The Impact of the Sense of Security from Crime on Residential Property Values in Brazilian Metropolitan Areas

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Main research questions

- Are households willing to pay more for residential properties where their sense of security from crime is higher?
- What variables influence this sense of security from crime?
The sense of security from crime refers to one’s perception about becoming a crime victim, rather than the actual risk of being a victim as measured by an indicator (e.g., robbery per 100,000 inhabitants from police records).

Sense of security from crime = Reverse of fear of crime
  ◦ Fear of crime = complement sense of security from crime
  ◦ Other side of the coin
Organization

In the following, we:

- Review the literature
- Discuss our methodology and its results
Linking different strands

- This paper links several different strands of literature:
  - Use the hedonic model of residential prices to measure the impact of the sense of security from crime on housing prices
  - Link this hedonic model with the literature on:
    - Empirical studies of fear of crime with microdata
    - Fear of crime
    - Defensible space
    - Fear of crime and police protection
The use of the hedonic housing price model to measure crime impact

- There are many Brazilian and international hedonic studies of this willingness to pay to live in areas with lower crime rates

- However:
  - Almost all use *crime rates*, rather than
    - the *sense of security from crime*, as we do
Empirical studies of fear of crime using microdata

- Corbacho et al. (2012) note the increase of crime studies using microdata in Latin America:
  - Colombia: Gaviria and Pagés (2002) and Gaviria and Velez (2001)
  - Trinidade and Tobago: Mohammed et al. (2009)
Using microdata in hedonic rent models in Brazil

- A number of Brazilian studies that calibrate hedonic residential rent models with microdata,
  - But not with sense of security from crime
- Use the hedonic rent model to estimate the stock of residential capital
  - i.e., residential wealth
- To this model, we will add the sense of security from crime and crime victimization variables
The crime victimization may \textbf{not} be the most important variable influencing the sense of security from crime

- Taylor and Hale (1986) conclude that:
  - “the results underscore the loose linkage between crime and fear. (...)”
  - “Crime was weaker as a predictor of fear of crime than perceptions of locale and sociodemographics.”
  - Socio-demographics variables include gender and age,
    - and other variables such as lower income and rental status related to the concept of social vulnerability.
Home Protection Measures: Establishing Defensible Space

• Since Oscar Newman’s book on *Defensible Space* (1972),
  ◦ there has been a discussion of the potential for crime prevention through environmental design
  ◦ Our survey data on home protection measures

• Focus on self-help:
  ◦ Relies on “self-help rather than on government intervention, and so it is not vulnerable to government’s withdrawal of support.”
Fear of Crime and Police Protection

- Confidence in police protection can reduce fear of crime, even for those who have been crime victims.

- Using probit models with microdata in Trinidad and Tobago, Mohammed et al. (2009) find that:
  - Crime victimization does increase fear of crime.
  - However, their results show that:
    - Fear was lower: If they reported the incident to the police and action was taken by the police.
    - On the other hand,
      - When there was no police action, fear of crime was higher.
Methodology and Results
Methodology

• In our methodology, we:
  
A. Calibrate a basic hedonic residential rent model using microdata:
  ◦ with our indicator of sense security from crime in the home
  ◦ as one of the independent variables
  
B. Use principal components analysis to identify the variables that can impact this sense of security from crime, including:
  ◦ Crime victimization
  ◦ Home protection measures
  ◦ Sex and age of the reference person
  
C. Introduce the component scores into our hedonic rent model as independent variables
Use data from IBGE’s 2009 national household sample survey

- **IBGE** = Brazilian Institute of Geography and Statistics
  - *Instituto Brasileiro de Geografia e Estatística*
  - Brazil’s main statistical agency
- **PNAD** = National Household Sample Survey
  - *Pesquisa Nacional por Amostra de Domicílios*
- Use the extraordinarily rich data on security from crime and crime victimization
  - From the supplement of the 2009 PNAD
Units of analysis

- For each household, we generate indicators for different levels:
  - Household:
    - Housing unit: Characteristics of the housing unit (e.g., number of rooms and home protection measures)
    - Household members: Characteristics of those living in the housing unit,
      - including the sense of security from crime and crime victimization for persons 10 or more years of age
  - Census sector: Characteristics of the households living in the census sector (setor censitário):
    - e.g., median household income, % who feel secure from crime
The data

