Borradores de ECONOMÍA

The Cost of Avoiding Crime: The Case of Bogotá

Por:Alejandro Gaviria, Carlos Medina, Leonardo Morales y Jairo Núñez

No. 508
2008

BANCO DE LA REPÚBLICA
COLOMBIA

The Cost of Avoiding Crime: The Case of Bogotá*

Alejandro Gaviria
agaviria@uniandes.edu.co
Universidad de los Andes

Carlos Medina
cmedindu@banrep.gov.co
Leonardo Morales
lmoralzu@banrep.gov.co
Banco de la República de Colombia

Jairo Núñez
jnunez@cable.net.co
Centro Nacional de Consultoría

Abstract

We use hedonic price models to estimate the value households are willing to pay to avoid violent crime in the city of Bogotá. We find that households living in the highest socioeconomic level (stratum 6) pay up to 7.2% of their house values in order to prevent average homicide rates from increasing in one standard deviation. Households in stratum 5 pay up to 2.4% of their house values to prevent homicide rates from increasing. The results indicate the willingness to pay for security by households in Bogotá, and additionally, reveal that a pure public good like security, ends up creating urban private markets that auction security. These markets imply different levels of access to public goods among the population, and actually, the exclusion of the poorest. We find as well evidence of negative capitalization of the rate of attacks against life, and positive capitalization of the presence of police authority.

Keywords: Housing Demand, Crime, Illegal Behavior, Law Enforcement
JEL codes: K40, K42 and R21.

* We thank Alfredo Canavese for detailed comments of a previous version, and Ernesto Schargrodsky, Carlos Esteban Posada, and seminar participants of the *Conference on Crime, Institutions and Policies* of the NBER–LICIP Inter-American Seminar on Economics, and the *Seminario de Economía* at Bogotá and Medellín of the *Banco de la República de Colombia* for comments. The opinions expressed here are those of the authors and not of the *Banco de la República de Colombia* nor of its Board.

1. Introduction

Quantifying the costs of crime and violence is a useful exercise because it contributes to the quality of the public discussion about a fundamental problem, and because it helps policy makers both prioritize and design cost-effective policies to diminish the adverse effects of crime. The cost of violence is usually estimated based on health care expenditures and losses to national economies coming from (among other things) days away from work, law enforcement expenditures, and unrealized investments.[1]

Nonetheless, these estimations do not usually consider the cost posed by crime and violence to households within cities, in terms of both the different risks faced by them and the coping mechanisms used by them. Specifically, within a city, the variation of crime and violence rates across neighborhoods creates private markets that action security. Households often end up paying for security in the form of higher property and rental values.

There are two relevant issues concerning the *market* for neighborhood safety (the amenity under consideration in this paper) that one should consider. First, one must quantify the cost of this amenity to households. Second, one must identify the barriers this cost poses to most households. Even though many households are willing to pay to avoid crime, just a few are actually able to do it, thus making neighborhood safety (a supposedly pure public good) subject to private markets and therefore to exclusion.

In this paper, we study the aforementioned issues for the city of Bogotá, Colombia. We find that households living in the highest socioeconomic stratum (stratum 6) are paying up to 7.2% of their house values in order to prevent average homicide rates from increasing in one standard deviation. For their part, households in stratum 5 are paying up to 2.4% of their house values to prevent homicide rates from increasing. These results indicate the willingness to pay for security by households in Bogotá, and, additionally, show the emergence of urban private markets that auction security. These markets imply different levels of access to public goods among the population, and actually, the exclusion of the poorest.

We now proceed to describe the levels of crime in Colombia and some previous work on the topic. Then we describe our data and present the empirical methodology and identification strategy. Finally, we present the results and offer some general conclusions.

2. Crime in Colombia and Previous Work

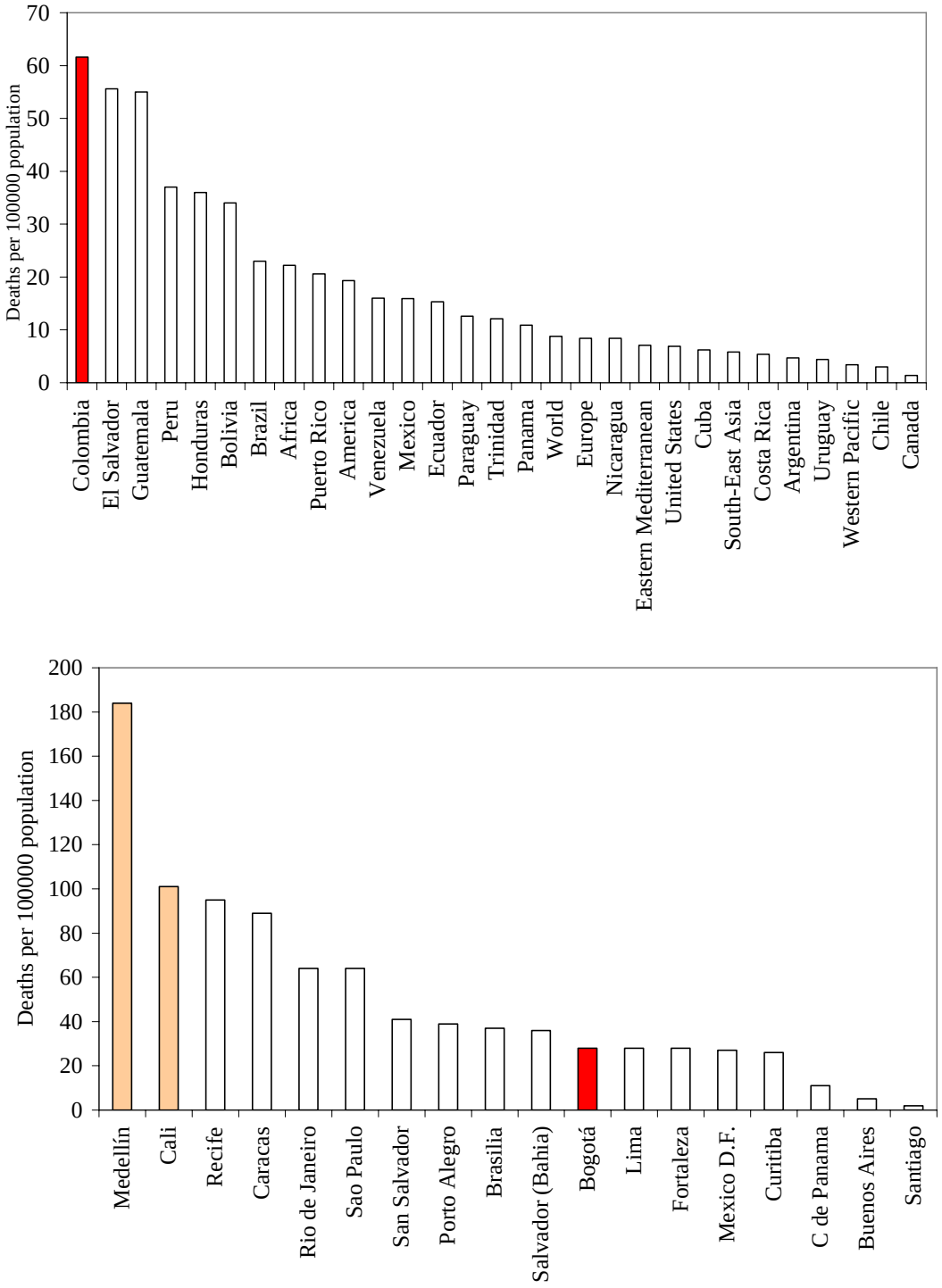
Figure 1 shows that in the late 1990s the homicide rate in Colombia was one of the highest in the Latin American and the Caribbean (LAC) region.[2] The Colombian rate was about six times as high as the average rate of the world and about three times as high as the average

[1] Other economic and personal costs are much less quantifiable, like the ones coming from the pain and suffering of victims of violence.

[2] Numbers shown in Figure 1 correspond to the late 1990s for the case of countries (top graph) and to 2002 for the case cities (bottom graph).

rate of the American continent. As of 2002, the homicide rate in the city is Bogotá was similar to that of other large Latin American cities, but it was lower than that of the most violent cities in the Colombia, Medellín and Cali. In recent years, the homicide rate in Bogotá has fallen precipitously (Llorente and Rivas, 2005).

Figure 1. Homicide Rates in LAC Countries and Cities



Source: Krug et al. (2002), Gaviria and Pages (2002), and Llorente and Rivas (2005).

There is a large literature about the overall costs of crime and violence (see Cohen and Rubio, 2007 for a recent review). For the case of the United States, Krug et al. (2002) argue that the costs of gunshot wounds are close to US$ 130 billion, whereas the costs of stab wounds are close to US$ 50 billion. For the United Kingdom, Atkinson et al. (2005) find that common, moderate, and serious assaults cost about £5,300, £31,000, and £36,000 per average victim household per year, respectively.

Among the studies seeking to estimate households' willingness to pay for security, Cohen et al. (2004) use a contingent valuation methodology to find that a typical American household is willing to pay between US$100 and US$150 per year for a crime prevention program that reduces specific crimes by ten percent. The said amount increases according to the severity of crime: US$104 for burglaries and US$146 for murders. Previously, Cook and Ludwig (2000) and Ludwig and Cook (2001) argued that the average household is willing to pay as many as US$200 per year in order to reduce gun violence caused by criminals and juvenile delinquents by 30%.

While studies that estimate hedonic price models have often included crime variables in the empirical estimations, the identification of causal effects of these variables has not been an explicit goal in most of the literature. Roback (1982) does not find a statistically significant coefficient of crime rates on log earnings.

For Colombia, the only previous attempt to quantify distributional effects of crime variables is that of Gaviria and Velez (2001). These authors find that rich households are more likely to be victims of property crime and kidnapping, to modify their behavior for fear of crime, to feel unsafe in the cities, and to invest in crime avoidance. The poorest are more likely to be victims of homicides and domestic violence. Other studies have focused on the overall economic cost of violence in Colombia. Trujillo and Badel (1998) estimate, for the early nineties, the gross cost of urban criminality and armed conflict in Colombia in 4.3% of GDP. Badel (1999) estimate, for the nineties, the gross direct cost of violence and armed conflict in 4.5% of GDP. Londoño and Guerrero (2000) estimate the *direct* cost of violence on health (medical attention and lost years of life) and material losses (public and private security and justice) in 4.9% of GDP for a subset of Latin American and Caribbean (LAC) countries, and 11.4% of GDP for the case of Colombia. Furthermore, Londoño and Guerrero (2000) also estimate the *indirect* costs of violence (i.e., the effect on productivity, investment, work, and consumption) in 9.2% of GDP for the same sample of LAC countries, and 13.3% of GDP for Colombia. These authors did not quantify the willingness of households to pay in order to avoid urban violence the way we do in this paper.

There also quite a few previous studies that investigate the spatial patterns of crime in Colombia in general and in Bogotá in particular. Núñez and Sánchez (2001) find statistically significant spatial correlation between assaults, auto thefts, residential, and commercial robberies. Similarly, Llorente et al. (2001) illustrate meticulously the spatial segregation of homicides in Bogotá, and, additionally, study its dynamics, finding that homicides are spatially very persistent; they take place mostly around the same places of the city with different degrees of intensity.

In what follows, we use the previous studies and provide some additional elements that, we believe, support the estimation strategy used in the calculation of the effects of homicide rates upon house values and rents. We describe the data used in the estimation before proceeding to present the methodology and the results of the empirical model.

3. Data[3]

Map 1. *Localidades* of Bogotá[4]

We use data at the household level taken from the *Encuesta de Calidad de Vida (ECV)* of 2003. The ECV is carried out every five years or so by the Administrative Department of National Statistics of Colombia, DANE.[5] The 2003 ECV (a LSMS survey) has detailed information about living conditions of households in Bogotá, with more than 12,000 households interviewed in all 19 sub city urban areas denominated *localidades* (See Map 1). The ECV was purportedly designed to compute employment and unemployment rates at the level of the locality. Within each locality, households were randomly selected. In each locality, households from each of the six different strata used in Colombia for targeting social programs were included.[6] Map 2 illustrates the location of the poorest and richest households in the city: the former live mostly in the northeast, and the latter mostly in the south and the periphery of the city.

We also use the 1993 Population Census data in order to collect information at the census sector level. This information allows us to split Bogotá into more than 500 sectors, with an average population of about 12,000 inhabitants per sector (See Map 3).[7] Most of the estimation is done at the level of the census sector.

[3] This section builds heavily on Medina et al. (2007).

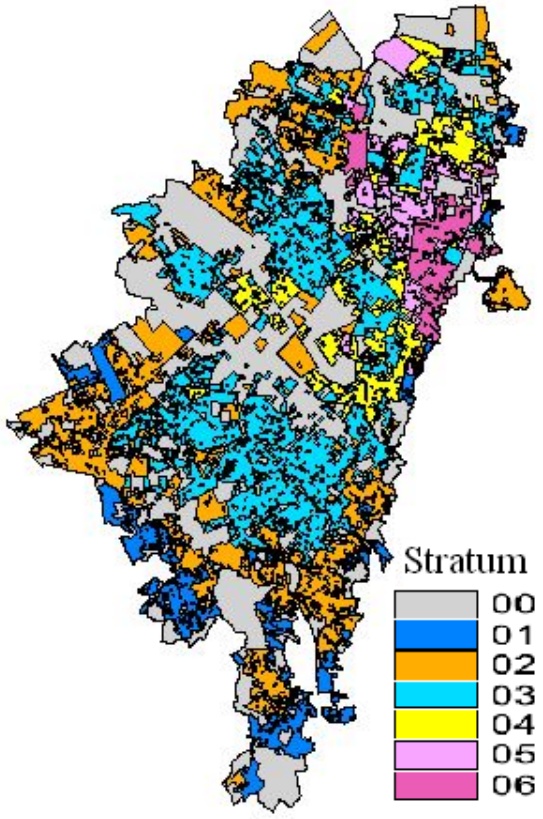
[4] The city of Bogotá is divided in 20 sub city urban areas (19 urban and one rural) denominated *Localidades*. We will use that denomination herein. See Medina et al. (2007) for a detailed description of the spatial data.

5 The survey was collected between June 6 and July 23 of 2003. Household members 18 and older were directly interviewed..

[6] Urban areas in Colombia are split into six socioeconomic strata: stratum one has the lowest socioeconomic level levels and stratum six the highest. The strata are used to target public service subsidies and other social programs (see Medina et al., 2007).

[7] Figures of the 2005 Colombia Population Census have not been made available yet.

