292	0.966	0.016	0.998
Difference Men-Women 31-40 years	-14.135***	0.031	-13.076***	0.045	-12.210***	0.047	-11.886**	0.053	-12.310***	0.044
EAFR*[1-SAR(Secondary)_L10]*HR_L10	0.001***	0.013	0.001***	0.013	0.001***	0.015	0.001***	0.014	0.001***	0.013
Homicide Rate Lagged 10 years (HR_L10)	-0.763***	0.005	-0.745***	0.007	-0.732***	0.007	-0.740***	0.007	-0.739***	0.007
[1-SAR(Secondary)_L10]	0.018	0.979	-0.098	0.884	0.001	0.999	-0.039	0.953	-0.032	0.961
Education level 25					14.699	0.363			6.936	0.534
Household Head Women (HH Women)			3.310***	0.009	3.349***	0.009	3.292***	0.010	3.281***	0.008
Illiteracy Rate					-2.294	0.316	-2.057	0.382	-2.141	0.371
_cons	116.783	0.615	-2.353	0.992	161.019	0.474	133.110	0.565	121.014	0.564
Number of observations	843		843		843		843		843	
R2	0.497		0.504		0.507		0.506		0.506	
r2_0										
r2_b		0.138		0.137		0.136		0.136		0.137
r2_w		0.497		0.504		0.507		0.506		0.506
Log-Likelihood	-4,623.31		-4,617.49		-4,615.32		-4,616.04		-4,615.56	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

To correct for measurement error we instrument the homicide rates of 1993 and 1985 with those of 1985 and 1973 respectively. The results of the estimation that corrects for measurement error are reported in Table 9. Our triple interaction remains robustly positive across specifications, and additionally, our instrumented variable becomes insignificantly different from zero. The effective adolescent fertility, although still negative, is no longer robustly significant. The last two results might as well be driven by the relation between our effective adolescent fertility rate, and the lagged instrumented homicide rate, since now they become contemporaneous and thus, according to all our discussion from previous sessions, correlated. This might be preventing us from actually being able to reliably identify those coefficients.

To give an idea of the magnitude of the effect of our interaction variable on the homicide rate, we estimate de standardized coefficients of Table 9, and find that a one standard deviation increase in our triple interaction variable, would increase the homicide rate about 0.36 standard deviations, a very significant amount.

Table 9. Panel with FE with Interactions for Bogota and using IV for the 10 years lag of the Homicide rate

Variables	P_INTERAC_INST_FPOBb		P_INTERAC_INST_FPOBc		P_INTERAC_INST_FPOBd		P_INTERAC_INST_FPOBe	
	coef	p-value	coef	p-value	coef	p-value	coef	p-value
Effective Adolescent Fertility Rate (EAFR)	-3.996	0.424	-4.393**	0.087	-4.824	0.336	-4.331*	0.107
Unsatisfied Basic Needs (NBI)	-5.732	0.280	-2.846	0.284	-6.293	0.232	-2.133	0.463
School Attendance Rate (Primary) (SAR(Primary))	11.364*	0.106	3.050	0.273	10.895*	0.132		
School Attendance Rate (Primary) (SAR(Secondary))	-11.139***	0.032	-3.726***	0.024	-10.557***	0.040	-4.058***	0.028
School Attendance Rate (Primary) (SAR(College))	-2.421	0.377	-3.436	0.196	-1.451	0.573		
Household Head Women (HH women)	11.994***	0.029	8.426***	0.000	12.368***	0.023	7.965***	0.000
Illiteracy Rate	3.954	0.501	-3.258	0.353	4.330	0.479	-4.505	0.299
Unemployment rate	-7.779	0.417	1.463	0.769	-9.439	0.335	-0.614	0.900
Minority ethnic rate	0.000	0.553	0.000*	0.136	0.000	0.733	0.000	0.165
Education level 25	45.017	0.280						
Schooling Rate	-23.201	0.640						
Share Residents (Born in Atlantico)	-1.584	0.316	0.754	0.363	-1.461	0.360	1.152	0.202
Share Residents (Born in East Zone)	-0.977	0.369	0.319	0.536	-1.052	0.326	0.250	0.624
Share Residents (Born in Central Zone)	8.607**	0.053	0.770	0.622	8.764***	0.048	0.445	0.750
Share Residents (Born in Pacific Zone)	5.463	0.306	4.429***	0.030	5.848	0.285	4.958***	0.031
Share Residents (Born in Antioquia)	0.611	0.771	1.113***	0.025	0.637	0.764	1.166***	0.017
Share Residents (Born in Valle)	-3.148	0.581	-1.771	0.581	-2.950	0.602	-2.476	0.421
Share Residents (Born in S. A and P) (i)	-109.248	0.197	-9.183	0.852	-119.736	0.159	-15.529	0.755
Share Residents (Born in Orinoquía Zone)	9.683	0.535	8.844	0.360	11.687	0.453	8.844	0.358
Share womenpop. 0-10	-3.852	0.681	-2.310	0.322	-1.526	0.860	-4.933**	0.068
Share womenpop. 11-20	-10.174	0.437	0.524	0.889	-12.544	0.278	0.127	0.973
Share womenpop. 21-30	11.721**	0.090	2.491	0.464	11.384**	0.084	2.802	0.398
Share womenpop. 31-40	8.236	0.311	5.128**	0.079	7.810	0.210	8.308***	0.039
Difference Men-Women 0-10 years	46.881**	0.078	17.415*	0.117	45.769**	0.085	18.578*	0.129
Difference Men-Women 11-20 years	18.972	0.264	9.876	0.343	21.679	0.215	10.232	0.363
Difference Men-Women 21-30 years	16.863	0.198	0.998	0.901	18.359	0.160	3.209	0.673
Difference Men-Women 31-40 years	-13.729	0.561	-5.382	0.483	-8.715	0.679	-2.133	0.770
EAFR*[1-SAR(Secondary)_L10]*HR_L10(Predicted)	0.000***	0.000	0.000**	0.059	0.000***	0.000	0.000**	0.051
Predicted Homicide Rate lagged 10 years (HR_L10(Predicted))	-0.414*	0.119	0.021	0.586	-0.417*	0.111	0.006	0.860
[1-SAR(Secondary)_L10]	-0.468	0.839	-0.407	0.659	-0.610	0.790	-0.041	0.961
_cons	-605.113	0.270	-98.457	0.650	-378.395	0.487	97.379	0.550
Number of observations	853		843		853		843	
R2	0.398		0.327		0.394		0.309	
r2_0								
r2_b	0.000		0.000		0.001		0.001	
r2_w	0.398		0.327		0.394		0.309	
Log-Likelihood	-5,397.80		-4,746.42		-5,400.45		-4,757.56	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

