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Article

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Nonlinear relationship between income, age and criminal victimization in Brazil[☆]

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Abstract

This study was mainly intended to investigate the effects of the income and age of individuals on their risk of becoming victims of physical assault, theft, robbery and attempted theft or robbery. Specifically, we were looking for evidence for a nonlinear relationship between these variables and victimization risk. Data from a national victimization survey were used to estimate victimization probability models. We found that, except for robbery and physical assault, the relationship between personal income and victimization risk has an inverted-U shape. We also found an inverted U-shape relationship between the age of individuals and victimization risk for the four types of crimes analyzed.

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Keywords: Victimization; Crime; Income; Age; Violence

Resumo

O objetivo principal desse artigo é investigar o efeito da renda e da idade sobre o risco de vitimização para quatro tipos de crime (agressão física, furto, roubo e tentativa de furto ou roubo). Especificamente, buscamos evidências de uma relação não linear entre essas variáveis com o risco de vitimização. Para tanto, utilizamos dados da pesquisa nacional de vitimização realizada em conjunto com a PNAD-2009 para estimar o risco de vitimização. Os resultados sugerem, exceto para roubo e agressão física, a existência de uma relação em forma de U invertido entre o rendimento pessoal e risco de vitimização. Essa mesma relação de U invertido também foi encontrada entre a idade dos indivíduos e o risco de vitimização para os quatro tipos de crimes analisados.

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Palavras-chave: Vitimização; Crime; Renda; Idade; Violência

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1. Introduction

Victimization has been a major issue in Brazilian society in recent years. About 10% of the Brazilian population over 10 years old had been victimized by at least one crime between September 2008 and September 2009 (PNAD, 2009). Of these, 5.4% were victims of attempted theft or robbery, 1.5% were physically assaulted, 3.7% were robbed, and 3.9% were victims of theft. In addition, 51% of all people aged 10 or over felt insecure. The fear of being victimized reduces the well-being of individuals and, consequently, the social well-being.¹ It is therefore important to investigate what are the “determinants” of victimization. Routine activities outside one’s home increase the risk of victimization and convergence in time and space between victims, criminals, and the absence of police leads to victimization even without changes in the variables that determine criminal behavior (Cohen and Felson, 1979). Based on this concept, Cohen et al. (1981) formalized a “theory” according to which the risk of victimization is determined by five factors: exposure, guardianship, proximity to potential offenders, attractiveness of potential targets, and definitional properties of specific crimes themselves. The first three factors are related to routine and the fourth one is related to the victim’s attributes, especially economic attributes.

In previous studies, the determinants of single victimization are usually identified using samples of data which nevertheless have little geographic coverage. In most cases, the sample is restricted to the population of a large city. For example, Gomes and Paz (2008) used a sample made up of some municipalities located in the state of São Paulo; Madalozzo and Furtado (2011), Gomes (2011), Peixoto et al. (2011), Scorzafave et al. (2011) and Justus and Kassouf (2013) used data collected in São Paulo city. Recently, Scorzafave et al. (2015) used data covering Brazil as a whole, focusing on criminal victimization in Brazilian rural areas.

In this context, this article is intended to identify “determinants” of personal victimization by four types of crimes (physical assault, theft, robbery and attempted theft or robbery) using a representative sample for all the Brazilian territory, with specific emphasis on the effects of personal income and age on this process.

Gomes and Paz (2008) and Justus and Kassouf (2013) found evidence supporting the hypothesis that the effect of wealth on victimization risk is positive, but not linear. These results were, however, obtained from samples that were rather limited geographically due to the unavailability of data when they were defined. It will therefore be investigated whether the positive and nonlinear effect of income on victimization holds for a sample covering the entire Brazilian territory with a much greater variability in income distribution.

In the literature, for example, Freeman (1999) points out that a situation in which the income of the richest increases while that of the poorest remains constant does not necessarily lead to greater victimization of the former. The latter can spend more on security devices, thus decreasing their likelihood of falling prey to crime. However, the literature does not focus specifically on analyzing the nonlinearity of the effect of income on victimization, which is one of the main aspects addressed in this article. This aspect is only discussed briefly by a few authors. For example, Gomes and Paz (2008) found that the middle class is the one exposed to the greatest risk of victimization, while for the lower and upper class the risk is less pronounced. Using dummies for household income (Souza and da Cunha, 2015) or logarithms for monthly per capita household income (Justus et al., 2015), recent research found that income affects the risk of victimization and the number of crimes (repeat victimization) of robbery, theft and attempted theft or robbery positively. Our study is therefore intended to identify the effects of personal income on victimization risk by testing the hypothesis that the income–victimization risk curve increases to a peak and then drops off.