Map 2. Socioeconomic Strata in Bogotá



Map 3. Census Sectors in Bogotá

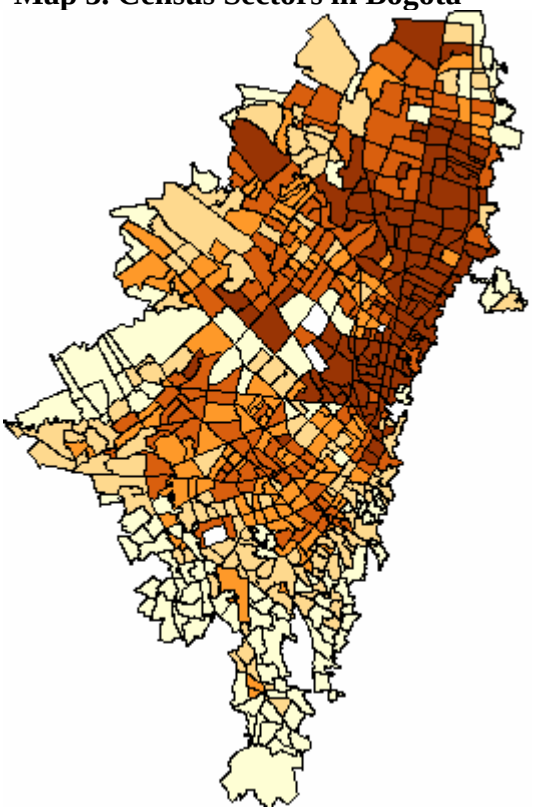


Table 1 presents all variables used in the estimation. Most households in Bogotá live in socioeconomic strata two and three (75%), and just about 6% in strata 5 and 6, and in stratum 1, respectively. Coverage of public utility services is very high in the city, with nearly 100% in electricity, and nearly 90% in fixed phone lines. We have cadastral data for nearly 70% of the households. Our variables related to crime include common thefts, aggravated assaults, residential and commercial robberies, auto thefts and homicides.[8] Figure 2 presents the distribution of the crime variables across census sectors. The figure shows that almost all distributions and in particular, those corresponding to common thefts (object thefts herein) and homicides are rather skewed. Figure 2 also presents the spatial distribution of the Police Centers of Immediate Attention, CAIS. This distribution has the same shape as the distribution of the crime and violence variables.

We have cadastral data on property values for close to 8,900 houses in Bogotá. In addition, we have the owner's reported values for households claiming ownership of the houses where they live. Reported rent prices are available for houses with tenant households (how much do you pay?) and for those living in their own house (how much would you pay if the house were rented?). Figure 3 presents the distribution of property values. The distribution of property values obtained using only cadastral data is similar to the one obtained when reported rent values are used to complement cadastral data.

[8] For the purpose of this study, we understand homicide as the activity by which one person kills another (Art. 323 Penal Code); attacks against life, as hurting someone's body or health (Art. 332 Penal Code); and objects theft as the act of subtracting someone else's goods for own benefit (Art. 349 Penal Code).

Table 1. Descriptive Statistics

Variable		N	Mean	Std. Dev.
Stratum 2		12,744	0.325	0.468
Stratum 3		12,744	0.434	0.496
Stratum 4		12,744	0.116	0.320
Stratum 5		12,744	0.030	0.170
Stratum 6		12,744	0.032	0.175
Cadastral House Value (as Opposed to Reported)		12,871	0.690	0.463
Number of rooms		12,771	3.37	1.52
Number of bathrooms		12,760	1.558	0.842
House with piped gas service		12,771	0.656	0.475
House with telephone		12,771	0.877	0.329
Good quality of electricity		12,746	0.899	0.302
Good quality of garbage collection		12,750	0.891	0.312
Water available 24 hrs a day		12,678	0.982	0.133
Water available every day of the week		12,771	0.967	0.178
Good quality of phone line		12,871	0.731	0.444
House with garden		12,771	0.419	0.493
House with court yard		12,771	0.046	0.210
House with garage		12,771	0.285	0.451
House with terrace		12,771	0.217	0.412
Parks in neighborhood		12,771	0.131	0.338
The house has suffered because of a natural disaster		12,771	0.046	0.209
House in area vulnerable to natural disasters		12,771	0.070	0.255
Factories in neighborhood		12,771	0.119	0.324
Garbage collector in neighborhood		12,771	0.030	0.172
Market places in neighborhood		12,771	0.070	0.255
Airport in neighborhood		12,771	0.037	0.188
Terminals of ground transportation in neighborhood		12,771	0.033	0.178
House close to open sewers		12,771	0.103	0.304
House close to high tension lines of electricity transmission		12,771	0.018	0.132
You feel safe in your neighborhood		12,771	0.680	0.466
Provision of water is inside the house		12,771	0.973	0.163
The kitchen is a individual room		12,771	0.960	0.195
Shower bath		12,771	0.974	0.160
House*		12,771	0.378	0.485
Walls material is any of: Brick, block, stone, polished wood		12,771	0.978	0.146
Floor material is any of: Marmol, parque, lacquered wood		12,771	0.084	0.277
Floor material is Carpet		12,771	0.133	0.339
Floor material is any of: Floor tile, vinyl, tablet, wood		12,771	0.595	0.491
Floor material is any of: Coarse wood, table, plank		12,771	0.054	0.227
Floor material is any of: Cement, gravilla, earth, sand		12,771	0.134	0.341
House with Toilet connected to the public sewerage		12,771	0.989	0.103
House with potable water service		12,771	0.985	0.120
Number of infantile shelters	♣	12,771	0.070	0.352
Number of asylums	♣	12,771	0.140	0.456
Number of convents	♣	12,771	0.260	0.888
Objects theft rate	♣	12,861	0.869	6.088
Assaults rate	♣	12,861	3.24	22.13
Residential and commercial assault rate	♣	12,861	2.99	9.23
Cars theft rate	♣	12,861	2.48	12.53
Crime rate	♣	12,120	0.538	0.668
Land use	♣	12,861	0.002	0.017
Attacks of FARC, ELN or other groups**	♣	12,871	0.232	0.422
Share of women heads of households	♣	12,861	0.275	0.051

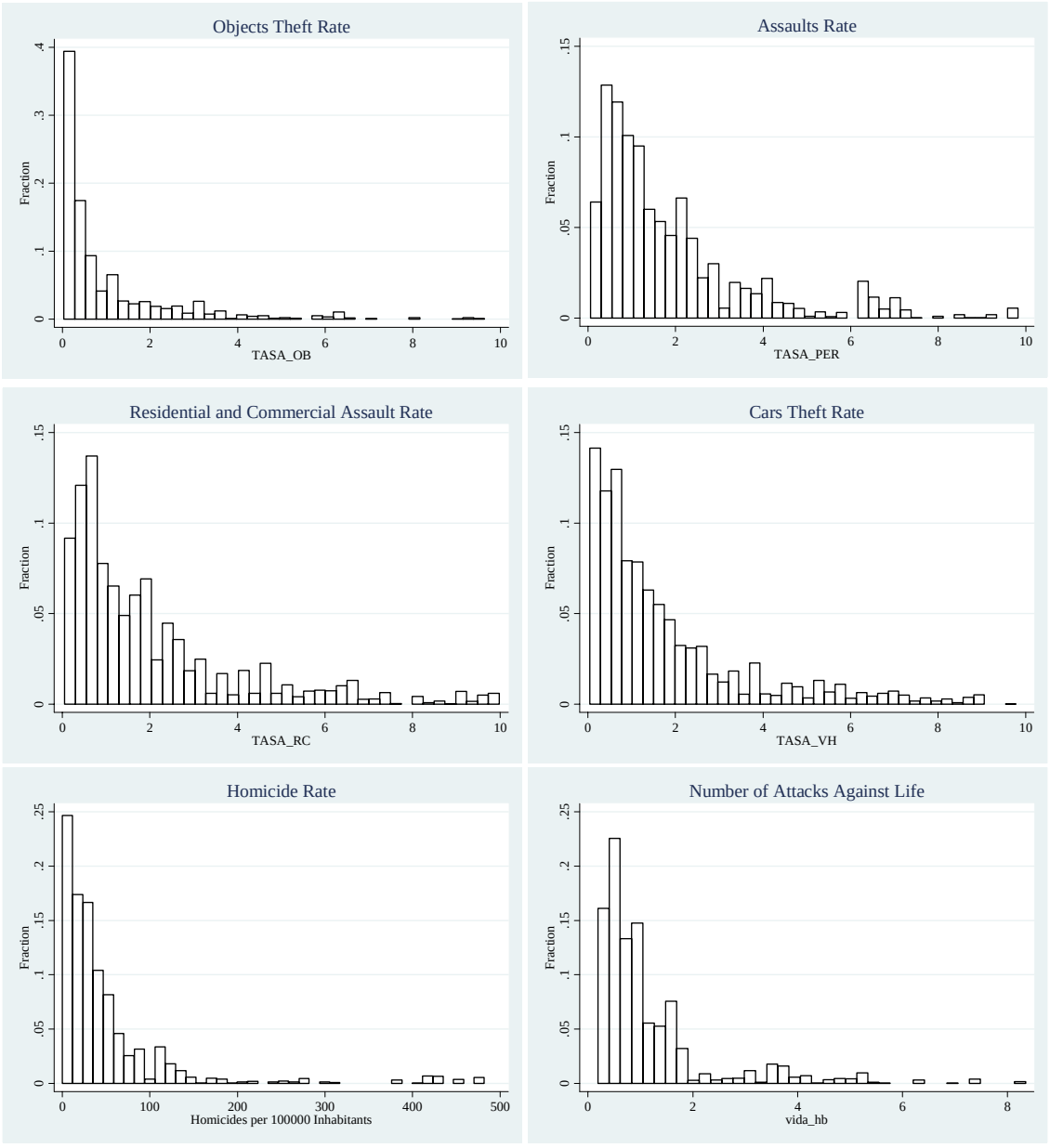
Table 1. Descriptive Statistics (Continuation)

Variable		N	Mean	Std. Dev.
Labor force Unemployment rate	♣	12,871	3.89	1.01
Illiteracy rate	♣	12,861	0.030	0.021
Average education	♣	12,861	8.365	1.896
Index of Quality of Life***	♣	12,871	82.12	7.09
Gini of education	♣	12,861	0.051	0.013
Number of CAIS****	♣	12,861	0.474	9.894
Number of medical centers	♣	12,861	0.281	1.476
Number of private hospitals	♣	12,861	0.243	1.384
Number of police headquarters	♣	12,861	0.241	17.64
Number of local security funds	♣	12,861	6.95	60.45
Number of public hospitals	♣	12,861	0.572	19.630
Number of religious centers	♣	12,861	1.12	3.45
Number of social welfare centers	♣	12,861	2.30	7.39
Number of cultural centers	♣	12,861	2.91	11.48
Number of prisons	♣	12,861	0.032	0.966
Number of attacks against life	♣	12,861	0.844	18.082
Number of attacks against wealth	♣	12,861	1.30	22.17
Number of bars	♣	12,861	1.179	18.727
Number of brothels	♣	12,861	0.630	17.689
Number of casinos/places for bets	♣	12,861	0.288	17.659
Number of places selling drugs/narcotics	♣	12,861	0.879	20.300
Number of people 0-4 years old	♣	12,771	1,183	980
Number of people 5-9 years old	♣	12,771	1,156	929
Number of people 10-14 years old	♣	12,771	1,168	910
Number of people 15-19 years old	♣	12,771	1,092	793
Number of people 20-24 years old	♣	12,771	1,211	890
Number of people 25-29 years old	♣	12,771	1,217	898
Number of people 30-34 years old	♣	12,771	1,132	814
Number of people 35-39 years old	♣	12,771	898	638
Number of people 40-44 years old	♣	12,771	696	499
Number of people 45-49 years old	♣	12,771	506	352
Number of people 50-54 years old	♣	12,771	413	270
Number of people 55-59 years old	♣	12,771	299	186
Number of people 60 + years old	♣	12,771	700	415
Unsatisfied Basic Needs (NBI): Dependency	♣	12,771	37.01	43.36
NBI: Accumulation	♣	12,771	418.35	410.15
NBI: Dropouts	♣	12,771	6.04	9.18
NBI: Public utility services	♣	12,771	37.71	76.72
NBI: Housing in	♣	12,771	69.09	97.20
NBI: NBI in Municipality where were born	♣	12,871	26.86	17.34
NBI: NBI in Municipality where were born	♣	12,871	0.097	0.296
Born in urban area		12,771	0.753	0.431
Share of women in household		12,771	0.535	0.268
Household with children		12,771	0.716	0.451
Age of mother minus age of oldest children		12,771	17.13	12.77
Logarithm of rent values		12,669	12.44	0.771
logarithm of cadastral house values		8,879	17.48	0.777
logarithm of cadastral or reported house values		10,845	17.50	0.792

Sources: *Encuesta de Calidad de Vida* 2003, Real State Appraisal of Bogotá, National Police-DIJIN 2000, Paz Pública (2000). Colombian 1993 Population Census.

* Dummy variable equal to one if house, zero otherwise (apartment, etc.). ** Dummy variable equal to one if there have been attacks in census sector by *Fuerzas Armadas Revolucionarias de Colombia*, FARC, *Ejército de Liberación Nacional*, ELN, or other groups. *** A-Theoretical estimation of QoL (See methodology in DNP, 1997). **** *Centros de Atención Inmediata*, CAIS: Centers of Immediate -Police- Attention. ♣ At the census sector level.

Figure 2. Distribution of Variables Related to Crime by Census Sector. Bogotá



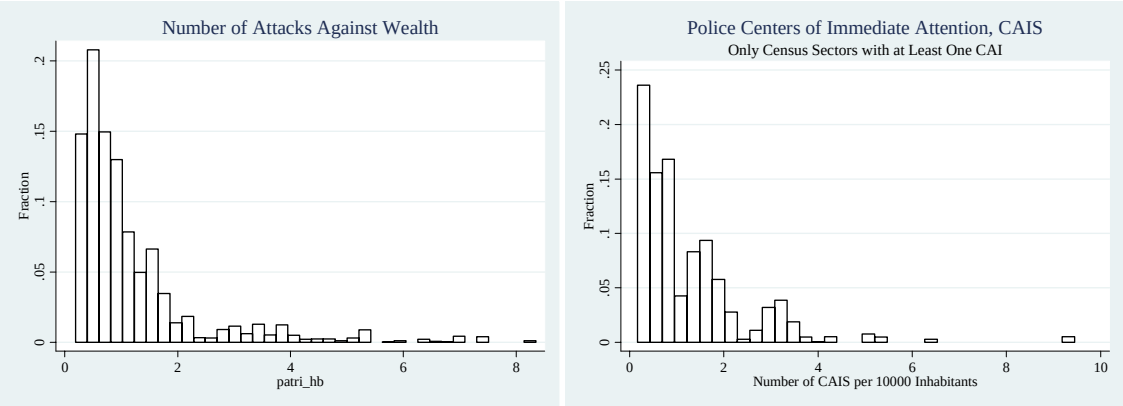
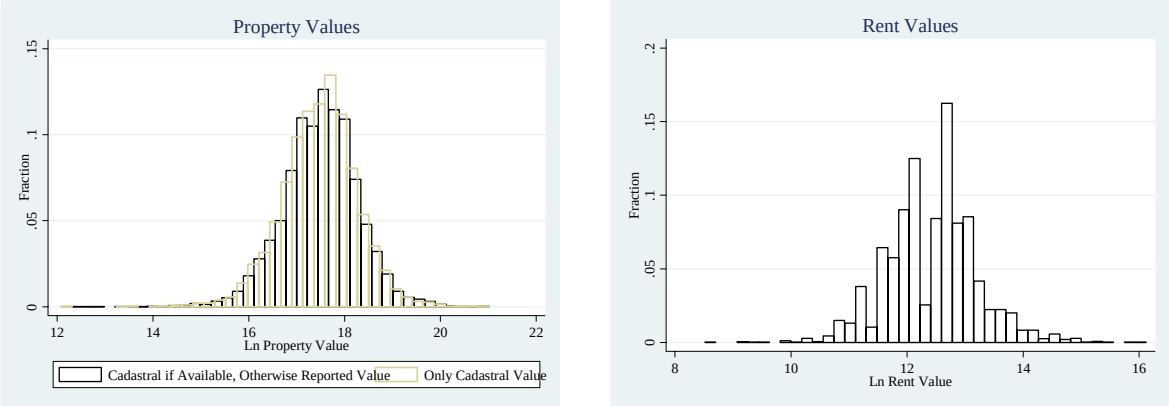