4. Accounting for the Spatial Dynamics of Crime

An important issue that we stood up in last paragraphs was the "spatial" effect of urban crime.[48] In order to capture this spatial effect, we estimate spatial autoregressive panel with fixed effects following Elhorst (2009). The spatial lag model posits that the homicide rate at a specific census sector is a function of the homicide rates of the other census sectors of the city weighted by a function of the distance to them. Thus, our previous model is now augmented with the **W***h* term, where **W** is a weighting matrix with zeros in its diagonal. The specification used takes the following form

[48] The Moran's *I*-static of the last regression, using different specifications for **W** which we detail later, is 0.42 with a *p*-value of 0.0023.

$$h_{it} = \delta \sum_{j=1}^{N} w_{ij} h_{jt} + X_{it}\psi + \mu_i + u_{it} \qquad (7)$$

Where h_{it} is the homicide rate for census sector *i* and time t, w_{ij} is de *i,j* element of the spatial weights matrix **W** (Describing the spatial arrangement of the homicide), and X_{it} are all the control variables used in last regression[49]. We use ML estimator proposed by Elhorst (2009) inspired in Anselin et al. (2006). Table 9 presents estimates of Fixed Effect Spatial Lag Model using the distance between the *x,y* coordinates of census sectors to construct the spatial weigh matrix and using the same specification that we use in the last regression, except that we use the age structure of women (*Share wpop. 0-10, Share wpop. 11-20, Share wpop. 21-30 and Share wpop. 31-40*) by census sector in order to avoid simultaneity problems with the age structure of men and homicide rates.[50]

Results presented in Table 10 are similar to those presented in the last regression. The interacted variable (one minus secondary school attendance rate lagged ten years interacted with "effective adolescent fertility" and the homicide rate lagged ten years (*EAFR*[1-SAR(Secondary)_L10]*HR_L10(Predicted)*) remains positive and significant at 5% in all of the specifications of the weight matrix. As previously expected, the 10 years lagged homicide instrumented rate becomes statistically non different from zero, coercing its former bias towards minus one.

We also find that sectors with high school attendance in secondary and college rates and with high proportion of middle-women-adult age have low homicide rates. In this model we find that the homicide rate does not increase with high share of migrants from other zones, except in some cases for the Orinoquia zone. Finally, the spatial lag variable is always positive and statistically significant, meaning that increases in the homicide rate in a specific census sector spills over its neighboring census sectors.

We also perform other estimations using different configuration for the weigh matrix and find similar results from those presented in Table 10, in all cases finding that the interacted variable remain positive and significant at 5%, meaning that, census sectors with lower secondary school attendance rates, higher homicide rates ten years before, and higher adolescent fertility rates, have higher homicide rates.

[49] We use different specification to construct **W.** Specifically we construct the spatial weigh matrix using the distance between the x,y coordinates of census sectors, using a distance between 900 to 1500 meters, then we row-normalized the resulting matrix **W.** Other specifications that we use for **W** are the *n nearest neighbor*, *a row stochastic nearest neighbor* and r*ook and queen contiguity*.

[50] In the spatial lag model, stationarity requires that $1/w_{\min} < \delta < 1/w_{\max}$ where w_{min} and w_{max} denote the smallest and largest characteristic root of **W** matrix. For row-normalized spatial weights, the largest characteristic root is indeed +1, and the smallest bound is typically less than -1. (Elhorst, 2009). TableA3 and A4 present the results of estimates of Fixed Effect Spatial Lag Model using *n*-nearest neighbors and row-stochastic nearest neighbor to construct spatial weight matrix respectively.

Table 10 Fixed Effect Spatial Lag Model with Interactions (Education and Homicide Rate Lagged 10 Years), and Using IV for the 10 Years Lag of the Homicide Rate. Bogotá[51]

	W=800 mts		W=1000 mts		W=1500 mts	
Variable	**Coefficient**	**z-probability**	**Coefficient**	**z-probability**	**Coefficient**	**z-probability**
Effective Adolescent Fertility Rate (EAFR)	-3.68477	0.00280	-3.68490	0.00281	-3.67577	0.00601
Unsatisfied Basic Needs (NBI)	0.57944	0.49258	0.57622	0.49510	0.34317	0.70812
School Attendance Rate (Primary) (SAR(Primary))	0.32118	0.85869	0.31942	0.85950	0.20036	0.91852
School Attendance Rate (Primary) (SAR(Secondary))	-3.16600	0.00034	-3.16589	0.00034	-3.25530	0.00067
School Attendance Rate (Primary) (SAR(College))	-2.24230	0.00330	-2.24616	0.00325	-3.31362	0.00006
Education level 25	20.03294	0.11865	20.05825	0.11828	23.77225	0.08792
Household Head Women (HH Women)	6.19820	0.00000	6.20488	0.00000	6.85894	0.00000
Schooling Rate	-19.58748	0.24059	-19.61347	0.24010	-20.49898	0.25790
Illiteracy Rate	-5.49902	0.03574	-5.50178	0.03570	-6.59743	0.02023
Unemployment rate	4.88756	0.19201	4.89003	0.19190	5.19423	0.20140
Minority ethnic rate	0.00015	0.56306	0.00015	0.56320	0.00012	0.65875
Share Residents (Born in Atlantico)	0.51410	0.55307	0.51508	0.55241	0.55666	0.55408
Share Residents (Born in East Zone)	0.01811	0.96821	0.01808	0.96826	-0.03601	0.94179
Share Residents (Born in Central Zone)	0.72810	0.43758	0.72871	0.43732	0.88342	0.38556
Share Residents (Born in Pacific Zone)	2.95755	0.12992	2.96344	0.12927	3.68810	0.08177
Share Residents (Born in Antioquia)	1.80688	0.03392	1.80570	0.03409	1.57632	0.08810
Share Residents (Born in Valle)	0.81591	0.67390	0.81143	0.67567	-0.55441	0.79234
Share Residents (Born in S. A and P) (i)	6.55318	0.82591	6.52713	0.82664	5.01368	0.87678
Share Residents (Born in Orinoquía Zone)	13.83636	0.00604	13.82533	0.00609	13.00862	0.01737
Share womenpop. 0-10	-3.71930	0.11104	-3.72212	0.11087	-4.26014	0.09228
Share womenpop. 11-20	-10.38429	0.01234	-10.38964	0.01232	-11.77163	0.00896
Share womenpop. 21-30	-1.48521	0.59534	-1.49105	0.59399	-2.61107	0.38966
Share womenpop. 31-40	-7.09643	0.04883	-7.10376	0.04866	-8.94667	0.02206
Difference Men-Women 0-10 years	15.10581	0.00023	15.12671	0.00023	19.30014	0.00001
Difference Men-Women 11-20 years	9.89817	0.04061	9.90304	0.04056	12.96479	0.01347
Difference Men-Women 21-30 years	5.23226	0.07997	5.23518	0.07988	6.49405	0.04554
Difference Men-Women 31-40 years	4.64593	0.34418	4.63793	0.34514	4.78753	0.36910
EAFR*[1-SAR(Secondary)_L10]*HR_L10(Predicted)	0.00020	0.04711	0.00020	0.04721	0.00018	0.09161
Predicted Homicide Rate lagged 10 years (HR_L10(Predicted))	0.11335	0.37525	0.11348	0.37483	0.12948	0.35079
[1-SAR(Secondary)_L10]	-0.35280	0.45127	-0.35279	0.45140	-0.41546	0.41370
W*dep.var.	0.43000	0.00000	0.42899	0.00000	0.32699	0.00000
Number of Observations	786		786		786	
R2	0.8052		0.8051		0.7706	
Log-Likelihood	-4361.6907		-4361.4126		-4404.3375	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Pro