- **Sample:** Households living in private permanent units,
  - located in urban areas
  - in the nine metropolitan areas and the Distrito Federal/ DF (Hereafter, Metro Areas)

- **Total sample of persons 10 or more years of age is:**
  - 118,286 persons in 40,095 households
  - Distributed among a total of 2,784 sectors
  - in the ten Metro Areas defined above
Brazil: Metro Areas:
% of Reference Persons in Rented Houses Who Feel Secure in Their Home, Neighborhood and City
by Per Capita Household Income Groups: 2009

<table>
<thead>
<tr>
<th>Per capita household income in Minimum Salaries (MS)</th>
<th>Secure in the home</th>
<th>Security in the neighborhood</th>
<th>Secure in city</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 1/4 MS</td>
<td>31.1%</td>
<td>32.1%</td>
<td>32.6%</td>
</tr>
<tr>
<td>&gt; 1/4 thru 1/2 MS</td>
<td>32.1%</td>
<td>32.6%</td>
<td>32.4%</td>
</tr>
<tr>
<td>&gt; 1/2 thru 1 MS</td>
<td>32.6%</td>
<td>30.7%</td>
<td>33.5%</td>
</tr>
<tr>
<td>&gt; 1 thru 2 MS</td>
<td>30.7%</td>
<td>32.4%</td>
<td>32.5%</td>
</tr>
<tr>
<td>&gt; 2 thru 3 MS</td>
<td>32.4%</td>
<td>33.5%</td>
<td></td>
</tr>
<tr>
<td>&gt; 3 thru 5 MS</td>
<td>33.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 5 MS</td>
<td>32.5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Crime levels rise with household income

- Rob those who have most to rob
- Following bank robber Willie Sutton’s strategy: He robbed banks: "because that's where the money is."
Brazil: Metro Areas:

Crime Rate Per 100,000 Persons of 10 or More Years of Age:

<table>
<thead>
<tr>
<th>Income Per Capita (Minimum Salaries)</th>
<th>Robbery</th>
<th>Theft</th>
<th>Aggression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 1/4 MS</td>
<td>2,969</td>
<td>1,975</td>
<td>1,541</td>
</tr>
<tr>
<td>&gt; 1/4 thru 1/2 MS</td>
<td>2,573</td>
<td></td>
<td>1,341</td>
</tr>
<tr>
<td>&gt; 1/2 thru 1 MS</td>
<td>3,137</td>
<td></td>
<td>1,313</td>
</tr>
<tr>
<td>&gt; 1 thru 2 MS</td>
<td>3,723</td>
<td></td>
<td>1,399</td>
</tr>
<tr>
<td>&gt; 2 thru 3 MS</td>
<td>4,817</td>
<td></td>
<td>1,064</td>
</tr>
<tr>
<td>&gt; 3 thru 5 MS</td>
<td>5,185</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 5 MS</td>
<td>5,805</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Per capita household income in Minimum Salaries (MS)
Brazil: Metro Regions: 2009
% reference persons in rented units who feel secure from crime at home and
victims of theft per 100,000 persons 10+ years of age
by per capita household income groups (Minimum Salaries)
Why does higher sense security in the home rise for higher income households when crime levels are higher?

- Home protection measures rise with household income
- Higher income households are:
  - at higher risk and
  - can also afford greater protection
Brazil: Metro Areas:
% of Households with Home Protection Measures
by Per Capita Household Income Groups (Minimum Salaries)
Brazil: Metro Regions

% reference persons in rented units who feel secure from crime at home and average % households with home protection measures by per capita household income groups (Minimum Salaries)

- % feel secure in home
- Average % with basic home protection measures

Household income groups in Minimum Salaries:
- Up to 1/4 MS
- > 1/4 thru > 1/2 MS
- > 1/2 thru > 1 MS
- > 1 thru 2 MS
- > 2 thru 3 MS
- > 3 thru 5 MS
- > 5 MS
A. The Basic Hedonic Rent Model

- Our basic hedonic residential rent model similar to existing models using PNAD microdata
Hedonic residential rent model

\[ \ln R = \beta_0 + S\beta_1 + A\beta_2 + N\beta_3 + \varepsilon \]

Where:

- **R** = Natural log of monthly rent
- **Matrices:**
  - **S** = Structural characteristics, including size and building materials, number of bathrooms
  - **A** = Access to employment and other opportunities
  - **N** = Neighborhood characteristics, including urban services and sense of security from crime
Variables for the basic hedonic rent model

- In our basic model, we use only two indicators of neighborhood quality (N):
  - Median household income of the census sector
  - Sense of security from crime in the home
Coefficient of the sense of security from crime in the home at the sector level was highly significant

- Is an indicator of the general view of the security level of those living in the neighborhood
Impact of improved security from crime on residential property value

- Impact on the home value of increasing the sense of security in the home at the sector level by one standard deviation (18.4%)?
- This would increase average home values by R$1,513 (about US$757)
B. Principal Components Analysis

Problem:
- The “independent” variables in the matrix of neighborhood indicators (N) are in fact correlated

- Use factor analysis with principal components extraction to address this problem

- Generate component scores to use as independent variables in our hedonic rent model
The variables in the principal components analysis

- Use 74 variables
- Both household and census sector levels
- The variables include:
  - Sense of security from crime in the home, neighborhood and city
  - Victimization from three types of crime:
    - Robbery
    - Theft
    - Physical aggression
  - Home protection measures
    - Intercoms
    - Bars on windows
    - High walls
    - Surveillance cameras,
    - Security personnel
The loadings on unrotated component 2

- Component shows high positive loadings for:
  - Household income
  - High sense of security from crime in the home at the sector level
  - Home protection measures
  - Theft reported to the police and registered by them
  - Theft
Component 2 of the Unrotated Matrix:
Variables with High Loadings Ranked: Household Income, Apartment, Home Protection, Security in Home and Neighborhood, Theft and Robbery

<table>
<thead>
<tr>
<th>Variables</th>
<th>Component Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector: median household income</td>
<td>0.732</td>
</tr>
<tr>
<td>Sector: % all persons in households: Feel secure in home</td>
<td>0.565</td>
</tr>
<tr>
<td>Home protection: Door viewer or intercom</td>
<td>0.504</td>
</tr>
<tr>
<td>Household: Apartment</td>
<td>0.495</td>
</tr>
<tr>
<td>Home protection: Surveillance camera</td>
<td>0.472</td>
</tr>
<tr>
<td>Sector: Theft reported to police</td>
<td>0.446</td>
</tr>
<tr>
<td>Sector: Theft registered by police</td>
<td>0.442</td>
</tr>
<tr>
<td>Sector: % all persons in households: Feel secure in neighborhood</td>
<td>0.425</td>
</tr>
<tr>
<td>Home protection: Security gate or person</td>
<td>0.403</td>
</tr>
<tr>
<td>Sector: % reference persons: Feel secure in home</td>
<td>0.365</td>
</tr>
</tbody>
</table>
C. Use the component scores in the hedonic rent model

- Introduce the component scores for the most pertinent components from our principal components model into our hedonic price model
  - with the log of monthly rent as the dependent variable
Regression Results for the Component Scores with Log-Linear Specification: Natural Log of Monthly Rent as the Dependent Variable

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High household income surveillance camera, sector inc</td>
<td>0.287****</td>
<td></td>
</tr>
<tr>
<td>Household: High income, apartment, security measures, and Sector: high security in the home</td>
<td>0.163****</td>
<td></td>
</tr>
<tr>
<td>High sector security in home, neighborhood and city</td>
<td>0.045****</td>
<td></td>
</tr>
<tr>
<td>High sector theft</td>
<td>0.038****</td>
<td></td>
</tr>
<tr>
<td>High sector robbery</td>
<td>0.021****</td>
<td></td>
</tr>
<tr>
<td>High household robbery</td>
<td>0.017****</td>
<td></td>
</tr>
<tr>
<td>Household and sector secure in the neighborhood and city</td>
<td>-0.043****</td>
<td></td>
</tr>
<tr>
<td>High sector aggression</td>
<td>-0.003</td>
<td></td>
</tr>
<tr>
<td>High household aggression</td>
<td>-0.004</td>
<td></td>
</tr>
<tr>
<td>High household: all persons and reference person feel secure in home</td>
<td>0.003</td>
<td></td>
</tr>
</tbody>
</table>
Main findings