Figure 3. Property and Rent Values

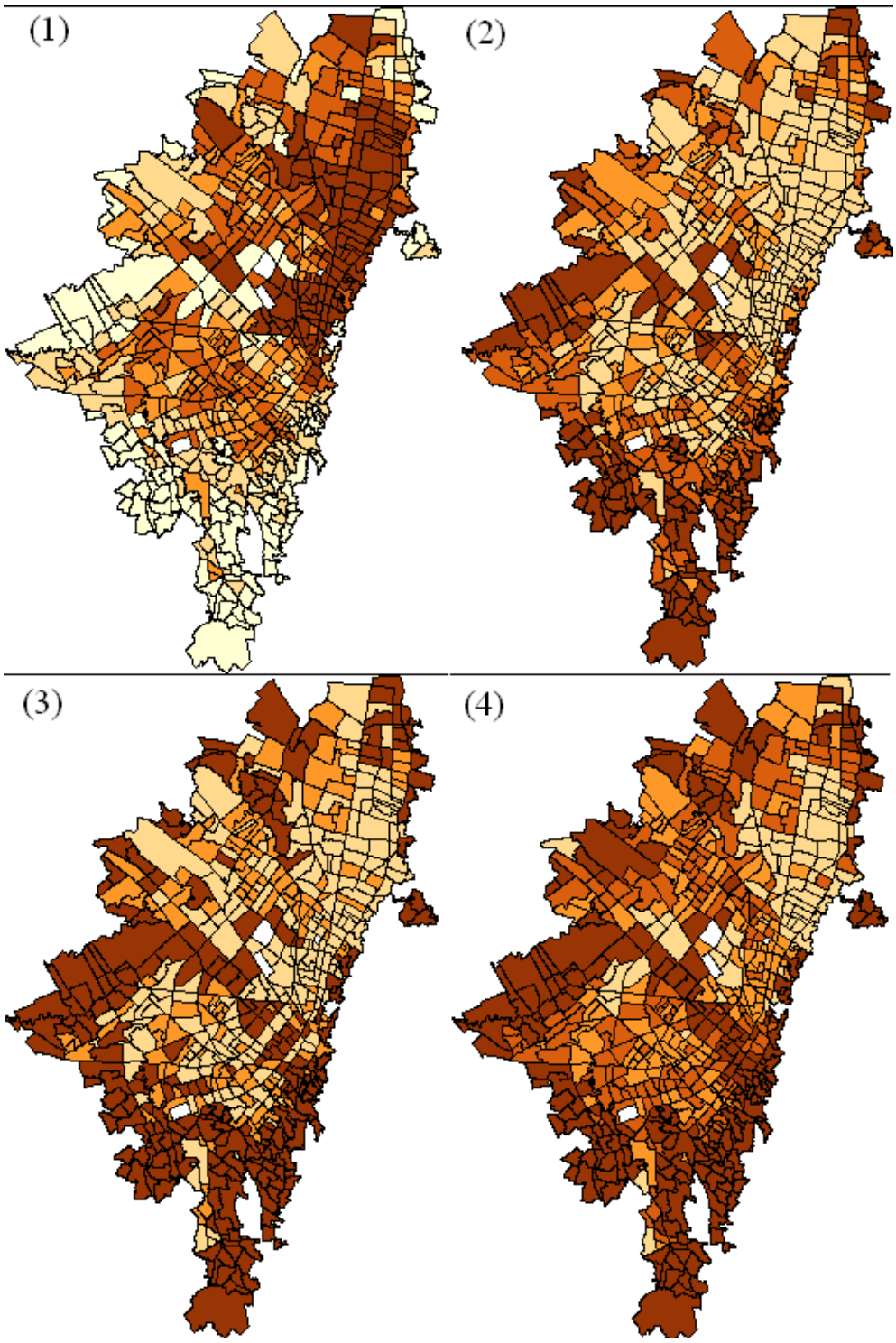


Map 4 complements the description of the spatial variation of quality of life in Bogotá (see Map 2). Four maps are presented. The first three depict the values by census sector of a different quality of life indicator; namely, an index of quality of life, ICV; and index of Unsatisfied Basic Needs, NBI; and a Misery Index, respectively (values were divided into quintiles to facilitate the graphical presentation). The fourth map shows the Gini coefficient of education, which measures the inequality in the distribution of the years of schooling in each census sector.[9] ICV, NBI and Misery indexes are highly correlated (the latter positively, the other two negatively) with the socioeconomic strata. Inequality in the distribution of education is higher in the poorest neighborhoods, which also suffer from higher rates of violent crime as well as from higher incidence of both attacks from guerrilla and other groups (See Map 5).[10]

[9] See details of the definition of the ICV in DNP (1997). The NBI index measures the share of households in a specific census sector that has at least one basic need unsatisfied: adequate housing, basic public utility services (water, sewerage, and electricity), economic dependency, primary school dropouts. The Misery Index is estimated as the share of households with at least two unsatisfied basic needs.

[10] See Fajnzylber, Lederman and Loayza (1998, 2000, 2002a, 2002b). These authors find a positive relation between income inequality and the homicide and robbery rates. A review of this regularity for Latin American and Caribbean Countries can be found in Heinemann and Verner (2006). For the Colombian case, Sánchez and Núñez (2000) find that inequality in land distribution is positively related to the homicide rate, although it explains just a small fraction of the cross sectional variation in the homicide rate.

Map 4. Quality of Life and Inequality Indicators[11]

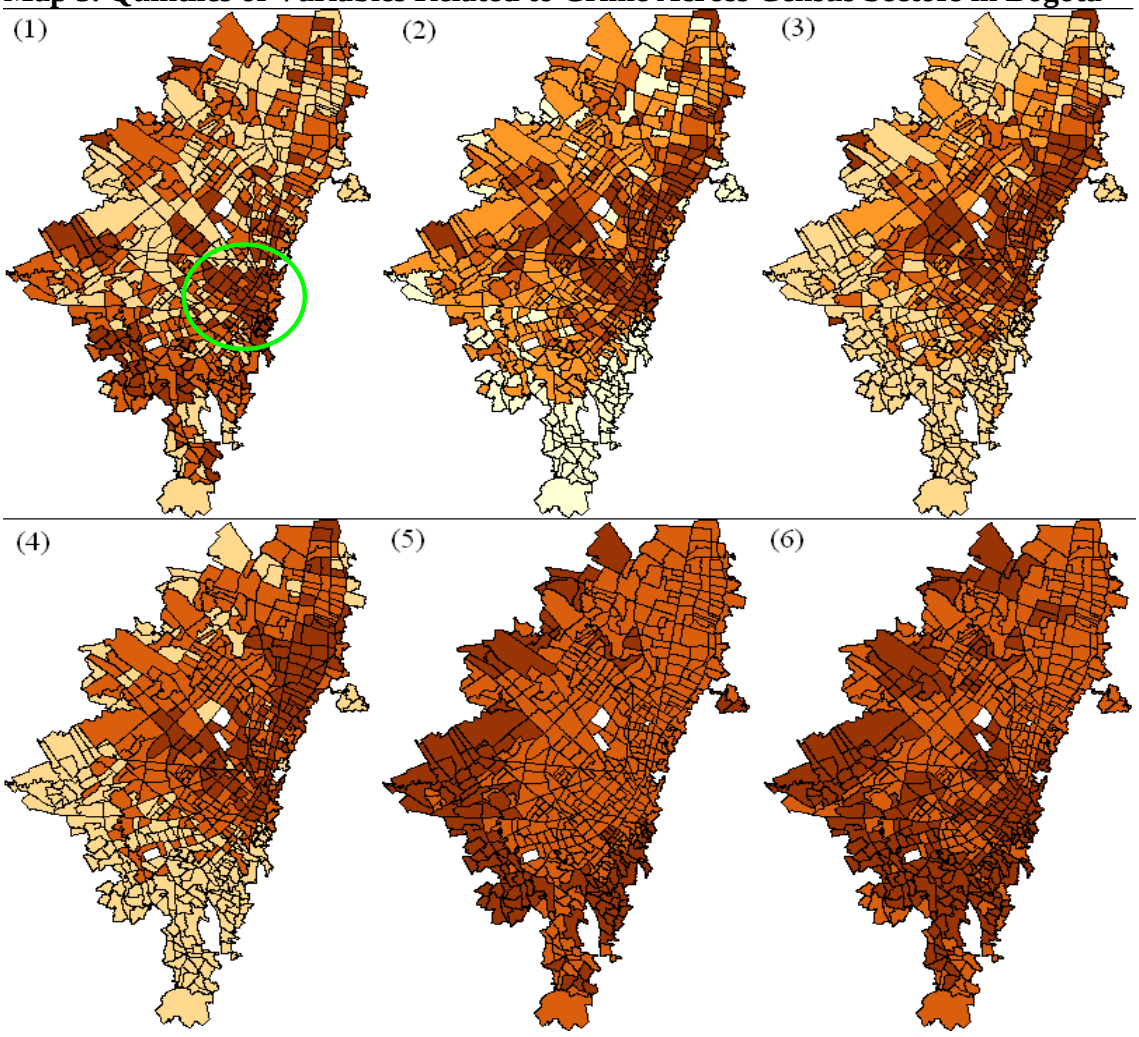


The darkest tones correspond to the highest quintiles. See sources in Table 1.
(1) ICV, (2) NBI, (3) Misery, (4) Gini coefficient of the years of education.

[11] Source: Medina et al. (2007)

We can now illustrate graphically the spatial correlation between quality of life indicators and crime variables. Map 5 illustrates the spatial patterns of crime variables at the census sector level (quintiles are also used). The circled area in the upper left map, which comprises downtown Bogotá, is the area with the highest homicide rate in the city. If we compare Maps 2 and 4 with Map 5, it becomes apparent that the highest assault, car, and object theft rates correspond to the highest stratum neighborhoods. On the contrary, homicides, guerrilla attacks, and attacks against life are all much more common in the periphery of the city, which is also much poorer. Spatial correlations suggested by the overlapping of the maps are consistent with the results found by Gaviria and Velez (2001).

Map 5. Quintiles of Variables Related to Crime Across Census Sectors in Bogotá[12]



The darkest tones correspond to the highest quintiles. See sources in Table 1.
(1) Homicide rates, (2) Assault rates, (3) Car theft rate, (4) Object theft rate, (5) Guerrilla attacks, (6) Attacks against life.

[12] Source: Medina et al. (2007)

3.1 Empirical Analysis

In this section, we present the empirical strategy and the estimation of the effect of crime and violence upon house values and rental prices. We estimate a hedonic regression model of the logarithm of house values on a battery of both household and *amenity* variables. The specification used takes the following form:

$$\ln(P_{ij}) = \alpha_0 + \alpha_1 H_i + \alpha_2 A_j + u_{ij} \quad (1)$$

where P_{ij} is either the value of the house (cadastral or reported by household) or the corresponding rental price (also reported by household), H_i is a vector of household characteristics, and A_j is a vector of amenities in census sector *j*. As customary in the literature, the model assumes that house values incorporate amenities, including access and quality of public goods and services (roads, parks and other green space, transport, security, etc.). In equilibrium, amenities would be capitalized into house values and rents.[13]

Table 2 presents the results of estimating equation (1) using three different dependent variables. First, the first variable takes the cadastral value of house if it is available, and takes the value reported by the household if it is not. In this case, we have up to 10,290 households in our sample. The second variable is restricted to the available cadastral values (8,435 observations). Finally, the third variable equals the rental values reported by households (12,024 observations). Each set of results contains both OLS and IV results. For all regressions, we estimate robust standard errors correcting for clustering at the census sector level.

We focus first on the OLS estimates. Overall, the reported estimates have the expected signs. As shown, property values increase for houses located in higher socioeconomic strata, for houses with better characteristics, including the number of rooms, the number of bathrooms, the availability of piped gas, the presence of parks in the neighborhood, the absence of open sewers, and so on. In the first panel, where cadastral values are used if available and reported values otherwise, we include a dummy variable equal to one if cadastral values are used, and to zero otherwise. The estimated coefficient on the dummy implies that cadastral values are on average 10.6% lower than the reported commercial values.

Regarding the crime variables, the common theft rate (object theft) is negatively related to house value. This variable is significant only when rent values are used (Panel 3). Homicides rates are negatively related to house values. Attacks by FARC, ELN and other groups are also negatively related to house rental values but the coefficients are hardly significant. On the other hand, residential and commercial assaults and car thefts are unrelated to house values. Finally, property crimes (attacks against wealth) are positively related to house values.

Although we expect all crime variables to be negatively related to house values and rents, there are several sources of endogeneity that can bias the results. On the one hand, if some

[13] See Rosen (1971, 1974, 2002), Blomquist et al. (1982), Roback (1982, 1988), and Gyourko et. al. (1999), among others.

types of crime occur more often in better neighborhoods—as it is generally the case with property crime—omitted characteristics might be positively correlated with this type of crimes. For example, the coefficient of auto theft may be picking up some unobserved characteristics that make houses more expensive but also increase the probability of the crime in question. On the other hand, some crimes, like homicides or aggravated assaults, take place more often in poor neighborhoods because richest households are more likely to have much better security—not all of this is observed—, which should be already capitalized in house values and rents.

To minimize the endogeneity problem, we estimate equation (1) interacting the crime variables included in Table 2 with the socioeconomic strata.[14] Results are presented in Table 3 for the crime related variables. Once we include the interactions, the object theft rate reveals a pattern of negative capitalization as one moves from the lower to the higher strata. The higher the stratum, the higher the negative effect of theft upon house values. Other variables (assaults, residential and commercial assaults, and attacks by FARC, ELN and other groups) show no discernable relationship to house or rent values.

As shown in Table 2, households who report feeling safe in their neighborhoods pay less rent for their houses. This finding is replicated once interactions are included, especially for the higher strata. This result should be interpreted cautiously, however, because it might be driven by differences in perceptions between the richest and the poorest households: if the richest live in safer neighborhoods and yet they feel more unsafe than the poorest do, the coefficient would be capturing these differences in perceptions rather than the effect of greater security on capitalized house values.

The variable that measures the number of Centers of Immediate Attention, CAIS—an indicator of police presence—, which previously appeared positively related to house rents but not to house values, become positively and significantly related to house values when interactions are included in the specification.