5. Discussion

The robustness of our results can still be subject to additional tests. Here we will mention some issues that can be considered in future work, and provide a preliminary analysis of how they might be affecting our results.

A first issue that arises is related to our empirical analysis, which does not include among the explanatory variables the homicides arrest rate. As it is explained by Levitt (1998), either through deterrence or incapacitation, homicides arrest rates might diminish the homicide rate. Whether that is the case in the case of Bogotá is an empirical question. Such question

[51] We perform Fixed Effect Spatial Lag Model (SAR), following Elhorst (2009) and the code provided by him.

was assessed by Sánchez et al. (2003), who estimate a model to explain the homicide rate in the city as a function of several controls including the homicides arrest rate. Their model specification is very similar to the one adopted by Levitt (1998), nonetheless, they argue that in order to eliminate the endogeneity of the arrest rate, they rather explain the homicide rate at *t* as a function of the arrest rate at *t*-1. They find that an increase in the level of the homicides arrest rate of 0.1, would reduce the homicide rate 1.8 percent.

Beyond the potential endogeneity that might still be present in the lagged homicides arrest rate, it is worth to assess how much their estimate would be subject to measurement error, and to what extent such potential problem might call into question the robustness of their result. We first represent a simplified version of their model as $\ln(Y_{it}) = \alpha_i + \beta \ln\left(\frac{A_{it-1}}{Y_{it-1}}\right) + \varepsilon_{it}$, where Y_{it} is the homicide rate, and A_{it} is the number of arrest. Under measurement error, we have that the observed homicide rate is a noisy signal of the true one, $Y_{it}^{*} = Y_{it}V_{it}$, where V_{it} is the measurement error. Expressing the log of the variables in lowercases, the model to estimate, under measurement error, becomes $y_{it}^{*} = \alpha_i + \beta a_{it-1}^{*} + \beta v_{it-1} + v_{it} + \varepsilon_{it}$. Following a similar procedure to the one presented by Levitt (1998), but now for the case of Sánchez et al. (2003), we find that under measurement error their estimated coefficient would be

$$p\lim b_w = -\frac{\left[\sigma_{a-y}^2 - \frac{2\sigma_{a-y}^2}{T(T-1)}\sum_{j=1}^{T-1}(T-j)\rho_j\right]\beta - \left[\sigma_v^2 - \frac{2\sigma_v^2}{T(T-1)}\sum_{j=1}^{T-1}(T-j)r_j\right]r_1}{\sigma_{a^*}^2 - \frac{2}{T(T-1)}\sum_{j=1}^{T-1}\left[\sigma_{a-y}^2(T-j)\rho_j - \sigma_v^2(T-j)r_j\right]} \quad (8)$$

Where b_w is the within estimator, $\sigma^2_{a\text{-}y}$ is the variance of the true homicides arrest rate, σ^2_v is the variance of the measurement error, ρ_j and r_j are the correlation coefficients of the true homicides arrest rates, $(a\text{-}y)_t$ and $(a\text{-}y)_{t\text{-}j}$, and the measurement error, v_t and $v_{t\text{-}j}$, respectively. Their estimated coefficient is then a weighted average of the actual coefficient and minus r_1, the correlation coefficient between v_{it} and $v_{it\text{-}1}$.

In light of the results presented above, which provide evidence of measurement error in the homicide rate, it seems then very likely that an exercise that corrected by measurement error could obtain a non statistically significant coefficient, implying that omitting the homicides arrest rates in our case, might not lead us to biased estimates. Note also that the bias leads to a coefficient that is more negative the higher the variance of the measurement error. Measurement error in the case of assaults larger than in the case of homicide rates would be consistent with Sánchez et al. (1998) results, which find a more negative coefficient of arrest rates in the case of assaults.

This does not mean that homicides arrest rates in Bogotá do not have any effect on homicide rates, but rather that identifying such effect might be a challenge for several reasons. An important reason is that unlike the case in which the units of analysis are the cities, here they are different neighborhoods of one city. Important longitudinal variations in the homicides

arrest rates for several neighborhoods might be consistent with constant homicides arrest rates in the whole city, and an increase in the homicides arrest rate in the city might be explained by the dismantling of important gangs in a few sectors of the city, having potentially a negligible effect on other sectors.

Another important issue is related to the endogenous choice of the place of residence by households. Although this issue is not absent from previous work like that by Donohue and Levitt (2001), it would be expected to be more important in our case, since households' mobility within a city is more likely to happen more often than between states. Still, analyses like the one by Donohue and Levitt (2001) are as well subject to the fact that households face incentives that might lead them to consider moving from one state to another. Changes in legislation, or existent social programs, are likely to imply changes in the incentives households face. Moffit (1992) review literature that shows that changes in welfare benefits offered by specific states might make low income potential beneficiaries move across them. Although work by Brueckner (2000) presents mixed evidence on this issue, more recent work by Fiva (2007) present evidence for Norway showing that potential welfare beneficiaries actually move across different local governments.