With regard to age, it is known, on the one hand, that young people are more prone to crime both as offenders and victims (Sweeten et al., 2013; Spagnol, 2005; Beato et al., 2004; Farrington, 1986). On the other hand, the theory of predatory victimization suggests that older individuals are less exposed to criminals than younger people, especially in connection with property crimes. For this reason, it will also be investigated whether there is a nonlinear relationship between age and risk of victimization. Specifically, we will estimate the age at which the risk of victimization becomes the highest (or the lowest) for each type of crime, i.e. we will estimate an age–victimization risk curve.

The rest of this article is structured as described below. The methodology and the data are presented in Section 2. In this same section we will make a descriptive analysis of the variables of interest. The empirical results are shown in Section 3 and Section 4 concludes the study.

¹ For a more detailed discussion on the relationship between crime and fear, see, for example, Tseloni and Zarafonitou (2008) and Borges (2013).

2. Methodology

In this section, we first present a model of individual victimization based on the literature. Next, we present the data used, a detailed description of the four types of crimes analyzed, the plausible “determinants” of victimization and a brief descriptive analysis.

2.1. Empirical model

According to the approach adopted by [Cohen et al. \(1981\)](#), the nature of a crime is one of the five determinants of the risk of victimization. Therefore, we conducted separate estimates for three types of property crimes (theft, robbery and attempted theft or robbery), for one type of crime against persons (physical assault) and for victimization risk regardless of the crime (victim). Data from a special supplement on victimization included in the National Household Sample Survey – 2009 (PNAD, in the Brazilian acronym) were used.²

In addition, one of the main issues involved in economic evaluations of crime is the under-reporting of crimes, that is, when an individual victim chooses not to report the occurrence of a crime to the competent authorities. This usually leads to the actual crime rate being underestimated. The microdata used in the estimation of empirical models in this article are less prone to measurement errors than official crime data, especially for property crimes. Thus, the data sample used in the estimations is made up of both individuals who reported victimization episodes and individuals who did not.³

Probit models were estimated,⁴ as the variable $y_{i,j}$ is a binary variable that takes 1 if individual i was the victim of a crime j ($j = \{\text{victim, theft, attempted theft or robbery, physical assault}\}$) and 0 otherwise. Thus, the risk of victimization $p_{i,j}$ is defined as

$$p_{i,j} = \text{Prob}[y_{i,j} = 1|\mathbf{x}] = \Phi(\mathbf{x}'\boldsymbol{\beta}),$$

where Φ is the cumulative normal distribution, $\boldsymbol{\beta}$ is a vector of parameters to be estimated and \mathbf{x} contains values for the variables: sex (man, woman), skin color (white, nonwhite), age, marital status (single, married, widowed, separated), years of education, place of residence (urban, rural), region of residence (metropolitan, non-metropolitan), migration status (migrant, non-migrant), individual monthly personal income,⁵ occupation status (working, not working), dummies for time spent to go to work (less than 30 min, 30 min to 1 h, 1–2 h and more than 2 h), state-level income inequality (Gini index)⁶ and dummy variables for Brazilian states.

It should be noted that age squared and income squared were included as a way to capture a nonlinear relationship between these variables and victimization risk. Interactions among some variables were also included: (i) the interaction between urban and metropolitan areas, to take into account the possibility that the effect of urbanization on victimization risk may be different in the latter; (ii) gender and marital status were also interacted, as there is evidence in the literature suggesting that single men are more likely to be victimized; (iii) gender and skin color were interacted to check for heterogeneity in the combination of these variables in the victimization process.

These control variables (see [Table 1](#)) are based on other studies found in the literature on victimization. It is expected that the risk of victimization for people living in an urban area and/or in a large city is higher due to the greater proximity between potential victims and criminals, increased exposure of the victims, higher return on criminal activity ([Justus and Santos Filho, 2011](#)), and lower cost of committing a crime ([Glaeser and Sacerdote, 1999](#)).

Skin color or race and gender variables are commonly utilized in the literature in order to take into account the role of these attributes in victimization. Being married is associated with increased responsibilities, as it tends to lead people to adopt less risky behaviors. As for the variables of working or not and years of schooling, it is expected, due

² The questions on victimization refer to the period from September 2008 to September 2009.

³ According to data from the 2009 National Household Survey, less than 50% of all victims filed a police report. The main alleged reasons for not filing a police report include lack of evidence and disbelief in the police (see [Table A.3](#)).

⁴ See [Cameron and Trivedi \(2005\)](#).

⁵ Total income from employment and other sources earned by the individual.

⁶ The Gini index was calculated for the 27 Brazilian states considering the urban and rural disaggregation. Thus, 54 distinct values were generated. Although the Gini index is an aggregated variable, it will be used together with microdata in order to control for possible effects of income inequality in the environment in which the individual lives.