Instrumenting the Crime Rate

In this section, we try to identify the capitalization effect of crime on house values and rents by using an instrumental variable approach. As always, finding a good instrument is the key aspect of this approach. In this case, we need a variable that (i) affects the decision of the household to live in a neighborhood with a determined crime rate, (ii) do not affect the value or rent of the house in a direct fashion.

[14] The variables "Cadastral", "You feel safe in Neighborhood", "Land use", "Attacks of FARC, ELN, or other groups", "Number of medical centers", "Number of private hospitals", "Number of police headquarters", "Number of local security funds", "Number of public hospitals", "Number of religious centers", "Number of social welfare centers", "Number of cultural centers", "Number of prisons", "Number of attacks against life", "Number of attacks against wealth", "Number of bars", "Number of brothels", "Number of casinos/places for bets", "Number of places selling drugs/narcotics", "Number of people by age range", and the dummy variables of father's and mother's education levels and their interactions, are not interacted with the socioeconomic strata.

We use as instruments two variables related to the likelihood that the household head (or his spouse) is a teenage mother. Our instrument choice is based on the following rationale: (i) children of teenage mothers are more likely to become criminals; (ii) households harboring a teenage mother are more likely to live in neighborhoods with high crime and homicide rates; and (iii) house vales are not directly affected by teenage mother residence. If the previous rationale is true, then we can argue that our instrument is related to crime or homicide rates but not to the house value or rent.

The first element of our reasoning, namely that children of teenage mothers are more likely to become criminals, is supported by a wealth of evidence. For example, Krug et al. (2002) enumerated, among the many factors associated to violence in youths¸ the influence of families. These authors enumerate, in turn, parental conflict in early childhood and poor attachment between parents and children among the relevant family variables.[15] Households headed by teenage mothers are likely to be characterized by a family environment that includes all said factors. Furthermore, Krug et al. (2002) mention "**a mother who had her first child at an early age"** and "a low level of family cohesion" as important risk factors. In the same vein, Donohue and Levitt (2000) provide indirect evidence, for the United States, to the effect that children being born out of unwanted pregnancies are more likely to become criminals, and in particular, violent offenders. Hunt (2003) provides evidence, also for the United States, that children of teenagers are more likely to commit assaults later in their lives.

If children of teenage mothers are more likely to become criminals and their households are more likely to be poor, then it seems reasonable to expect that these households will sort themselves out in neighborhoods where youth crime is high. These high levels of crime tend to reinforce themselves through social interactions (another risk factor cited by Krug et al. 2002). Again, teenage mothers are more likely to inhabit a neighborhood with high crime and homicide rates. Of course, one could argue that teenage motherhood is related to socioeconomic level. But the point is that teen pregnancies should be related to violent crime rates even after controlling for several socioeconomic status variables.

As proxy variables for teenage mothers in a household or neighborhood, we use the difference between the age of the spouse of the household (or alternatively the age of the head if the household is female headed) and her oldest co-residing child. This variable is equal to the age of the woman at the time of her first childbearing when all their children live in their respective households at the moment of the survey; otherwise, the variable in question would be an upper bound of their age at their first childbearing. We also use the share of mothers between 13 and 19 on their respective census sector population.[16]

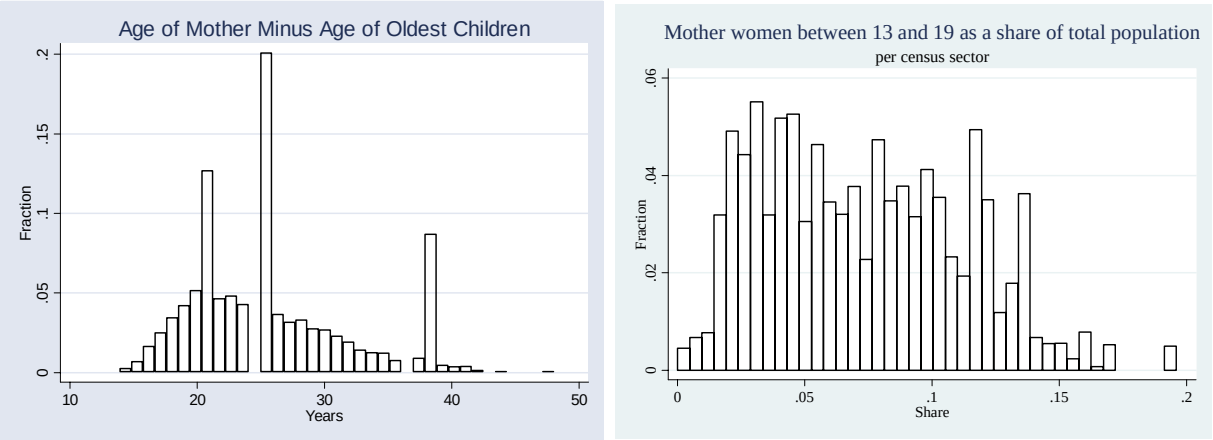
Figure 4 shows the distribution of the variables we use as instruments. Nearly 13% of households have a child that was born when his or her mother was between 13 and 19 years

[15] Other studies supporting the relationship between teenage motherhood and their children's likelihood to commit crime in the future are Farrington (1998), Morash (1989), and Nagin (1997).

[16] Note that if women were exactly half the population in each census sector, the share of mothers between 13 and 19 on total number of women in that age range would be twice as large.

old. The median of the share of young mothers is 0.07, and about 14% of young women are mothers.

Figure 4. Relative Frequencies of Instrumental Variables



Map 6 shows the quintiles of the homicide rate, and of the proxy variables used as instruments: the age difference between the oldest child and his/her mother, and the share of teenage mothers in the relevant census sector (quintiles are also used). As expected, the age difference variable is negatively correlated to the share of teenage mothers in the census sector. Map 7 shows that there is a high spatial correlation between the age difference and the share of teenage mothers in the census sector, and between these two variables and the quintiles of the homicide rate.

Map 7 presents the results of an exercises that computes local Moran I_i estimates by census sector for the three variables shown in Map 7.[17] To briefly illustrate how to read the map, we can use the example of the homicide rate. By construction, red sectors indicate the existence of a local cluster of census sectors with high homicide rates; dark blue census sectors indicates the existence of a cluster of census sectors with low homicide rates; light blue census sectors, the existence of a census sector with low homicide rate surrounded by sectors with high homicide rates; and orange census sectors, a census sector with high

[17] The **local Moran index** is used to identify spatial clusters and it is defined as

$$I_i = \frac{Z_i}{\sum_i Z_i^2 / N} \sum_{j \in j_i} W_{ij} Z_i$$

Where Z=[I-E(I)]/[V(I)]1/2~N(0,1), and is the **Moran index**

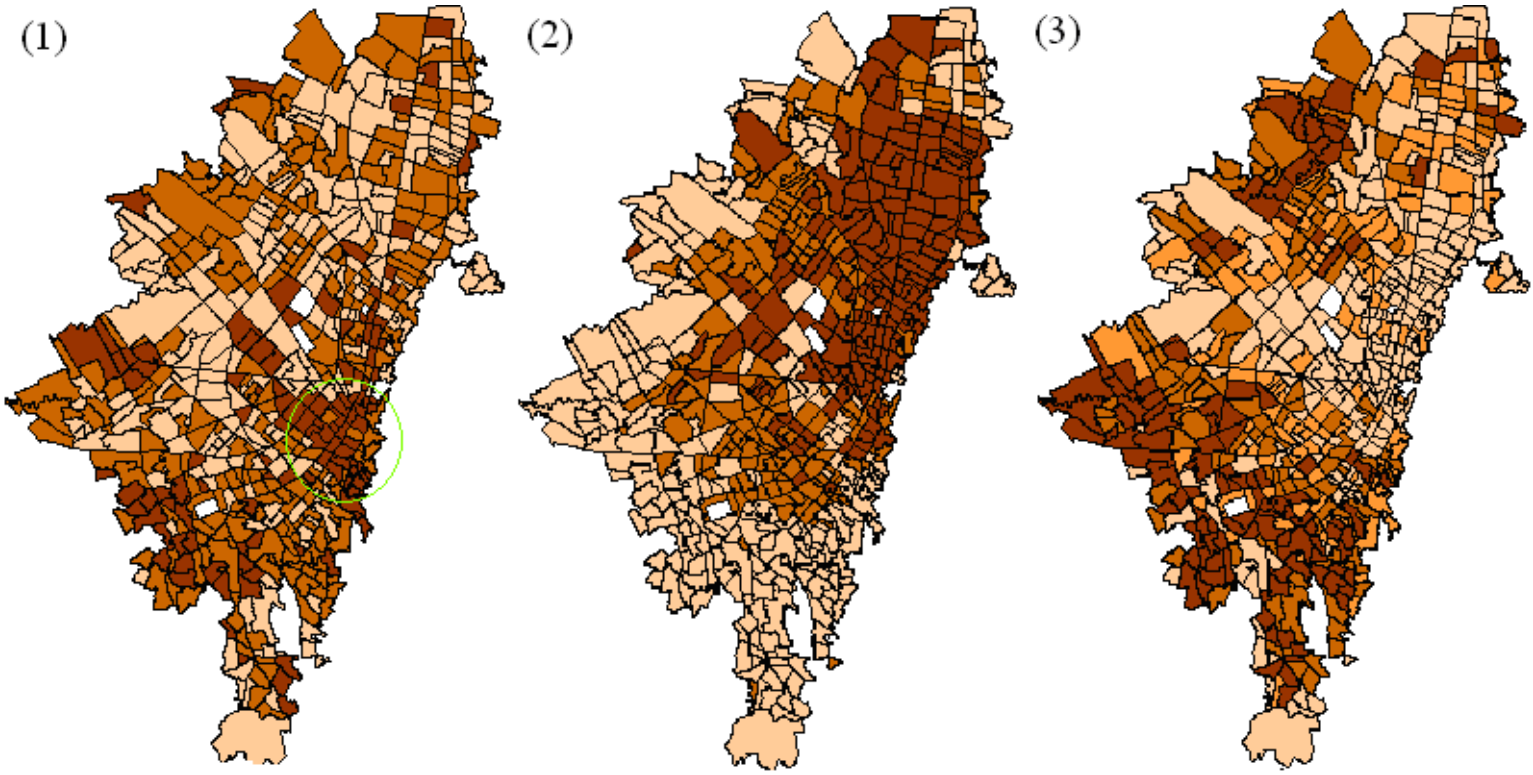
$$I = \frac{N}{S_0} \frac{\sum_{ij}^{N} W_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

where x_i is the variable of interest on which we are interested to test spatial correlation, W_{ij} is a matrix of weights, and $S_0 = \sum_i \sum_j W_{ij}$. Matrix W will be defined depending of the variable of interest, using immediate neighbors with their respective neighbors. Positive (negative) values of the I_i index imply the existence of similar (different) values of the phenomenon of interest around area i.

homicide rates surrounded by sectors with low homicide rates. When constructing the local Moran estimates, we compare the homicide rates at each census sector with those of its neighbors and with those of the neighbors of its neighbors.[18]

According to Map 7, there are only a few clusters with high homicides rates in the city, most of them located in downtown Bogotá (the circled area shown in Map 6). On the other hand, there is a wide area in the north of the city that exhibits a very low homicide rate. The other two maps, corresponding to the two instrumental variables used, confirm that the southern part of the city is characterized by clusters of women having children at a much younger age and also by a high incidence of teen pregnancies. The opposite is true for the northeastern area of the city.

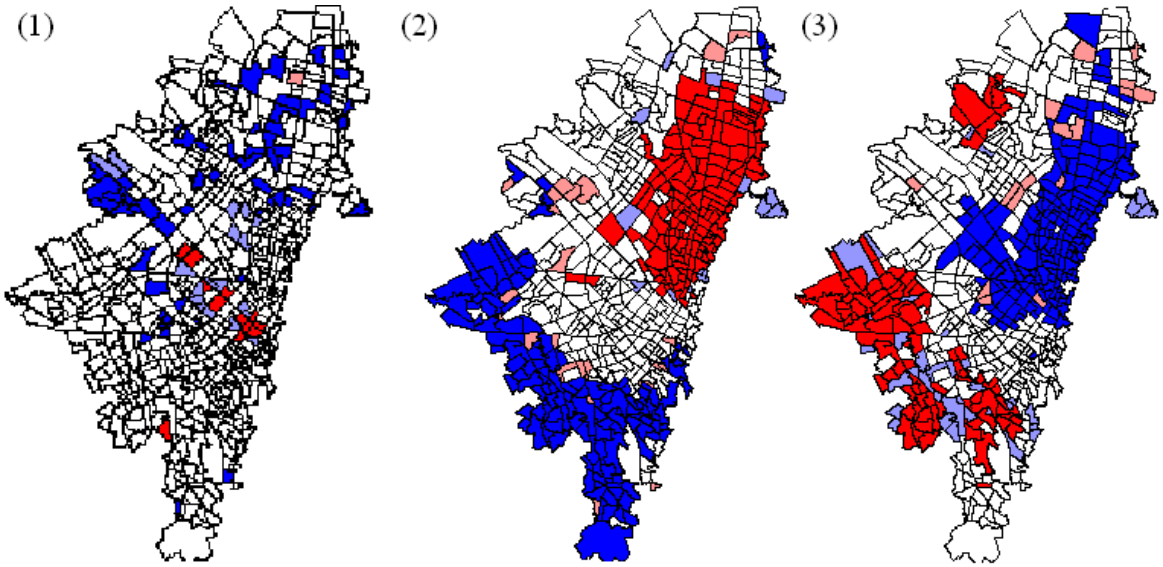
Map 6. Quintiles of Key Variables at the Census Sector Level



Quintiles: (1) homicide rate, (2) age difference: oldest child and mother, (3) rate of teenage mothers

[18] See Anselin (1988) and Moran (1948).