In the case of the United States, one could expect that programs like the Aid to Families with Dependent Children (AFDC), or the Temporary Assistance for Needy Families (TANF), would provide incentives for teen mothers or their families to move to the neighboring states with more generous components of those programs. In our case, people might move as well endogenously across municipalities, and within Bogotá, responding to their specific situations and incentives. The more important adolescent fertility could be for households to make their residential choices, the more difficult it would be to identify the effect of adolescent fertility on the homicide rate. Also, our ability to identify the effect of interest would be as well limited when the adolescents' characteristics that determine adolescent fertility are as well determinants of their residential choices.

Medina and Tamayo (2010) assessed the determinants of the probability of households changing of residence from one census sector to another, controlling for a battery of covariates that included the presence of young teen mothers in the household. They found that, in a range of 6 to 8 years, the probability to change of residence is not affected by the presence of an adolescent mother in the household. This probability was determined positively by the deficit of human capital, the marital status and the adolescent woman being not enrolled in social security; and negatively, by the marital status of her parents and their education.

They also found that the probability to move to a residence located in a census sector with a lower socioeconomic stratum was positively related to the absence of health insurance of adolescents in the household, and negatively related to the presence of an adolescent mother, the marital status of her parents, and the baseline socioeconomic stratum. When they assess the cases when households with adolescent women move to a better socioeconomic stratum, they found that this probability was not affected by the presence of an adolescent mother in the household.

Those results call for caution at the moment of getting to definite conclusions when interpreting our results. Accounting for the issues enumerated in this section is beyond the scope of this article and it is left for future work.

VI. Conclusions

We review previous work that form part of a vast literature that argues that children born from adolescent mothers are more likely to become criminals in the future, and test that hypothesis using data of neighborhoods of Bogotá.

We find that actually neighborhoods with (i) high effective adolescent fertility rates, (ii) low secondary enrollment, and (iii) high crime rates at the moment the children of their teen mothers become teenagers, are more likely to have higher homicide rates in the future, when those children reach their peak crime ages, estimated to be between 18 to 26 years old in violent cities of Colombia. We find that a one standard deviation increase in our triple interaction variable would increase the homicide rate about 0.36 standard deviations, a very significant amount.

Once controlling by our triple interaction variable that accounts for the effective adolescent fertility rate, and neighborhoods' schooling and crime rates, the effective adolescent fertility rate does not explain the homicide rate of the neighborhood, or if something, it becomes negatively related to it. Nonetheless, secondary enrollment keeps being negatively related to the homicide rate of the neighborhood. Thus, although secondary schooling reduces the neighborhoods' homicide rate across various specifications, we find that for the effective adolescent fertility rate to affect the homicide rate, it would be required to take place simultaneously with low secondary enrollment in the midst of a negative, in our case criminal, environment.

We did not find evidence that a high effective adolescent fertility rate could affect the neighborhoods' homicide rate when it was only coupled with a low secondary enrollment rate, without the concurrence of a criminal environment.

This result is consistent with anecdotic evidence according to which the most vulnerable youths in poor neighborhoods of the main Colombian cities are bound to be either recruited, or threaten and potentially punished, by criminal gangs. Whether youths in these cases drop out of schools because of the criminal environment they live in, or they become engaged in that criminal environment because they previously dropped out, is an open question we could not address.

Our results are robust to various specifications, including measurement error corrections, and the modeling of the spatial autocorrelation of the homicide rate.

VII. References

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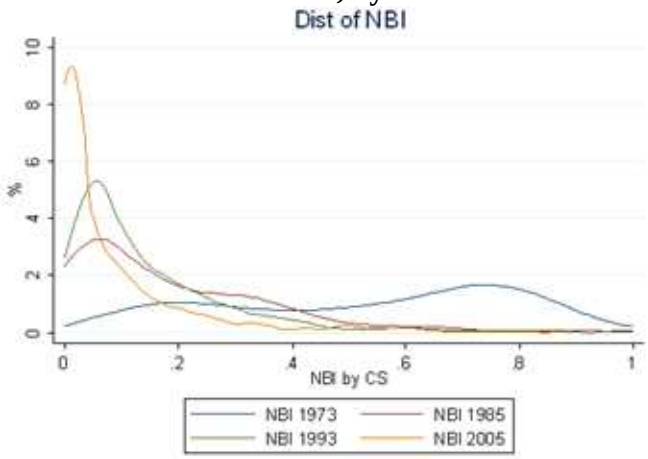
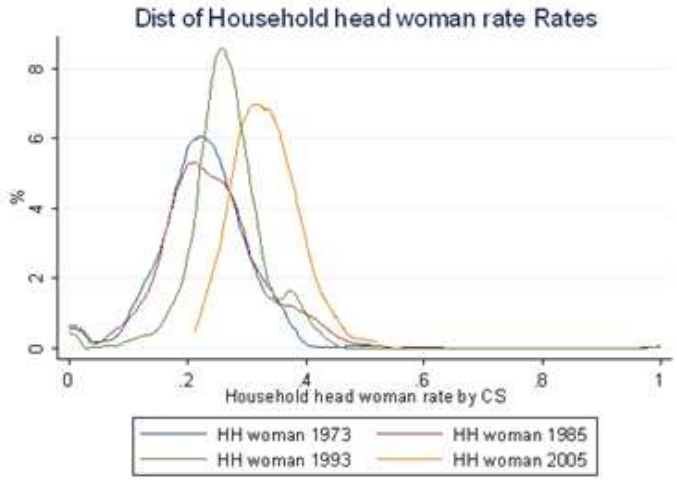
VIII. Appendix

Figure A1. Distribution of NBI, by Census Sector in Bogotá.



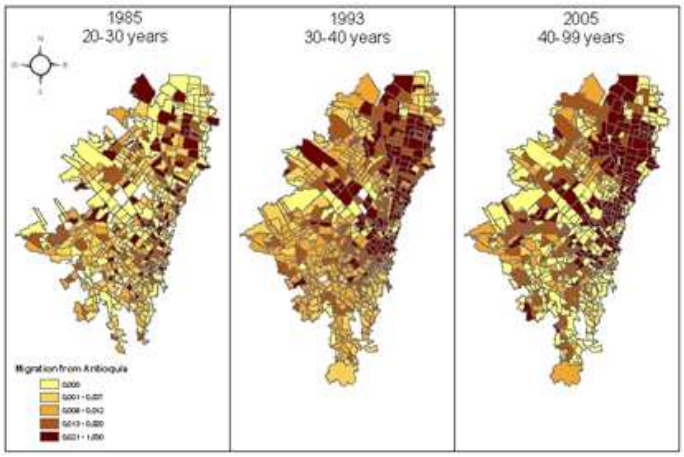
Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Figure A2. Distribution of the Share of Female Headed Households by Census Sector is Bogotá.