- There is a strong and significant relationship between:
  - monthly rent and
  - sense of security in the home at the sector level
- Higher income households tend to feel more secure from crime in the home,
  - even though theft and robbery victimization tend to rise with household income and rent
- Higher levels of home protection measures and greater confidence in the police by higher income households partially explain this seeming paradox
  - Higher income households are more willing to report crime to the police, and of the police to register the crime
- The results from introduction of the component scores into our hedonic rent model support these findings
Brief look at some policy implications

- Importance of efforts to make space more defensible:
  - Changes policies on buildings and their surrounding areas to make them safer
  - Programs of greater community involvement
  - Studies to determine what environmental changes prevent crime and increase the sense of security

- Improve police effectiveness would increase the sense of security by increasing confidence in them.
  - Increase technical expertise in solving crimes (e.g., improved information systems and training)
  - Prosecution of police crime
  - Improvements in the way the public is treated when reporting crime
Future Studies

- Results show that the 2009 PNAD supplement provides the data necessary for a systematic, robust, and comprehensive analysis of the economic impact of crime and violence in Brazil.
- Only able to initiate this analysis of this rich database within the rigorous time constraint of this study.
- There are numerous areas for additional study.
Further analysis of key aspects of the sense of security and crime victimization

- There are a number of topics that could best be studied with the individual as the unit of analysis,
  - rather than households
- For example, analyze the relationships between sense of security and reporting crime to the police
  - including the attitudes about the police as shown by:
    - willingness to report crime and
    - the of police to register the crime
  - Along the lines in Trinidad and Tobago by Mohammed et al. (2009)

- Physical aggression certainly deserves further analysis, especially of:
  - violence against women
  - of the aggressors
  - impact of such violence on labor force participation and infant mortality
The Impact of Improved Sense of Security on Residential Wealth

- Simulate the impacts of improvements in the sense of security from crime on housing prices
  - and therefore the stock of residential wealth
  - Applying IPEA’s methodology
- Further work on the hedonic models
EXTRA SLIDES
Sense of security from crime in the home rises with per capita household income

- Lowest and Highest per capita household income groups in Minimum Salaries:
  - Lowest = Up to ¼ minimum salary =
    - US$58 per month per person or
    - US$233 per month for a family of four
  - Highest = Five minimum salaries =
    - US$1,160 per month per person or
    - US$4,640 for a family of four
- 1 Minimum Salary = US$233
Sense of security in the home

- PNAD 2009 asked all persons of 10 or more years of age:
  - Do you feel secure from crime in your home?

- For each household, we generate the binary variable for security from crime as:
  - $= 1$, if all of persons 10 years of age or more feel secure from crime
  - $= 0$, if not

- For each **census sector**, we calculate the percentage of households in which all persons 10 years or more feel secure from crime
Some of the Differences between Most Hedonic Housing Models of the Impact of Crime on Residential Prices and Our Study with Microdata

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Most hedonic housing models of the impact of crime</th>
<th>Our study with PNAD microdata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covers sense of security from crime</td>
<td>No</td>
<td>Yes, sense of security in the home, neighborhood and city</td>
</tr>
<tr>
<td>Covers home protection measures</td>
<td>No</td>
<td>Yes, covers a number of measures, including intercoms, bars on windows, surveillance cameras and security personnel</td>
</tr>
<tr>
<td>Covers both reported and unreported crime</td>
<td>No, reported crime only</td>
<td>Both reported and unreported crime, and also the reasons for not reporting. Also covers whether the crime was registered by the police or on the internet</td>
</tr>
<tr>
<td>Crime coverage</td>
<td>One or two types</td>
<td>Theft, robbery and physical aggression, as well as the frequency and location.</td>
</tr>
<tr>
<td>Unit of analysis</td>
<td>Spatial units: Neighborhoods and districts</td>
<td>Households, persons living in them and also census sectors</td>
</tr>
<tr>
<td>Area coverage</td>
<td>One city or urban area</td>
<td>Full area of Brazil. Analysis of individual metropolitan areas possible</td>
</tr>
<tr>
<td>Sources of data</td>
<td>Normally data from a number of sources: real estate sales and crime reports</td>
<td>Very large sample that covers sense of security from crime, crime victimization, as well as other housing and household characteristics.</td>
</tr>
</tbody>
</table>