Map 7. Clusters of Key Variables at the Census Sector Level



Cluster: (1) homicide rate, (2) age difference: oldest child and mother, (3) rate of teenage mothers

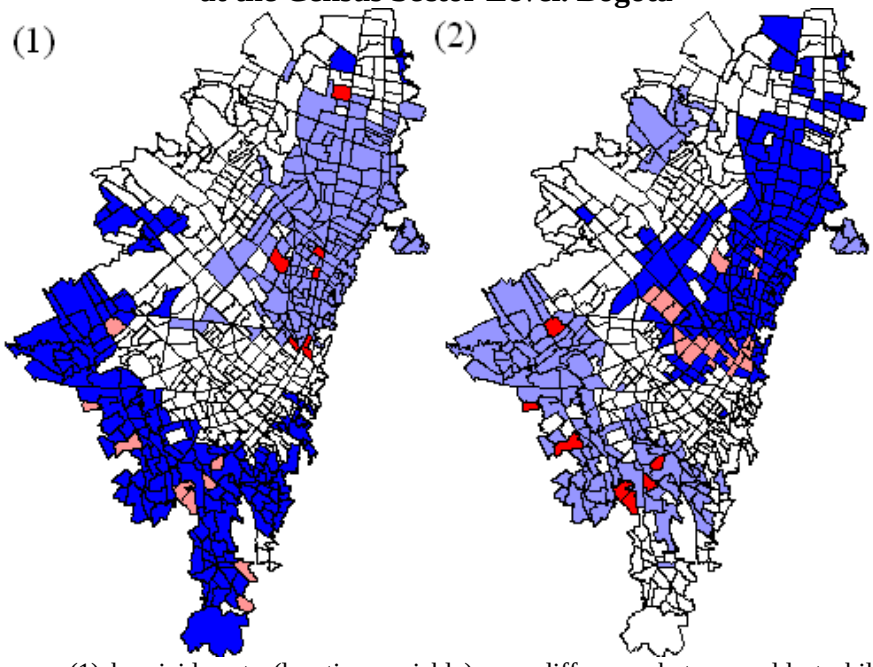
Map 8 presents the spatial covariance between our instrumental variables and the homicide rate at the census sector level. This map shows that our instrumental variables are significantly correlated to the homicide rate in the south and northeast of the city. Red census sectors indicate a cluster of census sectors with high values of our first instrument (age difference) or low values of our second instrument (share of teenage mothers), and high homicide rates; dark blue census sectors, a cluster with low values of our first instrument and low homicide rates; light blue census sectors, a cluster with low values of our first instrument and high homicide rates; and orange census sectors, the existence of a cluster with high values of our first instrument and low homicide rates. Results at the northeast of the city are evident: clusters of low homicide rates with high (low) age differences (share of teen mothers), meaning that the homicide rate is negatively (positively) spatially correlated to our first (second) instrument. This results show up as light blue areas in Map 8.1 and dark blue areas in Map 8.2. At the south of the city, we find some clusters of higher homicide rates with low (high) age differences (share of teen mothers), meaning that the homicide rate is spatially correlated to our instruments in some census sectors. This shows up as orange census sectors in Map 8.1 and red census sectors in Map 8.2.

The global spatial autocorrelation is 0.044 (*p*-value: 0.0302) between the share of teen mothers and the homicide rate, and -0.0254 (*p*-value: 0.2101) between the age difference and the homicide rate.[19] Finally, it is worth stressing that our choice of the instruments is

[19] Our $W(\cdot)$ is built using the closest neighbors and their closest neighbors. Results for the share of teen mothers are very robust to the $W(\cdot)$ chosen, although those for the age difference are more sensible. When we perform simple averages among the 4 closest neighbors the spatial correlations become -0.0526 (*p*-value: 0.0132) and -0.0310 (*p*-value: 0.1375) for the spatial correlations between the homicide rate and the share of teen mothers and age difference variables respectively.

based on the assumption that individuals commit a good part of their crimes in the neighborhoods where they live (i.e., we assume that, in a particular neighborhood, the residence of criminals is associated with the incidence of crimes).

Map 8. Spatial Covariance between Instrumental Variables and the Homicide Rate at the Census Sector Level. Bogotá



Cluster covariance: (1) homicide rate (location variable), age difference between oldest child and mother (average of neighbors), (2) homicide rate (location variable), rate of teenage mothers (average of neighbors).

In sum, we find that, in the city of Bogotá, our instrumental variables are spatially correlated with the homicide rate. Since households are spatially segregated according to these variables, we expect them to be correlated with the homicide rate in the census sector. On the other hand, we do not expect the instruments to affect house values in a direct fashion, as they constitute neither relevant house characteristics nor amenities people care about when deciding where to live. In other words, we assume that the teenage pregnancies in the neighborhood are not likely to be capitalized into house values or rents.

Table 2. Hedonic Regression for Bogotá

Variable	Homicide Rate		Ln house price [/1]				Ln house price [/2]				Ln house rent			
			OLS		2SLS		OLS		2SLS		OLS		2SLS	
	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
Stratum 2	0.0461	0.53	0.1449	2.83	0.1419	2.58	0.1722	3.06	0.1721	2.84	0.0197	0.62	0.0342	1.01
Stratum 3	0.0826	0.70	0.3047	4.56	0.2980	4.08	0.3087	4.18	0.3061	3.80	0.1105	3.05	0.1362	3.25
Stratum 4	0.2040	1.24	0.3822	4.18	0.3630	3.16	0.3518	3.43	0.3411	2.65	0.2078	4.32	0.2711	3.81
Stratum 5	0.1735	0.91	0.4643	3.78	0.4469	3.22	0.3599	2.59	0.3481	2.22	0.4267	7.09	0.4803	6.45
Stratum 6	0.0469	0.20	0.6254	4.21	0.6206	4.12	0.5027	3.11	0.5011	3.05	0.7254	9.63	0.7390	9.70
Cadastral	0.0148	0.65	-0.1066	-5.00	-0.1078	-4.92	0.0000	0.00	0.0000	0.00	-0.0297	-2.67	-0.0251	-2.14
Number of rooms	-0.0013	-0.16	0.0116	1.67	0.0116	1.66	0.0083	1.13	0.0083	1.12	0.1395	24.80	0.1394	24.73
Number of bathrooms	0.0037	0.24	0.2011	12.83	0.2007	12.57	0.1968	11.66	0.1965	11.46	0.1290	11.63	0.1301	11.50
House with piped gas service	-0.0300	-1.00	-0.0046	-0.26	-0.0015	-0.08	-0.0047	-0.24	-0.0026	-0.11	0.0459	3.97	0.0363	2.41
House with telephone	-0.0541	-1.76	-0.1483	-4.89	-0.1430	-3.79	-0.1522	-4.79	-0.1494	-3.75	0.2016	11.35	0.1839	7.40
Good quality of electricity	0.0027	0.16	-0.0197	-1.00	-0.0197	-0.99	-0.0220	-0.97	-0.0224	-0.99	-0.0285	-1.96	-0.0277	-1.91
Good quality of garbage collection	0.0081	0.26	0.0371	1.95	0.0366	1.90	0.0320	1.70	0.0319	1.66	-0.0136	-0.96	-0.0111	-0.78
Water available 24 hrs a day	0.0098	0.21	0.1238	2.83	0.1218	2.78	0.1526	2.99	0.1512	2.92	0.0223	0.61	0.0255	0.69
Water available every day of the week	0.0126	0.16	0.0318	0.77	0.0311	0.76	0.0398	0.87	0.0401	0.89	-0.0065	-0.29	-0.0022	-0.10
Good quality of phone line	0.0074	0.49	0.0301	2.13	0.0292	2.03	0.0242	1.56	0.0236	1.50	0.0174	1.40	0.0199	1.55
House with garden	-0.0017	-0.07	0.1391	8.23	0.1389	8.23	0.1383	7.67	0.1381	7.67	-0.0055	-0.50	-0.0061	-0.55
House with court yard	-0.1146	-3.68	0.1441	3.77	0.1551	3.09	0.1610	3.61	0.1661	2.78	-0.0236	-0.81	-0.0598	-1.55
House with garage	-0.0546	-2.17	0.0742	3.84	0.0793	2.92	0.0681	3.38	0.0705	2.40	0.1023	7.11	0.0851	4.05
House with terrace	-0.0221	-0.90	0.1328	7.86	0.1352	7.20	0.1118	6.24	0.1134	5.54	0.0380	3.14	0.0311	2.27
Parks in neighborhood	0.0172	0.47	-0.1084	-3.54	-0.1107	-3.56	-0.1731	-4.75	-0.1763	-4.73	0.0284	1.56	0.0335	1.81
The house has suffered because of a natural disaster	-0.0836	-1.47	0.0916	1.92	0.0994	1.87	0.0293	0.57	0.0345	0.59	0.0180	0.56	-0.0080	-0.21
House in area vulnerable to natural disasters	0.1003	1.77	-0.1416	-3.39	-0.1514	-3.17	-0.1054	-2.49	-0.1122	-2.12	-0.0420	-1.41	-0.0107	-0.27
Factories in neighborhood	0.0548	0.54	0.0883	3.34	0.0822	2.76	0.0862	3.14	0.0821	2.62	0.0055	0.33	0.0230	1.05
Garbage collector in neighborhood	-0.0067	-0.11	-0.0488	-0.97	-0.0479	-0.94	-0.0695	-1.21	-0.0688	-1.18	0.0238	0.91	0.0217	0.82
Market places in neighborhood	-0.0758	-1.04	0.0136	0.36	0.0218	0.49	0.0024	0.06	0.0095	0.19	0.0225	0.93	-0.0010	-0.03
Airport in neighborhood	-0.1967	-2.52	-0.0485	-1.13	-0.0282	-0.36	-0.0609	-1.26	-0.0473	-0.54	0.0640	2.45	0.0023	0.04
Terminals of ground transportation in neighborhood	0.0012	0.02	-0.0103	-0.26	-0.0101	-0.26	-0.0708	-1.54	-0.0725	-1.58	0.0541	1.98	0.0546	2.00
House close to open sewers	-0.0642	-1.80	-0.0516	-2.01	-0.0455	-1.38	-0.0489	-1.67	-0.0452	-1.17	-0.0034	-0.21	-0.0234	-1.04
House close to high tension lines of electricity transmission	0.0069	0.09	0.0667	1.35	0.0667	1.35	0.0861	1.54	0.0871	1.56	-0.0222	-0.64	-0.0195	-0.56
You feel safe in your neighborhood	-0.0675	-4.44	-0.0076	-0.58	-0.0005	-0.02	-0.0119	-0.86	-0.0077	-0.27	-0.0189	-2.00	-0.0401	-1.93
Provision of water is inside the house	0.0367	0.68	0.0085	0.12	0.0033	0.05	0.0086	0.11	0.0049	0.06	0.2043	3.51	0.2159	3.62
The kitchen is a individual room	0.0561	0.92	0.1194	2.73	0.1123	2.24	0.1043	2.19	0.0991	1.82	0.1254	4.49	0.1444	4.36
Shower bath	-0.0551	-1.49	0.0318	0.63	0.0356	0.61	0.0107	0.20	0.0131	0.21	0.0921	2.29	0.0749	1.74
House[*]	0.0166	0.59	-0.1797	-8.23	-0.1808	-8.29	-0.1953	-8.36	-0.1958	-8.35	0.0583	4.46	0.0632	4.67

Table 2. Hedonic Regression for Bogotá (Continuation)

Variable		Homicide Rate		Ln house price /1				Ln house price /2				Ln house rent			
				OLS		2SLS		OLS		2SLS		OLS		2SLS	
		Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
Walls material is any of: Brick, block, stone, polished wood		0,0599	1,07	0,1004	1,41	0,0925	1,27	0,0908	1,01	0,0841	0,92	0,1432	3,61	0,1626	3,82
Floor material is any of: Marmol, parque, lacquered wood															
Floor material is Carpet		0,0268	0,77	-0,2370	-7,68	-0,2408	-7,58	-0,2397	-6,57	-0,2427	-6,48	0,0097	0,49	0,0177	0,85
Floor material is any of: Floor tile, vinyl, tablet, wood		0,0330	0,86	-0,0290	-1,06	-0,0334	-1,12	-0,0134	-0,44	-0,0166	-0,50	-0,0167	-0,98	-0,0063	-0,33
Floor material is any of: Coarse wood, table, plank		0,1531	2,47	0,0487	1,21	0,0307	0,45	0,0638	1,47	0,0519	0,69	-0,0835	-3,07	-0,0355	-0,72
Floor material is any of: Cement, gravilla, earth, sand		-0,0218	-0,60	-0,2331	-5,99	-0,2318	-5,84	-0,2084	-4,84	-0,2078	-4,72	-0,1473	-5,65	-0,1538	-5,68
House with Toilet connected to the public sewerage		0,0886	0,69	-0,1361	-1,09	-0,1489	-1,16	-0,1925	-1,24	-0,2009	-1,26	0,0742	0,74	0,1015	0,99
House with potable water service		0,1759	1,22	0,2373	2,13	0,2212	1,72	0,3368	2,41	0,3253	2,06	-0,0368	-0,55	0,0188	0,22
Number of infantile shelters	♣	0,0073	0,12	-0,0594	-1,75	-0,0600	-1,76	-0,0994	-1,96	-0,0992	-1,97	0,0019	0,09	0,0042	0,21
Number of asylums	♣	-0,0107	-0,18	0,0009	0,03	0,0019	0,07	0,0116	0,37	0,0123	0,39	0,0209	1,25	0,0175	1,05
Number of convents	♣	-0,0459	-1,35	-0,0035	-0,25	0,0014	0,07	0,0072	0,40	0,0108	0,43	-0,0057	-0,78	-0,0201	-1,41
Objects theft rate	♣	-0,0991	-1,21	-0,0281	-1,37	-0,0182	-0,47	-0,0141	-0,66	-0,0081	-0,18	-0,0252	-3,10	-0,0562	-1,96
Assaults rate	♣	0,0913	3,95	-0,0053	-0,71	-0,0147	-0,46	-0,0035	-0,46	-0,0095	-0,27	0,0035	1,17	0,0322	1,29
Residential and commercial assault rate	♣	0,0693	1,51	0,0129	1,00	0,0062	0,24	0,0127	0,90	0,0089	0,30	0,0020	0,45	0,0236	1,20
Cars theft rate	♣	-0,0721	-2,75	-0,0017	-0,23	0,0056	0,21	-0,0064	-0,70	-0,0019	-0,06	0,0030	0,88	-0,0197	-0,99
Homicide rate (deaths per 10'000,000 people)	♣			-0,0470	-1,70	0,0555	0,17	-0,0411	-1,45	0,0224	0,06	-0,0115	-1,43	-0,3253	-1,18
Land use	♣	-0,5262	-0,44	-0,0725	-0,15	-0,0094	-0,02	-0,1376	-0,28	-0,0813	-0,16	-0,2480	-0,61	-0,4099	-0,95
Attacks of FARC, ELN or other groups**	♣	-0,0237	-0,31	-0,0461	-1,26	-0,0441	-1,15	-0,0366	-0,91	-0,0362	-0,87	-0,0324	-1,60	-0,0400	-1,91
Share of women heads of households	♣	-0,2071	-0,21	-2,2102	-5,45	-2,1998	-5,33	-2,4374	-5,40	-2,4475	-5,33	-0,1445	-0,60	-0,2130	-0,84
Labor force Unemployment rate	♣	0,0296	0,57	-0,1002	-4,75	-0,1037	-4,40	-0,1260	-5,84	-0,1288	-5,33	-0,0161	-1,61	-0,0069	-0,50
Illiteracy rate	♣	-5,7389	-1,80	0,0479	0,03	0,6566	0,27	-0,3278	-0,20	0,1107	0,04	1,2972	1,69	-0,5061	-0,29
Average education	♣	-0,3234	-2,73	-0,0380	-0,96	-0,0050	-0,04	-0,0497	-1,10	-0,0282	-0,21	0,0983	4,95	-0,0035	-0,04
Index of Quality of Life***	♣	0,0565	2,11	0,0442	4,75	0,0384	1,80	0,0440	4,14	0,0399	1,67	0,0076	1,42	0,0253	1,52
Gini of education	♣	11,0243	1,44	0,2304	0,09	-0,9956	-0,22	-1,8934	-0,63	-2,8396	-0,55	2,8591	1,70	6,3087	1,73
Number of CAIS****	♣	0,0065	0,14	0,0014	0,10	0,0004	0,03	0,0037	0,27	0,0028	0,20	0,0127	2,10	0,0147	2,30
Number of medical centers	♣	-0,0655	-2,95	-0,0109	-1,10	-0,0044	-0,18	-0,0131	-1,26	-0,0091	-0,34	-0,0037	-0,87	-0,0243	-1,35
Number of private hospitals	♣	0,0654	1,89	0,0048	0,30	-0,0017	-0,06	0,0114	0,58	0,0076	0,24	0,0092	1,53	0,0297	1,57
Number of police headquarters	♣	0,0688	0,58	0,0543	1,04	0,0481	0,91	0,0818	1,50	0,0778	1,40	0,0313	2,48	0,0529	2,36
Number of local security funds	♣	-0,0064	-1,80	0,0018	1,41	0,0025	1,06	0,0018	1,26	0,0022	0,81	0,0010	1,61	-0,0010	-0,53
Number of public hospitals	♣	0,0405	0,71	0,0008	0,06	-0,0036	-0,19	-0,0056	-0,41	-0,0093	-0,47	0,0016	0,20	0,0142	1,02
Number of religious centers	♣	0,0288	0,76	0,0171	1,56	0,0145	0,93	0,0195	1,65	0,0178	1,05	0,0021	0,45	0,0112	1,22
Number of social welfare centers	♣	0,0266	1,67	0,0084	1,41	0,0054	0,50	0,0110	1,55	0,0091	0,73	-0,0010	-0,40	0,0074	0,97
Number of cultural centers	♣	0,0124	1,47	0,0023	0,98	0,0009	0,20	0,0010	0,42	0,0002	0,04	0,0006	0,56	0,0045	1,26
Number of prisons	♣	0,2469	0,91	0,0203	0,51	-0,0079	-0,09	-0,0009	-0,02	-0,0201	-0,19	0,0168	0,73	0,0944	1,31
Number of attacks against life	♣	0,0425	0,80	-0,0460	-2,60	-0,0508	-2,24	-0,0606	-3,23	-0,0637	-2,61	-0,0067	-0,72	0,0068	0,45
Number of attacks against wealth	♣	0,0716	1,26	0,0344	2,14	0,0262	0,88	0,0314	1,82	0,0251	0,75	0,0092	1,04	0,0316	1,49
Number of bars	♣	0,0285	0,51	0,0148	0,84	0,0130	0,71	0,0161	0,91	0,0159	0,82	0,0180	2,29	0,0269	2,48