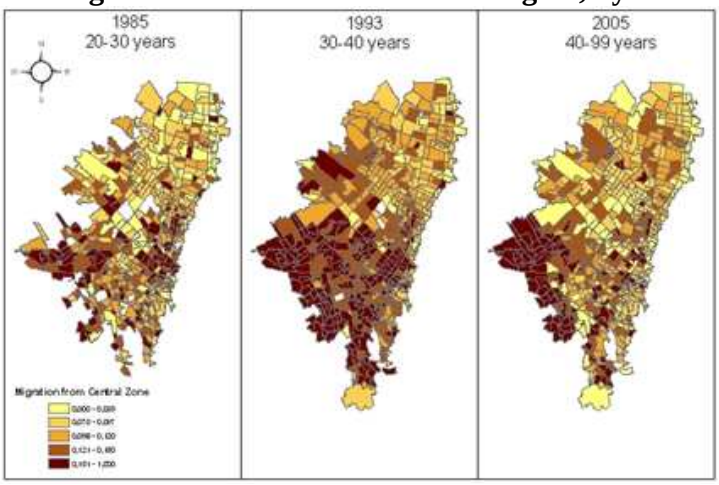
Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map A1. Migration from Antioquia to Bogotá, by Generation



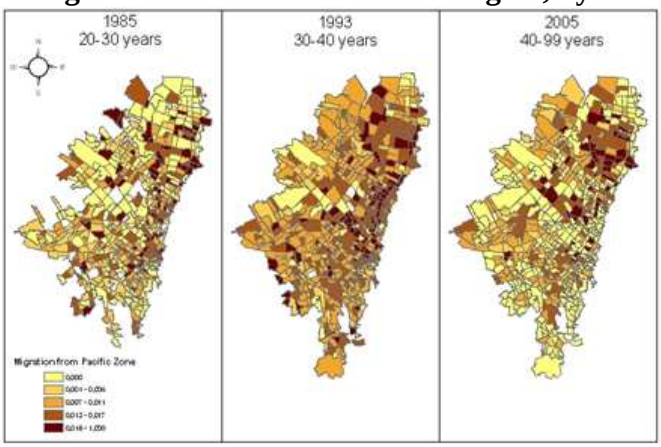
Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map A2. Migration from Central Zone to Bogotá, by Generation



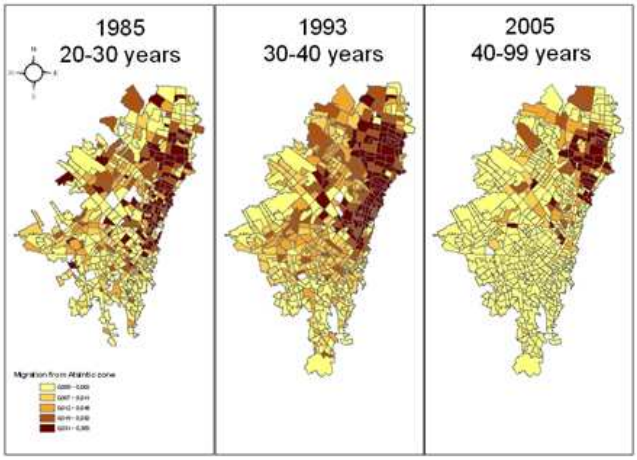
Source: 1973, 1985, 1993 and 2005 Population Census (DANE)

Map A3. Migration from Pacific Zone to Bogotá, by Generation



Source: 1985, 1993 and 2005 Population Census (DANE)

Map A4. Migration from Atlantic Zone to Bogotá, by Generation



Source: 1985, 1993 and 2005 Population Census (DANE)

Table A1. Panel with FE with Interactions using women age structure for Bogota

Variables	PANEL_INTERAC_FEd		PANEL_INTERAC_FEe		PANEL_INTERAC_FEf		PANEL_INTERAC_FEg	
	coef	p-value	coef	p-value	coef	p-value	coef	p-value
Effective Adolescent Fertility Rate (EAFR)	-7.036***	0.000	-6.906***	0.000	-6.904***	0.000	-6.805***	0.001
Unsatisfied Basic Needs (NBI)	0.849	0.738	1.213	0.640	1.213	0.640	1.106	0.669
School Attendance Rate (Primary) (SAR(Primary))	4.136**	0.070	2.862*	0.139	2.861*	0.136	2.647	0.151
School Attendance Rate (Primary) (SAR(Secondary))	-2.746***	0.028	-3.167***	0.019	-3.169***	0.018	-3.198***	0.019
School Attendance Rate (Primary) (SAR(College))	-3.009**	0.077	-3.067**	0.073	-3.067**	0.073	-2.890**	0.076
Unemployment rate	-2.154	0.664	-2.342	0.633	-2.340	0.636	-2.439	0.619
Minority ethnic rate	0.000	0.318	0.000	0.318	0.000	0.322	0.000	0.322
Schooling Rate	24.443**	0.084	23.195	0.252	22.901**	0.099		
Share Residents (Born in Atlantico)	0.867	0.243	0.920	0.205	0.919	0.209	0.821	0.250
Share Residents (Born in East Zone)	0.762	0.156	0.771	0.156	0.771	0.157	0.786*	0.146
Share Residents (Born in Central Zone)	-0.155	0.878	-0.160	0.875	-0.161	0.873	-0.209	0.834
Share Residents (Born in Pacific Zone)	2.500*	0.137	2.692*	0.128	2.692*	0.127	2.752*	0.120
Share Residents (Born in Antioquia)	0.682*	0.114	0.775**	0.096	0.775**	0.094	0.767**	0.095
Share Residents (Born in Valle)	-2.531	0.297	-2.321	0.345	-2.320	0.343	-2.184	0.376
Share Residents (Born in S. A and P) (i)	-0.509	0.990	1.209	0.976	1.259	0.975	3.846	0.923
Share Residents (Born in Orinoquía Zone)	5.619	0.435	6.060	0.400	6.054	0.402	5.929	0.408
Share womenpop. 0-10	-5.842***	0.022	-6.805***	0.007	-6.808***	0.007	-6.634***	0.007
Share womenpop. 11-20	-0.328	0.932	-0.891	0.812	-0.893	0.812	-1.570	0.673
Share womenpop. 21-30	-0.041	0.989	0.176	0.951	0.182	0.948	0.667	0.811
Share womenpop. 31-40	11.178***	0.002	11.444***	0.002	11.429***	0.001	9.949***	0.001
Difference Men-Women 0-10 years	8.448	0.249	9.552	0.195	9.562	0.183	10.301	0.162
Difference Men-Women 11-20 years	3.863	0.482	4.638	0.424	4.631	0.418	4.510	0.434
Difference Men-Women 21-30 years	3.619	0.591	4.077	0.532	4.066	0.542	3.309	0.617
Difference Men-Women 31-40 years	-7.908	0.374	-5.650	0.481	-5.655	0.485	-5.029	0.527
EAFR*[1-SAR(Secondary)_L10]*HR_L10	0.001***	0.003	0.001***	0.003	0.001***	0.003	0.001***	0.004
Homicide rate lagegd 10 years (HR_L10)	-0.820***	0.001	-0.817***	0.001	-0.817***	0.001	-0.802***	0.002
[1-SAR(Secondary)_L10]	0.568	0.472	0.688	0.369	0.688	0.371	0.742	0.334
Education level 25			-0.276	0.986			16.772*	0.140
Household Head Women (HH women)	4.129***	0.001	4.085***	0.002	4.087***	0.002	4.265***	0.001
Illiteracy Rate			-2.442	0.242	-2.447	0.259	-2.864	0.196
_cons	-322.169	0.176	-158.601	0.483	-158.518	0.482	-103.610	0.621
Number of Observations	843		843		843		843	
R2	0.515		0.5172		0.5172		0.5157	
r2_0								
r2_b	0.1339		0.1315		0.13152		0.1322	
r2_w	843		843		843		843	
Log-Likelihood	-4068.163		-4606.2447		-4606.245		-4607.614	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Table A2. Panel with FE with Interactions (Education and Homicide Rate Lagged 10 years) for Bogotá: Sensitivity to the Exclusion of Downtown Census Sectors