Table 2. Hedonic Regression for Bogotá (Continuation)

Variable	Homicide Rate		Ln house price [/1]				Ln house price [/2]				Ln house rent			
			OLS		2SLS		OLS		2SLS		OLS		2SLS	
	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
Number of brothels	♣ -0,1068	-1,98	0,0024	0,13	0,0133	0,35	0,0148	0,77	0,0215	0,50	-0,0179	-1,64	-0,0515	-1,70
Number of casinos/places for bets	♣ 0,0310	0,53	-0,0034	-0,18	-0,0080	-0,37	-0,0192	-1,02	-0,0232	-1,05	-0,0033	-0,30	0,0066	0,50
Number of places selling drugs/narcotics	♣ -0,0593	-1,15	-0,0198	-1,16	-0,0135	-0,53	-0,0207	-1,16	-0,0162	-0,58	-0,0002	-0,02	-0,0187	-1,02
Number of people 0-4 years old	♣ -0,0002	-0,52	0,0003	1,94	0,0004	1,91	0,0004	2,05	0,0004	1,98	0,0001	0,73	0,0000	0,02
Number of people 5-9 years old	♣ 0,0002	0,39	-0,0003	-1,40	-0,0004	-1,44	-0,0004	-1,53	-0,0004	-1,53	0,0000	0,06	0,0001	0,44
Number of people 10-14 years old	♣ -0,0012	-2,86	-0,0004	-1,73	-0,0002	-0,59	-0,0004	-1,85	-0,0003	-0,69	0,0000	-0,12	-0,0004	-1,13
Number of people 15-19 years old	♣ 0,0004	0,67	0,0000	-0,15	-0,0001	-0,28	0,0000	-0,15	-0,0001	-0,25	-0,0004	-2,68	-0,0003	-1,54
Number of people 20-24 years old	♣ 0,0000	0,07	-0,0001	-0,46	-0,0001	-0,45	-0,0001	-0,22	-0,0001	-0,21	0,0001	0,58	0,0001	0,67
Number of people 25-29 years old	♣ -0,0005	-1,21	-0,0001	-0,26	0,0000	-0,06	-0,0002	-0,64	-0,0001	-0,41	0,0000	0,43	-0,0001	-0,65
Number of people 30-34 years old	♣ 0,0004	1,00	0,0002	0,91	0,0002	0,61	0,0003	1,01	0,0002	0,72	-0,0001	-0,58	0,0001	0,44
Number of people 35-39 years old	♣ 0,0000	0,05	-0,0004	-1,62	-0,0004	-1,60	-0,0004	-1,50	-0,0004	-1,50	-0,0001	-1,03	-0,0001	-0,99
Number of people 40-44 years old	♣ 0,0010	1,23	0,0004	1,18	0,0003	0,58	0,0004	1,19	0,0003	0,65	0,0003	1,76	0,0006	1,79
Number of people 45-49 years old	♣ -0,0004	-0,44	0,0002	0,51	0,0002	0,59	0,0001	0,34	0,0002	0,42	0,0002	1,42	0,0001	0,59
Number of people 50-54 years old	♣ 0,0005	0,52	-0,0001	-0,19	-0,0001	-0,29	0,0000	-0,10	-0,0001	-0,17	0,0000	-0,02	0,0002	0,64
Number of people 55-59 years old	♣ 0,0005	0,54	-0,0003	-0,88	-0,0004	-0,94	-0,0002	-0,51	-0,0002	-0,52	-0,0001	-0,44	0,0001	0,20
Number of people 60 + years old	♣ -0,0004	-1,79	0,0005	5,08	0,0005	3,07	0,0005	4,35	0,0005	2,71	0,0001	2,21	0,0000	-0,12
Unsatisfied Basic Needs (NBI): Dependency	♣ -0,0008	-0,33	0,0012	0,94	0,0013	0,96	0,0013	0,96	0,0013	0,95	0,0010	1,79	0,0008	1,20
NBI: Accumulation	♣ 0,0007	2,27	0,0006	4,44	0,0006	2,11	0,0007	3,95	0,0006	1,98	0,0001	0,74	0,0003	1,35
NBI: Dropouts	♣ 0,0176	2,32	-0,0022	-0,77	-0,0039	-0,63	-0,0015	-0,50	-0,0025	-0,36	-0,0016	-1,07	0,0040	0,80
NBI: Public utility services	♣ 0,0006	1,79	-0,0002	-0,81	-0,0002	-0,77	0,0000	-0,14	-0,0001	-0,21	-0,0002	-1,68	0,0000	0,13
NBI: Housing in	♣ -0,0001	-0,14	0,0003	1,25	0,0003	1,26	0,0005	1,57	0,0005	1,57	-0,0001	-0,53	-0,0001	-0,70
NBI: NBI in Municipality where were born	♣ 0,0010	1,60	0,0008	1,85	0,0007	1,43	0,0011	2,24	0,0011	1,81	-0,0006	-2,07	-0,0003	-0,81
NBI: NBI in Municipality where were born	♣ 0,0353	1,74	0,0468	2,21	0,0431	1,87	0,0531	2,23	0,0507	1,97	0,0155	0,90	0,0260	1,31
Born in urban area	0,0219	1,22	-0,0078	-0,51	-0,0104	-0,61	-0,0067	-0,42	-0,0083	-0,45	-0,0056	-0,48	0,0016	0,12
Household with children	0,0673	2,60												
Age of mother minus age of oldest children	-0,0020	-2,52												
Constant	-2,5129	-1,32	14,2025	19,87	14,4826	13,33	14,4844	18,14	14,6996	12,12	9,3414	23,29	8,5617	10,37
Number of Observations	12.120		10.290		10.290		8.435		8.435		12.024		12.024	
R-squared	0,557		0,578		0,577		0,586		0,585		0,683		0,683	

All regressions include dummy variable of father's and mother's education levels and their interactions. *t* statistics computed based on robust standard errors corrected by clustering at the census sector level. 1/ Cadastral values if available, otherwise, the value reported by households surveyd. 2/ Only includes households for which cadastral values are available.

Sources: Encuesta de Calidad de Vida 2003, Real State Appraisal of Bogotá, National Police-DIJIN 2000, Paz Pública (2000). Colombian 1993 Population Census.

[*] Dummy variable equal to one if house, 0 otherwise (apartment, etc.). [**] Dummy variable equal to one if there have been attacks in census sector by Fuerzas Armadas Revolucionarias de Colombia, FARC, *Ejército de Liberación Nacional* , ELN, or other groups. [***] A-Theoretical estimation of QoL (See methodology in DNP, 1997). [****] *Centros de Atención Inmediata* , CAIS: Centers of Immediate -Police- Attention. ♣ At the census sector level.

Tables 2 and 3 present the results of the instrumental variables estimation. Table 2 presents the estimation results of a specification that does not incorporate interactions whereas Table 3 presents the results of a specification that incorporates interactions between the crime variables and the strata. We will focus on Table 3. The first column presents the first stage results. These results indicate that our instrument (the age difference) is statistically significant, and has the expected negative sign. When we use the combination of cadastral and rental values as the dependent variable, we find that the coefficient of the interactions between the homicide rate and strata 3 and 6 are positive in the OLS regression, whereas the coefficients of the interactions between the homicide rate and strata 5 and 6 are significant and negative in the IV regression. When we use only cadastral data as the dependent variable, we find that that the coefficient of the interaction between the homicide rate and stratum 6 becomes significant and negative. When rental values are used, the results are more erratic and neither of the interactions is significant in the IV regression.

Table 5 summarizes the results of the IV estimations. The upper panel of Table 5 shows that the elasticity of house values to the homicide rate for houses located in socioeconomic stratum 6 is about -0.90%. Put differently, if the homicide rate in stratum 6 were to increase by one standard deviation --an increase of 7.3 times the mean value--, house values would fall between 5.8% and 7.0%. In the case of stratum 5, the elasticity is between -0.23% and -0.26%, which implies a decrease of between 2.3% and 2.5% in the value of the house if homicides increase by on standard deviation.

The other crime variables (common theft, assaults, residential and commercial assaults rates, attacks of guerilla groups, and attacks against wealth) are not significant in the IV estimation. The car theft variable is negative and significant only for its interaction with stratum 5. Finally, “attacks against life” is negative and statistically significant in almost all specifications.

Table 3. Hedonic Regression for Bogotá.
Instrument: age difference between mother and oldest child

Variable	Homicide Rate		Ln house price /1				Ln house price /2				Ln house rent			
			OLS		2SLS		OLS		2SLS		OLS		2SLS	
	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
Cadastral value			-0.1135	-5.54	-0.1147	-5.51					-0.0232	-2.15	-0.0221	-1.95
You feel safe in your neighborhood	0.0146	0.69	0.0541	1.21	0.0565	1.23	0.0433	0.87	0.0423	0.83	-0.0095	-0.35	-0.0130	-0.47
" * Stratum 2	-0.0250	-0.68	-0.0411	-0.80	-0.0361	-0.70	-0.0167	-0.30	-0.0177	-0.31	-0.0181	-0.54	-0.0215	-0.62
" * Stratum 3	-0.0277	-0.73	-0.0629	-1.32	-0.0686	-1.39	-0.0632	-1.20	-0.0780	-1.41	-0.0160	-0.53	-0.0186	-0.58
" * Stratum 4	-0.0398	-0.97	-0.0732	-1.48	-0.0749	-1.50	-0.0637	-1.15	-0.0714	-1.27	0.0256	0.67	0.0281	0.74
" * Stratum 5	-0.0022	-0.04	-0.1112	-1.57	-0.1088	-1.47	-0.1210	-1.77	-0.1122	-1.53	0.0382	0.82	0.0439	0.90
" * Stratum 6	0.0538	1.23	-0.0809	-0.91	-0.0618	-0.71	-0.0738	-1.12	-0.0510	-0.75	-0.0867	-1.50	-0.0755	-1.27
Objects theft rate ♣	0.0430	0.95	0.0891	1.02	0.0910	0.39	0.0669	0.69	-0.0311	-0.12	-0.0695	-1.77	-0.1229	-0.72
" * Stratum 2	-0.5349	-3.57	-0.0541	-0.34	-0.0744	-0.29	-0.0198	-0.12	0.0507	0.18	0.0202	0.31	0.0733	0.43
" * Stratum 3	0.5236	1.73	-0.0645	-0.72	-0.0738	-0.38	-0.0440	-0.44	0.0225	0.10	0.0545	1.36	0.0950	0.70
" * Stratum 4	0.4175	1.75	-0.1225	-1.36	-0.1245	-0.54	-0.1114	-1.13	-0.0083	-0.03	0.0677	1.56	0.1174	0.69
" * Stratum 5	0.5246	3.38	-0.1667	-1.56	-0.1688	-0.72	-0.1063	-0.93	-0.0058	-0.02	0.0608	1.15	0.1131	0.65
" * Stratum 6	0.5335	3.23	-0.1566	-1.72	-0.0905	-0.43	-0.0364	-0.32	0.0016	0.01	0.0074	0.16	0.0927	0.60
Assaults rate ♣	0.4705	4.06	-0.0174	-0.93	-0.0211	-0.93	-0.0120	-0.59	-0.0119	-0.47	0.0061	0.75	0.0102	0.74
" * Stratum 2	0.0332	1.65	0.0106	0.39	0.0025	0.09	-0.0006	-0.02	-0.0055	-0.20	0.0029	0.29	0.0066	0.53
" * Stratum 3	0.0141	0.23	-0.0135	-0.67	0.0006	0.01	-0.0196	-0.86	0.0173	0.34	-0.0111	-1.22	-0.0019	-0.06
" * Stratum 4	0.1020	2.70	0.0021	0.10	0.0069	0.33	-0.0188	-0.82	-0.0146	-0.63	-0.0119	-0.95	-0.0161	-1.18
" * Stratum 5	-0.0150	-0.45	0.0035	0.13	0.0079	0.33	0.0210	0.80	0.0280	1.09	0.0045	0.26	0.0000	0.00
" * Stratum 6	-0.0152	-0.45	0.0023	0.10	0.0109	0.41	0.0131	0.54	-0.0013	-0.04	-0.0033	-0.22	-0.0050	-0.23
Residential and commercial assault rate ♣	-0.0367	-1.28	0.0358	0.58	-0.0194	-0.13	0.0262	0.41	0.0210	0.13	-0.0093	-0.53	0.0253	0.27
" * Stratum 2	0.2908	5.96	0.0414	0.60	0.0134	0.13	0.0478	0.68	0.0217	0.20	0.0239	0.94	0.0372	0.91
" * Stratum 3	0.0164	0.16	-0.0275	-0.44	0.0297	0.22	-0.0094	-0.15	0.0060	0.04	0.0202	1.06	-0.0111	-0.13
" * Stratum 4	-0.2549	-3.18	0.0156	0.26	0.0706	0.59	0.0420	0.67	0.0700	0.54	0.0254	1.29	-0.0049	-0.07
" * Stratum 5	-0.2107	-4.12	0.0192	0.28	0.0775	0.54	0.0011	0.02	0.0109	0.07	-0.0052	-0.21	-0.0385	-0.42
" * Stratum 6	-0.2774	-5.14	-0.0487	-0.69	-0.1159	-0.76	-0.0803	-0.90	-0.0716	-0.42	0.0287	0.82	-0.0647	-0.63
Cars theft rate ♣	-0.2890	-4.29	-0.0006	-0.04	0.0202	0.54	0.0109	0.47	0.0225	0.56	0.0125	1.32	0.0036	0.15
" * Stratum 2	-0.0655	-3.14	-0.0398	-1.09	0.0060	0.07	-0.0453	-1.13	-0.0331	-0.35	-0.0184	-0.98	-0.0497	-0.77
" * Stratum 3	-0.1964	-2.94	0.0083	0.43	-0.0189	-0.68	-0.0083	-0.34	-0.0413	-1.44	-0.0084	-0.83	-0.0067	-0.46
" * Stratum 4	-0.0098	-0.27	-0.0003	-0.01	-0.0218	-0.76	-0.0042	-0.16	-0.0275	-0.91	-0.0155	-1.20	-0.0088	-0.52
" * Stratum 5	0.0229	0.72	-0.0094	-0.30	-0.0348	-1.05	-0.0437	-1.26	-0.0735	-2.08	-0.0028	-0.14	0.0017	0.08
" * Stratum 6	0.0048	0.08	0.0602	2.12	0.1769	2.31	0.0359	0.97	0.1053	1.29	-0.0334	-1.43	0.0422	0.77
Homicide rate ♣	0.1320	2.77	-0.1541	-2.57	0.0261	0.06	-0.1335	-1.93	-0.1050	-0.21	0.0061	0.20	-0.1157	-0.36
" * Stratum 2			0.1281	1.71	0.1469	0.64	0.1141	1.34	0.1106	0.44	0.0160	0.47	-0.0054	-0.06
" * Stratum 3			0.1249	1.99	-0.1129	-0.65	0.1084	1.53	-0.1752	-0.92	-0.0198	-0.63	0.0031	0.04
" * Stratum 4			0.0452	0.47	-0.1160	-0.58	0.0422	0.40	-0.2800	-1.33	-0.0395	-0.76	0.0517	0.51
" * Stratum 5			-0.1817	-0.85	-0.4501	-2.14	-0.1569	-0.76	-0.3674	-1.60	-0.0673	-0.37	-0.0956	-0.55
" * Stratum 6			0.7461	2.64	-1.1070	-2.63	0.0634	0.19	-0.7913	-1.91	0.9072	4.25	0.2016	0.78
Attacks of FARC, ELN or other groups** ♣	-0.0443	-0.60	-0.0064	-0.19	-0.0027	-0.07	0.0175	0.46	0.0098	0.23	-0.0171	-0.85	-0.0213	-0.89
Number of CAIS****	0.0528	0.33	-0.1519	-1.88	-0.1384	-1.57	-0.1614	-1.42	-0.0931	-0.73	0.0093	0.18	0.0151	0.28
" * Stratum 2	0.0052	0.03	0.1831	2.06	0.1647	1.74	0.1965	1.61	0.1349	1.00	0.0204	0.38	0.0222	0.40
" * Stratum 3	-0.0588	-0.34	0.1732	2.12	0.1607	1.80	0.1784	1.56	0.1093	0.85	0.0024	0.04	-0.0042	-0.07
" * Stratum 4	-0.1729	-0.91	0.1726	1.94	0.1558	1.32	0.1852	1.53	0.0799	0.54	-0.0128	-0.22	-0.0235	-0.31
" * Stratum 5	-0.0201	-0.11	0.1765	1.83	0.1676	1.77	0.1629	1.29	0.0923	0.68	-0.0201	-0.33	-0.0136	-0.22
" * Stratum 6	-0.0615	-0.35	0.3128	3.46	0.3226	3.29	0.2461	1.79	0.1667	1.15	0.0995	1.61	0.1040	1.68
Number of police headquarters ♣	0.0661	0.61	0.0731	1.54	0.0793	1.51	0.0896	1.57	0.1153	1.85	0.0380	2.99	0.0363	1.43
Number of local security funds ♣	-0.0037	-1.05	0.0019	1.42	0.0016	0.85	0.0023	1.50	0.0013	0.60	0.0007	1.06	0.0003	0.19
Number of prisons ♣	0.2143	0.80	0.0230	0.82	0.0165	0.18	0.0246	0.73	0.0734	0.73	0.0060	0.28	0.0221	0.31
Number of attacks against life ♣	0.0041	0.08	-0.0332	-1.95	-0.0349	-2.02	-0.0569	-2.99	-0.0576	-2.98	-0.0076	-0.81	-0.0068	-0.73
Number of attacks against wealth ♣	0.0954	1.63	0.0195	1.20	0.0177	0.43	0.0294	1.62	0.0469	1.02	0.0031	0.37	0.0125	0.41
Number of bars ♣	-0.0093	-0.15	0.0070	0.45	0.0070	0.44	0.0043	0.26	0.0037	0.22	0.0143	1.77	0.0136	1.57
Number of brothels ♣	-0.0817	-1.57	0.0060	0.34	0.0069	0.20	0.0185	0.99	0.0013	0.03	-0.0117	-1.13	-0.0205	-0.78
Number of casinos/places for bets ♣	0.0431	0.70	0.0017	0.09	-0.0042	-0.17	-0.0149	-0.73	-0.0121	-0.45	-0.0061	-0.58	-0.0010	-0.07
Number of places selling drugs/narcotics ♣	-0.0512	-1.09	-0.0330	-2.00	-0.0366	-1.35	-0.0354	-2.03	-0.0487	-1.66	0.0002	0.02	-0.0046	-0.25
Age of mother minus age of oldest children	-0.0017	-2.32												
Constant	4.9914	1.56	13.2273	7.40	12.5977	4.33	13.7531	5.92	14.2756	4.08	9.0278	7.60	9.6076	5.08
Number of Observations	12,120		10,290		10,290		8,435		8,435		12,024		12,024	
R-squared	0.6314		0.6361		0.6357		0.6508		0.6510		0.7017		0.7012	

All regressions include dummy variable of father and mother's education levels and their interactions. *t* statistics computed based on robust standard errors corrected by clustering at the census sector level. 1/ Cadastral values if available, otherwise, the value reported by households surveyed. 2/ Only includes households for which cadastral values are available.

Sources: *Encuesta de Calidad de Vida* 2003, Real State Appraisal of Bogotá, National Police-DIJIN 2000, Paz Pública (2000). Colombian 1993 Population Census.

* Dummy variable equal to one if house, zero otherwise (apartment, etc.). ** Attacks by guerrilla groups *Fuerzas Armadas Revolucionarias de Colombia*, FARC, *Ejército de Liberación Nacional*, ELN, or other groups. *** A-Theoretical estimation of QoL (See methodology in DNP, 1997). **** *Centros de Atención Inmediata, CAIS*: Centers of Immediate - Police- Attention. ♣ At the census sector level.

Finally, Table 4 presents the results of instrumenting the homicide rate with the share of teenage mothers in the census sector. The first column presents the first stage results, and the other columns the second stage results. The first column shows that the instrument variable is statistically significant, and has the expected positive sign.

Turning now to the effects of the homicide rate on property values, we find that in the IV regression the coefficients of the interactions between the homicide rate and strata 5 and 6 are significant and negative when we use either house value. When we use only cadastral values, the coefficients of the interactions with strata 3 to 6 are all significant.

The IV results imply that the elasticity of the house value to homicide rate in socioeconomic stratum 6 is between -0.8% and -0.95%. That is, if the homicide rate in stratum 6 were to increase by one standard deviation, house values would fall between 5.8% and 6.9%. In the case of strata 3, 4, and 5, the elasticites are -6.9%, -0.72%, and -0.26% respectively, which imply a fall of 13.5%, 4.4% and 2.5% in house values after an increase of one standard deviation in homicide rates. Results for the other variables are very similar to those obtained when the age difference was the instrument of choice.

Table 4. Hedonic Regression for Bogotá.
Instrument: Share of teenage mothers in census sector

Variable		Homicide Rate		Ln house price /1				Ln house price /2				Ln house rent			
				OLS		2SLS		OLS		2SLS		OLS		2SLS	
		Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
Cadastral value		0.0152	0.73	-0.114	-5.54	-0.112	-5.40					-0.0232	-2.15	-0.0234	-2.17
You feel safe in your neighborhood		-0.022	-0.55	0.054	1.21	0.057	1.29	0.043	0.87	0.042	0.85	-0.009	-0.35	-0.007	-0.26
" * Stratum 2		-0.020	-0.49	-0.041	-0.80	-0.040	-0.79	-0.017	-0.30	-0.011	-0.19	-0.018	-0.54	-0.020	-0.59
" * Stratum 3		-0.038	-0.85	-0.063	-1.32	-0.072	-1.52	-0.063	-1.20	-0.068	-1.29	-0.016	-0.53	-0.017	-0.57
" * Stratum 4		-0.0003	-0.01	-0.073	-1.48	-0.074	-1.51	-0.064	-1.15	-0.065	-1.17	0.026	0.67	0.025	0.67
" * Stratum 5		0.048	1.01	-0.111	-1.57	-0.109	-1.57	-0.121	-1.77	-0.118	-1.71	0.038	0.82	0.035	0.75
" * Stratum 6		0.042	0.86	-0.081	-0.91	-0.062	-0.72	-0.074	-1.12	-0.048	-0.74	-0.087	-1.50	-0.084	-1.45
Objects theft rate	♣	-0.542	-3.53	0.089	1.02	0.109	0.88	0.067	0.69	0.103	0.78	-0.069	-1.77	-0.059	-0.98
" * Stratum 2		0.661	2.15	-0.054	-0.34	-0.084	-0.46	-0.020	-0.12	-0.074	-0.39	0.020	0.31	0.009	0.11
" * Stratum 3		0.432	1.83	-0.065	-0.72	-0.096	-0.83	-0.044	-0.44	-0.093	-0.74	0.054	1.36	0.044	0.80
" * Stratum 4		0.539	3.41	-0.123	-1.36	-0.145	-1.16	-0.111	-1.13	-0.142	-1.06	0.068	1.56	0.054	0.88
" * Stratum 5		0.552	3.30	-0.167	-1.56	-0.188	-1.41	-0.106	-0.93	-0.142	-1.01	0.061	1.15	0.048	0.71
" * Stratum 6		0.503	4.09	-0.157	-1.72	-0.106	-0.87	-0.036	-0.32	-0.135	-0.95	0.007	0.16	0.035	0.53
Assaults rate	♣	0.031	1.37	-0.017	-0.93	-0.027	-1.61	-0.012	-0.59	-0.025	-1.34	0.006	0.75	0.004	0.39
" * Stratum 2		0.027	0.49	0.011	0.39	0.014	0.56	-0.001	-0.02	0.002	0.08	0.003	0.29	0.004	0.34
" * Stratum 3		0.094	2.53	-0.014	-0.67	0.014	0.56	-0.020	-0.86	0.010	0.38	-0.011	-1.22	-0.010	-0.78
" * Stratum 4		-0.014	-0.42	0.002	0.10	0.012	0.61	-0.019	-0.82	-0.007	-0.33	-0.012	-0.95	-0.012	-0.92
" * Stratum 5		-0.018	-0.53	0.003	0.13	0.009	0.42	0.021	0.80	0.030	1.30	0.005	0.26	0.003	0.16
" * Stratum 6		-0.031	-1.06	0.002	0.10	0.018	0.80	0.013	0.54	0.010	0.43	-0.003	-0.22	0.002	0.09
Residential and commercial assault rate	♣	0.298	5.20	0.036	0.58	-0.049	-0.53	0.026	0.41	-0.084	-0.90	-0.009	-0.53	-0.016	-0.49
" * Stratum 2		-0.0397	-0.40	0.041	0.60	0.081	0.80	0.048	0.68	0.097	0.94	0.024	0.94	0.017	0.48
" * Stratum 3		-0.258	-3.04	-0.027	-0.44	0.061	0.68	-0.009	-0.15	0.105	1.17	0.020	1.06	0.026	0.83
" * Stratum 4		-0.213	-3.71	0.016	0.26	0.099	1.19	0.042	0.67	0.160	1.88	0.025	1.29	0.027	0.88
" * Stratum 5		-0.300	-4.91	0.019	0.28	0.108	1.15	0.001	0.02	0.116	1.23	-0.005	-0.21	0.002	0.07
" * Stratum 6		-0.319	-4.34	-0.049	-0.69	-0.087	-0.86	-0.080	-0.90	0.040	0.36	0.029	0.82	-0.022	-0.42
Cars theft rate	♣	-0.072	-3.03	-0.001	-0.04	0.033	1.32	0.011	0.47	0.054	2.12	0.013	1.32	0.013	1.05
" * Stratum 2		-0.207	-3.12	-0.040	-1.09	-0.038	-0.61	-0.045	-1.13	-0.037	-0.59	-0.018	-0.98	-0.009	-0.29
" * Stratum 3		0.003	0.08	0.008	0.43	-0.036	-1.42	-0.008	-0.34	-0.061	-2.36	-0.008	-0.83	-0.008	-0.67
" * Stratum 4		0.024	0.75	0.000	-0.01	-0.034	-1.36	-0.004	-0.16	-0.049	-1.93	-0.016	-1.20	-0.013	-0.92
" * Stratum 5		0.017	0.28	-0.009	-0.30	-0.044	-1.44	-0.044	-1.26	-0.089	-2.76	-0.003	-0.14	0.000	0.02
" * Stratum 6		0.149	3.18	0.060	2.12	0.162	2.77	0.036	0.97	0.073	1.32	-0.033	-1.43	0.024	0.66
Homicide rate	♣			-0.154	-2.57	0.112	0.60	-0.134	-1.93	0.238	1.16	0.006	0.20	0.041	0.43
" * Stratum 2				0.128	1.71	-0.044	-0.22	0.114	1.34	-0.119	-0.53	0.016	0.47	0.019	0.23
" * Stratum 3				0.125	1.99	-0.256	-1.72	0.108	1.53	-0.373	-2.23	-0.020	-0.63	-0.042	-0.60
" * Stratum 4				0.045	0.47	-0.174	-0.98	0.042	0.40	-0.415	-2.18	-0.039	-0.76	0.016	0.17
" * Stratum 5				-0.182	-0.85	-0.641	-3.22	-0.157	-0.76	-0.648	-2.84	-0.067	-0.37	-0.178	-1.00
" * Stratum 6				0.746	2.64	-1.173	-2.73	0.063	0.19	-1.174	-2.67	0.907	4.25	0.178	0.71
Attacks of FARC, ELN or other groups**	♣	-0.016	-0.21	-0.0064	-0.19	-0.0042	-0.12	0.0175	0.46	0.0184	0.47	-0.0171	-0.85	-0.0137	-0.68
Number of CAIS****		0.019	0.11	-0.1519	-1.88	-0.1408	-1.55	-0.1614	-1.42	-0.0760	-0.53	0.0093	0.18	-0.0121	-0.23
" * Stratum 2		0.027	0.16	0.1831	2.06	0.1715	1.74	0.1965	1.61	0.1098	0.74	0.0204	0.38	0.0409	0.77
" * Stratum 3		-0.039	-0.21	0.1732	2.12	0.1628	1.78	0.1784	1.56	0.0927	0.64	0.0024	0.04	0.0241	0.46
" * Stratum 4		-0.141	-0.70	0.1726	1.94	0.1621	1.61	0.1852	1.53	0.0882	0.59	-0.0128	-0.22	0.0184	0.32
" * Stratum 5		0.039	0.20	0.1765	1.83	0.1859	1.88	0.1629	1.29	0.0907	0.61	-0.0201	-0.33	0.0157	0.25
" * Stratum 6		0.009	0.05	0.3128	3.46	0.3217	3.21	0.2461	1.79	0.1377	0.87	0.0995	1.61	0.1316	2.24
Number of police headquarters	♣	0.047	0.48	0.0731	1.54	0.0768	1.70	0.0896	1.57	0.1017	1.88	0.0380	2.99	0.0275	1.84
Number of local security funds	♣	-0.004	-1.01	0.0019	1.42	0.0014	0.97	0.0023	1.50	0.0018	1.16	0.0007	1.06	0.0007	0.97
Number of prisons	♣	0.213	0.79	0.0230	0.82	0.0238	0.51	0.0246	0.73	0.0405	0.82	0.0060	0.28	-0.0042	-0.15
Number of attacks against life	♣	0.002	0.03	-0.0332	-1.95	-0.0335	-1.93	-0.0569	-2.99	-0.0572	-2.96	-0.0076	-0.81	-0.0079	-0.85
Number of attacks against wealth	♣	0.089	1.50	0.0195	1.20	0.0200	0.93	0.0294	1.62	0.0291	1.26	0.0031	0.37	0.0015	0.14
Number of bars	♣	0.003	0.04	0.0070	0.45	0.0091	0.59	0.0043	0.26	0.0079	0.48	0.0143	1.77	0.0150	1.82
Number of brothels	♣	-0.083	-1.60	0.0060	0.34	0.0014	0.06	0.0185	0.99	0.0123	0.50	-0.0117	-1.13	-0.0107	-0.86
Number of casinos/places for bets	♣	0.043	0.72	0.0017	0.09	-0.0033	-0.16	-0.0149	-0.73	-0.0205	-0.96	-0.0061	-0.58	-0.0078	-0.71
Number of places selling drugs/narcotics	♣	-0.050	-1.09	-0.0330	-2.00	-0.0393	-2.38	-0.0354	-2.03	-0.0408	-2.39	0.0002	0.02	0.0008	0.08
Share of Teenage Mothers in Census Sector		5.892	2.43												
Constant		5.725	1.44	13.2273	7.40	12.1418	5.68	13.7531	5.92	12.2925	4.59	8.9398	7.32	9.5284	7.17
Number of Observations		12,111		10,290		10,281		8,435		8,428		12,024		12,015	
R-squared		0.6382		0.6361		0.6348		0.6508		0.6499		0.7017		0.7011	