Variables	PANEL_SEN_a		PANEL_SEN_b		PANEL_SEN_c		PANEL_SEN_d		PANEL_SEN_e		PANEL_SEN_f		PANEL_SEN_g	
	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se
Effective Adolescent Fertility Rate (EAFR)	-5.617***	1.998	-5.662***	1.983	-5.422***	1.959	-4.376***	1.802	-4.172***	1.794	-4.412***	1.801	-5.884***	2.029
Unsatisfied Basic Needs (NBI)	-2.280	2.570	-2.062	2.419	-1.849	2.420	-1.862	2.251	-1.928	2.264	-1.799	2.353	-1.998	2.538
School Attendance Rate (Primary) (SAR(Primary))	4.382**	2.304	4.497***	2.284	4.739***	2.329	5.034***	2.388	5.151***	2.468	4.913***	2.467	4.595***	2.335
School Attendance Rate (Primary) (SAR(Secondary))	-2.748***	1.206	-2.716***	1.170	-2.910***	1.189	-3.300***	1.106	-3.623***	1.131	-3.100***	1.108	-2.580***	1.230
School Attendance Rate (Primary) (SAR(College))	-3.819***	1.629	-3.822***	1.619	-3.708***	1.618	-4.110***	1.682	-4.226***	1.828	-4.134***	1.759	-4.046***	1.658
Unemployment rate	-2.557	4.724	-1.888	4.623	-1.604	4.632	-0.349	4.155	-2.215	4.314	-0.974	4.115	-1.636	4.736
Minority ethnic rate	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Schooling Rate	8.667	13.476	10.059	13.024	10.719	13.045	11.910	12.906	12.615	13.075	12.937	13.442	10.950	15.119
Share Residents (Born in Atlantico)	0.960	0.807	0.921	0.794	0.672	0.735	0.579	0.683	0.653	0.691	0.236	0.633	0.913	0.812
Share Residents (Born in East Zone)	1.020**	0.549	1.035**	0.545	1.071***	0.541	0.902**	0.533	0.899**	0.546	0.896*	0.552	1.146**	0.666
Share Residents (Born in Central Zone)	-0.420	1.074	-0.378	1.067	-0.660	1.115	-0.226	1.063	-0.114	1.104	-0.553	1.174	-0.737	1.122
Share Residents (Born in Pacific Zone)	3.190**	1.828	3.242**	1.905	2.159	1.632	3.614**	1.975	3.735**	1.967	5.504*	3.489	3.113*	1.940
Share Residents (Born in Antioquia)	1.059**	0.543	1.139***	0.529	1.195***	0.513	1.092***	0.518	1.107***	0.533	0.560	0.510	1.127***	0.538
Share Residents (Born in Valle)	-1.567	3.169	-0.723	3.289	3.476	4.148	-2.154	3.192	-2.073	3.186	-2.286	3.040	-0.692	3.293
Share Residents (Born in S. A and P) (i)	-6.168	45.472	-34.660	41.419	-38.950	41.802	5.626	43.630	6.021	46.705	7.964	44.746	-34.897	42.072
Share Residents (Born in Orinoquía Zone)	7.459	7.452	8.056	7.073	7.823	7.483	-0.619	4.301	1.127	4.231	-2.827	5.166	7.982	7.448
Share pop. 0-10	1.876	3.224	1.789	3.123	1.566	3.114	2.846	2.800	2.450	2.893	3.160	2.835	2.182	3.412
Share pop. 11-20	2.606	3.507	2.292	3.463	2.893	3.504	1.712	3.448	1.486	3.478	1.660	3.452	2.313	3.906
Share pop. 21-30	-6.407***	2.772	-6.317***	2.763	-6.520***	2.711	-6.945***	2.666	-7.599***	2.829	-6.381***	2.640	-6.188***	2.898
Share pop. 31-40	-3.146	2.640	-2.853	2.561	-3.050	2.567	-2.750	2.604	-2.924	2.690	-2.123	2.681	-3.041	2.689
Difference Men-Women 0-10 years	-6.222	7.252	-6.718	7.138	-8.208	7.400	-8.479	6.949	-8.561	6.904	-6.555	6.814	-6.656	7.071
Difference Men-Women 11-20 years	1.257	6.596	3.533	6.241	3.379	6.457	6.150	5.536	6.902	5.738	7.090	5.865	3.486	6.373
Difference Men-Women 21-30 years	-1.015	6.814	-0.785	6.819	-0.835	6.925	-7.509*	4.764	-7.889*	4.831	-5.156	4.512	-0.638	6.819
Difference Men-Women 31-40 years	-14.770***	6.666	-14.576***	6.520	-14.949***	6.362	-15.573***	6.203	-15.819***	6.306	-14.787***	6.332	-15.035***	6.654
EAFR*[1-SAR(Secondary)_L10]*HR_L10	0.001***	0.000	0.001***	0.000	0.001***	0.000	0.001***	0.000	0.001***	0.000	0.001***	0.000	0.001***	0.000
Homicide Rate lagged 10 years (HR_L10)	-0.752***	0.277	-0.748***	0.274	-0.729***	0.290	-0.648***	0.269	-0.644***	0.267	-0.634***	0.272	-0.749***	0.275
[1-SAR(Secondary)_L10]	0.092	0.699	0.053	0.691	0.169	0.692	-0.448	0.578	-0.487	0.601	-0.303	0.580	-0.003	0.706
_cons	122.713	239.003	81.482	232.448	41.284	235.376	85.509	249.476	131.433	245.438	48.660	256.127	61.773	258.281
Number of observations	837		838		828		828		797		799		801	
R2	0.493		0.498		0.480		0.502		0.507		0.490		0.500	
r2_0														
r2_b		0.138		0.048		0.069		0.130		0.128		0.139		0.051
r2_w		0.493		0.498		0.480		0.502		0.507		0.490		0.500
Log-Likelihood	-4,591.49		-4,586.00		-4,529.76		-4,479.36		-4,321.32		-4,318.44		-4,398.02	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Table A3. Fixed Effect Spatial Lag Model with Interactions (education and homicide rate lagged 10 years), Using IV, and using *n*-nearest neighbors to construct spatial weight matrix, for Bogotá

	nn=3		nn=4		nn=6	
Variable	**Coefficient**	**z-probability**	**Coefficient**	**z-probability**	**Coefficient**	**z-probability**
Adolescent Fertility Rate (AFR)	-3.22124	0.00839	-3.67158	0.00325	-3.37883	0.00722
Unsatisfied Basic Needs (NBI)	0.74047	0.37650	0.85888	0.31503	0.84611	0.32612
School Attendance Rate (Primary) (SAR(Primary))	0.09399	0.95807	0.72377	0.69172	0.85022	0.64399
School Attendance Rate (Primary) (SAR(Secondary))	-3.15970	0.00030	-2.95547	0.00094	-3.03870	0.00073
School Attendance Rate (Primary) (SAR(College))	-3.43924	0.00001	-3.01900	0.00009	-3.23665	0.00003
Education level 25	14.66308	0.24918	14.12019	0.27712	14.78912	0.25880
Household Head women (HH women)	6.06263	0.00000	5.83358	0.00000	5.48639	0.00001
Schooling Rate	-8.88780	0.59120	-8.56592	0.61214	-7.14550	0.67478
Illiteracy Rate	-6.57551	0.01123	-5.66937	0.03232	-5.91649	0.02667
Unemployment rate	4.90403	0.18646	3.97834	0.29383	4.57333	0.23128
Minority ethnic rate	0.00015	0.54573	0.00019	0.46664	0.00017	0.49728
Share Residents (Born in Atlantico)	0.74123	0.38851	0.56764	0.51769	0.26409	0.76534
Share Residents (Born in East Zone)	-0.15565	0.72990	-0.02610	0.95477	0.01470	0.97472
Share Residents (Born in Central Zone)	0.87435	0.34707	1.06175	0.26342	0.66947	0.48423
Share Residents (Born in Pacific Zone)	2.83431	0.14297	3.29489	0.09542	2.89673	0.14592
Share Residents (Born in Antioquia)	1.64867	0.05085	1.63212	0.05830	1.62407	0.06162
Share Residents (Born in Valle)	1.01238	0.59841	-0.28802	0.88334	1.19236	0.54676
Share Residents (Born in S. A and P) (i)	-2.46728	0.93343	-14.04870	0.64135	-10.20116	0.73721
Share Residents (Born in Orinoquía Zone)	11.53441	0.02095	14.96752	0.00334	15.26863	0.00298
Share womenpop. 0-10	-3.96928	0.08568	-3.96410	0.09313	-4.01248	0.09178
Share womenpop. 11-20	-7.22342	0.07945	-8.63629	0.03988	-8.94962	0.03459
Share womenpop. 21-30	-1.83047	0.50939	-2.23108	0.43087	-2.46713	0.38762
Share womenpop. 31-40	-5.79158	0.10420	-5.57513	0.12560	-6.89427	0.06018
Difference Men-Women 0-10 years	17.69785	0.00001	18.19596	0.00001	17.29513	0.00004
Difference Men-Women 11-20 years	10.12761	0.03472	11.48434	0.01899	11.07790	0.02480
Difference Men-Women 21-30 years	4.81102	0.10461	5.73596	0.05837	5.78017	0.05854
Difference Men-Women 31-40 years	3.21844	0.50862	3.61574	0.46701	2.75463	0.58253
EAFR*[1-SAR(Secondary)_L10]*HR_L10(Predicted)	0.00021	0.03228	0.00022	0.02843	0.00023	0.02231
Predicted Homicide Rate lagged 10 years (HR_L10(Predicted))	0.10999	0.38525	0.07661	0.55368	0.07958	0.54165
[1-SAR(Secondary)_L10]	-0.80279	0.08386	-0.64409	0.17437	-0.52645	0.27071
W*dep.var.	0.43599	0.00000	0.47094	0.00000	0.52696	0.00000
Number of Observations	786		786		786	
R2	0.8085		0.8004		0.7957	
Log-Likelihood	-4355.1926		-4363.9214		-4372.8476	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Table A4. Fixed Effect Spatial Lag Model with Interactions (education and homicide rate lagged 10 years), Using IV, and using row-stochastic nearest neighbor to construct spatial weight matrix, for Bogotá