All regressions include dummy variable of father and mother's education levels and their interactions. *t* statistics computed based on robust standard errors corrected by clustering at the census sector level. 1/ Cadastral values if available, otherwise, the value reported by households surveyed. 2/ Only includes households for which cadastral values are available.

Sources: *Encuesta de Calidad de Vida* 2003, Real State Appraisal of Bogotá, National Police-DIJIN 2000, Paz Pública (2000). Colombian 1993 Population Census.

* Dummy variable equal to one if house, zero otherwise (apartment, etc.). ** Attacks by guerrilla groups *Fuerzas Armadas Revolucionarias de Colombia*, FARC, *Ejército de Liberación Nacional*, ELN, or other groups. *** A-Theoretical estimation of QoL (See methodology in DNP, 1997). **** *Centros de Atención Inmediata*, *CAIS*: Centers of Immediate - Police- Attention. ♣ At the census sector level.

Table 5. Summary Results of the Effects of the Homicide Rate on House Values
Instrument: Age Difference

Results with house values coming from cadastral or self reported data				
Variable	Coefficient	Elasticity	Δ Homicide Rate (1 st dev)/ Homicide Rate	Δ House Value/ House Value
Homicide Rate	0.02608	0.0104	1.31	0.014
Homicide Rate interacted with:				
Stratum 5	-0.45010	-0.0023	9.81	-0.023
Stratum 6	-1.10701	-0.0096	7.29	-0.070
Results with house values coming only from cadastral data				
Variable	Coefficient	Elasticity	Δ Homicide Rate (1 st dev)/ Homicide Rate	Δ House Value/ House Value
Homicide Rate	-0.10497	-0.0420	1.31	-0.055
Homicide Rate interacted with:				
Stratum 5	-0.36745	-0.0026	9.81	-0.025
Stratum 6	-0.79130	-0.0080	7.29	-0.058

Instrument: Share of Teenage Mothers

Results with house values coming from cadastral or self reported data				
Variable	Coefficient	Elasticity	Δ Homicide Rate (1 st dev)/ Homicide Rate	Δ House Value/ House Value
Homicide Rate	0.11250	0.0450	1.31	0.059
Homicide Rate interacted with:				
Stratum 3	-0.25556	-0.0354	1.95	-0.069
Stratum 4	-0.17383	-0.0011	6.19	-0.007
Stratum 5	-0.64121	-0.0029	9.81	-0.028
Stratum 6	-1.17334	-0.0095	7.29	-0.069
Results with house values coming only from cadastral data				
Variable	Coefficient	Elasticity	Δ Homicide Rate (1 st dev)/ Homicide Rate	Δ House Value/ House Value
Homicide Rate	-0.10497	-0.0420	1.31	-0.055
Homicide Rate interacted with:				
Stratum 3	-0.17516	-0.0693	1.95	-0.135
Stratum 4	-0.28005	-0.0072	6.19	-0.044
Stratum 5	-0.36745	-0.0026	9.81	-0.025
Stratum 6	-0.79130	-0.0080	7.29	-0.058

Conclusions

In this paper, we use hedonic price models to estimate the value households resident in the city of Bogotá (Colombia) are willing to pay to avoid crime, and in particular, to avoid high homicides rates. We find that households living in the highest socioeconomic stratum (stratum 6) are willing to pay up to 7.0% of their house values to avoid an increase of the homicide rate in one standard deviation. Households in stratum 5 are willing to pay up to 2.8% of their house values, and those in stratum 4 up to 4.4%.

The results reveal the willingness to pay for security by households in Bogotá, and additionally, reveal the emergence of urban private markets that auction security. These markets imply different levels of access to public goods among the population, and actually, the exclusion of the poorest. We find as well evidence of negative capitalization of aggravated assaults, and of positive capitalization of the presence of police authority in the form of Centers of Immediate Attention, CAIS.

References

Atkinson, Giles; Healey, Andrew, and Mourato, Susan (2005). "Valuing the Costs of Violent Crime: A Stated Preference Approach", *Oxford Economic Papers* 57, pp. 559-585. Oxford University Press.

Ansellin L. (1988). Spatial Econometrics Methods and Models. Klwer Academics Publisher, University of California, Santa Barbara.

Badel, Martha (1999). "La violencia de los años noventa en Colombia: Su evolución en las grandes ciudades y costos económicos directos" Informe de Consultoría DNP-UPRU, Santafé de Bogotá D.C.

Bogotá (2004). "Diagnóstico físico y socioeconómico de las localidades de Bogotá, D.C."

Blomquist, G.C.; Berger, M.C. and Hoehn, J.P. (1988). "New Estimates of Quality of Life in Urban Areas", *American Economic Review*, 78, pp.89-107.

Castaño, Elkin (2006). "Condiciones de vida en la ciudad de Medellín" Planeación Metropolitana – Centro de Estudios de Opinión, Universidad de Antioquia.

Cohen, Mark; Rust, Roland; Oteen, Sara and Tidd, Simon T. (2004). "Willingness to Pay For Crime Control Programs", *Criminology*, February.

Cohen, Mark and Rubio, Mauricio (2007). "Violence and Crime in Latin America, Solution Paper, Copenhagen Consensus and Inter--American Development Bank, San José, Costa Rica.

Conley, Timothy G. and Topa, Giorgio (2002). "Socio-Economic Distance and Spatial Patterns in Unemployment", *Journal of Applied Econometrics*, Vol. 17, 2002, pp. 303-327.

Cook, Philip J. and Ludwig, Jens (2000). "Gun Violence: The Real Costs", New York: Oxford University Press.

Departamento Nacional de Planeación, DNP (1997). "Índice de condiciones de vida urbano-rural", Misión Social.

Donohue, John J. and Levitt, Steven D. (2000). "The Impact of Legalized Abortion on Crime", NBER WP 8004.

Fajnzylber, Pablo; Lederman, Daniel and Loayza, Norman (1998). "Determinants of Crime Rates in Latin America and the World: An Empirical Assessment", The World Bank, Washington DC.

Fajnzylber, Pablo; Lederman, Daniel and Loayza, Norman (2000). "Crime and Victimization: An Economic Perspective", *Economia*, Vol. 1 (1), pp. 219-278.

Fajnzylber, Pablo; Lederman, Daniel and Loayza, Norman (2002a). "What Causes Violent Crime?", *European Economic Review*, Vol. 46, pp. 1323-1357.

Fajnzylber, Pablo; Lederman, Daniel and Loayza, Norman (2002b). "Inequality and Violent Crime", *Journal of Law and Economics*, Vol. XLV, (April), pp. 1-40.

Farrington DP (1998). "Predictors, Causes, and Correlates of Male Youth Violence" In: Tonry M, Moore MH, eds. Youth Violence. Chicago, IL, University of Chicago Press, pp. 421–475.

Flórez, Carmen E. (2007). "Demographics and Poverty in Colombia", Poverty Mission, mimeo

Gaviria, Alejandro and Pages, Carmen (2002). "Patterns of Crime Victimization in Latin America", *Journal of Development Economics*, Vol. 67, 2002.

Gavira, Alejandro and Vélez, Carlos Eduardo (2001). "Who Bears the Burden of Crime in Colombia?", mimeo, Fedesarrollo, Bogotá, Colombia.

González, J; Fresneda, O.; Martínez, P.; Rodríguez, O.; Sarmiento, A.; Oviedo, M.; Lasso, F. and Camacho, D. (2004). "Evolución de los principales indicadores sociales de Bogotá (1990-2003)", mimeo, Alcaldía de Bogotá.

Gyourko, J.; Kahn, M. and J. Tracy (1999). "Quality of Life and Environmental Comparisons", Handbook of Regional and Urban Economics, Volume 3, edited by Paul Cheshire and Edwin Mills, pp. 1413-1454. New York, North-Holland.

Hall, P.; Fisher, N.I. and Hoffman, B. (1994). "On the Non-Parametric Estimation of Covariance Functions", *The Annals of Statistics*, Vol. 22, No. 4 (December), pp. 2115-2134.

Heinemann, Alessandra and Verner, Dorte (2006). "Crime and Violence in Development: a Literature Review of Latin American and Caribbean", World Bank Policy Research Working Paper 4041, October.

Hunt, Jennifer (2003). "Teen Births Keep American Crime High", NBER WP 9632.

Krug, Etienne G.; Dahlberg, Linda L.; Mercy, James A.; Zwi, Anthony B. and Lozano, Rafael (2002). "World Report on Violence and Health", Geneva, World Health Organization.

Londoño, Juan Luis and Guerrero, Rodrigo (2000). "Violencia en América Latina: Epidemiología y costos", Inter-American Development Bank.

Ludwig, Jens and Cook, Philip J. (2001). "The Benefits of Reducing Gun Violence: Evidence from Contingent-Valuation Survey Data", Journal of Risk and Uncertainty, 22, pp. 207-26.

Llorente, María Victoria; Escobedo, Rodolfo; Echandía, Camilo and Rubio, Mauricio (2001). "Violencia homicida en Bogotá: Más que intolerancia", Documento CEDE , Universidad de los Andes?, 2001-04.

Medina, Carlos and Morales, Leonardo (2006). "Stratification and Public Utility Services in Colombia: Subsidies to Households or Distortions on Housing Prices?", forthcoming in *Economia*.

Medina, Carlos; Morales, Leonardo and Núñez, Jairo (2007). "Quality of Life in Urban Neighborhoods: The Case of Bogotá", Proposal to the Research Network of the Research Department, Inter American Development Bank.

Medina, Carlos and Núñez, Jairo (2006). "La oferta de servicios del sector financiero formal en Bogotá", *Coyuntura Social* N° 35, December 2006. Fedesarrollo, pp. 111-129.

Morales, Leonardo (2006). "La calidad de la vivienda en Bogotá: Enfoque de precios hedónicos de hogares y agregados espaciales", *Revista Sociedad y Economía* 9.

Moran P. (1948). "The Interpretation of Statistical Maps", *Journal of the Royal Statistical Society* B, 10, pp. 243-251.

Morash M, Rucker L. (1989). "An Exploratory Study of the Connection of Mother's Age at Childbearing to Her Children's Delinquency in Four Data Sets", Crime and Delinquency, 35, pp. 45–93.

Nagin, DS; Pogarsky, G and Farrington, DP (1997). "Adolescent Mothers and the Criminal Behavior of their Children", *Law and Society Review*, 31, pp. 137–162.

Núñez, Jairo and Sánchez, Fabio (2001). "Interrelaciones espaciales en los delitos contra el patrimonio en Bogota", mimeo.

Paz Pública (2000). "Escenarios del crimen en los barrios y localidades de Bogotá", Investigación "Caracterización de la Violencia Homicida en Bogotá", Documento de Trabajo No. 1. Bogotá: Paz Pública-CEDE-UNIANDES and Alcaldía de Bogotá.

Roback, Jennifer (1982). "Wages, Rents, and the Quality of Life", *Journal of Political Economy* 90, pp. 1257-1278.

Roback, Jennifer (1988). "Wages, Rents, and Amenities: Differences Among Workers and Regions", *Economic Inquiry* 26 (January), pp. 23-41.

Rosen, Sherwin (1974). "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition", *Journal of Political Economy* 82 (January/February), pp. 34-55.

Rosen, Sherwin (1979). "Wage-based Indexes of Urban Quality of Life", In Current Issues in Urban Economics, edited by Peter Mieszkowski and Mahlon Straszheim. Baltimore, Johns Hopkins University Press.

Rosen, Sherwin (2002) "Markets and Diversity" *The American Economic Review*, Vol. 92, No. 1. (Mar., 2002), pp. 1-15.

Sanchez, F. and Nuñez, J. (2000). "Determinantes del crimen violento en un país altamente violento: el caso de Colombia", Mimeo, Universidad de los Andes, Bogotá.

Topa, Giorgio (2001). "Social Interactions, Local Spillovers and Unemployment", *Review of Economic Studies*, Vol. 68 (2), April, pp. 261-295.

United Nations Population Fund, UNFPA (2007). "State of World Population 2007: Unleashing the Potential of Urban Growth".