	nn=3		nn=5		nn=7	
Variable	**Coefficient**	**z-probability**	**Coefficient**	**z-probability**	**Coefficient**	**z-probability**
Adolescent Fertility Rate (AFR)	-3.42254	0.00900	-3.67053	0.00322	-3.25487	0.01055
Unsatisfied Basic Needs (NBI)	0.72760	0.41772	0.88357	0.30065	0.67959	0.43574
School Attendance Rate (Primary) (SAR(Primary))	0.76546	0.68961	0.74104	0.68435	0.94484	0.61179
School Attendance Rate (Primary) (SAR(Secondary))	-3.01186	0.00131	-2.95301	0.00093	-3.10378	0.00066
School Attendance Rate (Primary) (SAR(College))	-3.28782	0.00005	-3.00603	0.00009	-3.03532	0.00011
Education level 25	18.41248	0.17715	13.87072	0.28504	15.77098	0.23405
Household Head women (HH women)	6.09546	0.00000	5.78558	0.00000	5.75147	0.00000
Schooling Rate	-10.70136	0.54633	-8.23571	0.62545	-9.68363	0.57412
Illiteracy Rate	-6.26018	0.02435	-5.65436	0.03254	-6.00254	0.02628
Unemployment rate	5.70687	0.15158	3.94904	0.29674	5.21326	0.17748
Minority ethnic rate	0.00007	0.79146	0.00019	0.46439	0.00016	0.53085
Share Residents (Born in Atlantico)	0.19851	0.82945	0.56217	0.52116	0.25908	0.77228
Share Residents (Born in East Zone)	0.10734	0.82414	-0.02658	0.95387	0.15938	0.73420
Share Residents (Born in Central Zone)	0.55717	0.57625	1.06286	0.26227	0.53397	0.58138
Share Residents (Born in Pacific Zone)	2.97757	0.15128	3.26244	0.09827	2.19767	0.27572
Share Residents (Born in Antioquia)	1.48220	0.10159	1.63706	0.05720	1.72639	0.04961
Share Residents (Born in Valle)	1.95467	0.34317	-0.27595	0.88805	2.56748	0.19978
Share Residents (Born in S. A and P) (i)	-10.20408	0.74730	-14.19073	0.63752	-7.36581	0.81077
Share Residents (Born in Orinoquía Zone)	13.45626	0.01199	15.05469	0.00312	13.68947	0.00851
Share womenpop. 0-10	-3.95178	0.11102	-3.94985	0.09386	-3.55063	0.14038
Share womenpop. 11-20	-11.03319	0.01249	-8.57609	0.04101	-10.41103	0.01518
Share womenpop. 21-30	-2.56046	0.39139	-2.20500	0.43565	-2.37432	0.41195
Share womenpop. 31-40	-8.49615	0.02644	-5.50569	0.12985	-7.82124	0.03516
Difference Men-Women 0-10 years	16.73872	0.00012	18.10905	0.00001	16.01605	0.00015
Difference Men-Women 11-20 years	12.18938	0.01779	11.47702	0.01891	11.05417	0.02692
Difference Men-Women 21-30 years	6.90463	0.03033	5.72495	0.05851	6.58814	0.03319
Difference Men-Women 31-40 years	4.95490	0.34255	3.65131	0.46203	4.25102	0.40185
EAFR*[1-SAR(Secondary)_L10]*HR_L10(Predicted)	0.00021	0.04391	0.00022	0.02780	0.00022	0.03381
Predicted Homicide Rate lagged 10 years (HR_L10(Predicted))	0.10475	0.44056	0.07524	0.56025	0.09304	0.48066
[1-SAR(Secondary)_L10]	-0.37783	0.44785	-0.64849	0.17085	-0.34649	0.47368
W*dep.var.	0.54599	0.00000	0.47798	0.00000	0.52797	0.00000
Number of Observations	786		786		786	
R2	0.7799		0.801		0.7923	
Log-Likelihood	-4388.2547		-4363.761		-4373.2499	

notes: *** p<0.05, ** p<0.1, * p<0.15. (i) San Andres and Providence Islands

Table A5. Variables Definitions

Description	Variable
Adolescent fertility rate	AFR
Effective adolescent fertility rate	EAFR
Unsatisfied Basic Needs	NBI
School attendance rates in Primary	SAR (Primary)
School attendance rates in Secondary	SAR (Secondary)
School attendance rates in College	SAR (College)
Numbers of years of study for people with more than 25 years	Education level 25
Household head woman rates	HH Women
Schooling rates of all of the population.	Schooling Rate
Illiteracy Rate	Illiteracy Rate
Unemployment rate	Unemployment rate
Minority ethnic rate	Minority ethnic rate
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(Atlantico)** between twenty and thirty years old	Share Residents (Atlantico)
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(East Zone)** between twenty and thirty years old	Share Residents (East Zone)
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(Central Zone)** between twenty and thirty years old	Share Residents (Central Zone)
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(Pacific Zone)** between twenty and thirty years old	Share Residents (Pacific Zone)
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(Antioquia)** between twenty and thirty years old	Share Residents (Antioquia)
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(Valle)** between twenty and thirty years old	Share Residents (Valle)
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(San Andres and Providence Islands)** between twenty and thirty years old	Share Residents (San Andres and Providence Islands)
Share of residents (Who have lived for more than 5 years in that census sector) who born outside of Bogota **(Orinoquía Zone)** between twenty and thirty years old	Share Residents (Orinoquía Zone)
Share of the total population between 0-10 ten years	Share pop. 0-10
Share of the total population between 11-20 ten years	Share pop. 11-20
Share of the total population between 21-30 ten years	Share pop. 21-30
Share of the total population between 31-40 ten years	Share pop. 31-40

Share of the total women population between 0-10 ten years	Share wpop. 0-10
Share of the total women population between 11-20 ten years	Share wpop. 11-20
Share of the total women population between 21-30 ten years	Share wpop. 21-30
Share of the total women population between 31-40 ten years	Share wpop. 31-40
Difference between men and women average age, between 0-10 years	D1
Difference between men and women average age, between 11-20 years	D2
Difference between men and women average age, between 21-30 years	D3
Difference between men and women average age, between 31-40 years	D4
Effective adolescent fertility rate interacted with one minus secondary school attendance rate lagged ten years	EAFR*[1-SAR(Secondary)_L10]
One minus secondary school attendance rate lagged ten years, interacted with “effective adolescent fertility” and the homicide rate lagged ten years	EAFR*[1-SAR(Secondary)_L10]*HR_L10
Homicide rate lagged ten years	HR_L10
One minus secondary school attendance rate lagged ten years, interacted with “effective adolescent fertility” and the predicted homicide rate lagged ten years	EAFR*[1-SAR(Secondary)_L10]*HR_L10(Predicted)
Predicted homicide rate lagged ten years	HR_L10(Predicted)
One minus secondary school attendance rate lagged ten years	[1-SAR(Secondary)_L10]