Table 1
Definition, mean and standard deviation of variables of criminal victimization models.

| Variable | Definition | Mean | Std. dev. |
|----------------------------|---|-------|-----------|
| Victim | 1 if the individual was a victim of, at least, one crime, and 0 otherwise | 0.110 | 0.313 |
| Physical assault | 1 if the individual was a victim of physical assault, and 0 otherwise | 0.016 | 0.127 |
| Theft | 1 if the individual was a victim of theft, and 0 otherwise | 0.040 | 0.196 |
| Robbery | 1 if the individual was a victim of robbery, and 0 otherwise | 0.043 | 0.203 |
| Attempted theft or robbery | 1 if the individual was a victim of attempted theft or robbery, and 0 otherwise | 0.058 | 0.234 |
| Man | 1 if the individual is a man, and 0 otherwise | 0.481 | 0.500 |
| White | 1 if the individual is Caucasian or Asian, and 0 otherwise | 0.453 | 0.498 |
| Works | 1 if the individual works, and 0 otherwise | 0.559 | 0.497 |
| Less than 30 min | 1 if the individual spends less than 30 min to go work and 0 otherwise | 0.859 | 0.348 |
| 30 min to 1 h | 1 if the individual spends between 30 min and 1 h to go work and 0 otherwise | 0.101 | 0.302 |
| 1–2 h | 1 if the individual spends between 1 h and 2 h to go work and 0 otherwise | 0.033 | 0.178 |
| More than 2 h | 1 if the individual spends more than 2 h to go work and 0 otherwise | 0.007 | 0.082 |
| Migrant | 1 if the individual is a migrant, and 0 otherwise | 0.176 | 0.381 |
| Single | 1 if the individual is single, and 0 otherwise | 0.518 | 0.500 |
| Married | 1 if the individual is married, and 0 otherwise | 0.385 | 0.487 |
| Separated | 1 if the individual is separated, and 0 otherwise | 0.046 | 0.209 |
| Widower | 1 if the individual is a widower, and 0 otherwise | 0.051 | 0.220 |
| Urban | 1 if the individual lives in an urban area, and 0 otherwise | 0.852 | 0.355 |
| Metropolis | 1 if the individual lives in a metropolis, and 0 otherwise | 0.375 | 0.484 |
| Schooling | Years of schooling | 7.203 | 4.392 |
| Age | Age in years | 36.04 | 18.59 |
| Income | Income in thousands of reals | 0.728 | 1.829 |
| Gini | Gini index (at state level for urban and rural areas) | 0.661 | 0.030 |

Note: Prepared with data from the sample used in the estimations; $n = 308,760$.

to the correlation of these features with personal income, that both have a positive effect on victimization risk, as they tend to increase the economic return on crime. The time spent to go to work may increase the risk of victimization, since it is a proxy for exposure.

The variable for migrant is a proxy based on the theory of social organization. According to this theory, certain community features, including residential mobility, reduce people's ability to exercise social control and, consequently, increase crime and delinquency rates.⁷ This variable is therefore likely to have a positive effect on victimization risk.

Income inequality is a good proxy for the difference in gains made in legal and illegal activities, at least with regard to crime for pecuniary gain (Scorzafave and Soares, 2009; Dahlberg and Gustavsson, 2008; Demombynes and Özler, 2005; Bourguignon, 2000), whereas personal income or household income level is widely used as a proxy for the expected return on crime and is not necessarily expected to show a positive relationship, as it carries both aspects related to the benefit of crime and to its costs (Just and Kassouf, 2007).

From the standpoint of Farrington (1986), many of the questions about age and offending rates would probably also apply to age and victimization. For this reason, the same nonlinearity found in the age–crime curve is likely to be detected in the relationship between age and victimization risk. However, if age–crime curves reach their peak during youth, the age–victimization risk curve is expected to reach its peak during adulthood, as adults enjoy higher returns (they earn income from work and had more time to accumulate wealth) as compared to young people.

2.2. Data and sample

The source of the data used to estimate the model with the above-described variables was a victimization survey jointly conducted with the National Household Sample Survey (PNAD). Every year, except in those in which the Demographic Census is carried out, the Brazilian Institute for Geography and Statistics (IBGE) collects data for a

⁷ For a more detailed discussion see, for example, Villarreal and Silva (2006).

Box 1: Types of crimes and definitions.

| Crime | Definition |
|----------------------------|---|
| Physical assault | Assault characterized by the occurrence of bodily harm, where the victim suffers bodily injury by the attacker in some way, such as slapping the face, shoving, punching, beating up, rape or sexual violence, injuries caused by firearms or use of bodily force or objects (knives, stones, makeshift wooden clubs, etc.) by the assaulter. |
| Theft | Removal of any object from a person without the use of threats or violence. Usually the person is not present at the event or is not aware of it as it happens. |
| Robbery | Removal of any object from a person with the use of threats, force or violence. Commonly known as stickup or mugging. |
| Attempted theft or robbery | Action aimed at committing robbery (involving threats or the use of force or violence) or theft (without threats or violence) that is not successful. An attempted crime is considered to have occurred from the moment that there is evidence that the offender intended to commit it. |

Source: Prepared with technical notes from 2009 PNAD.

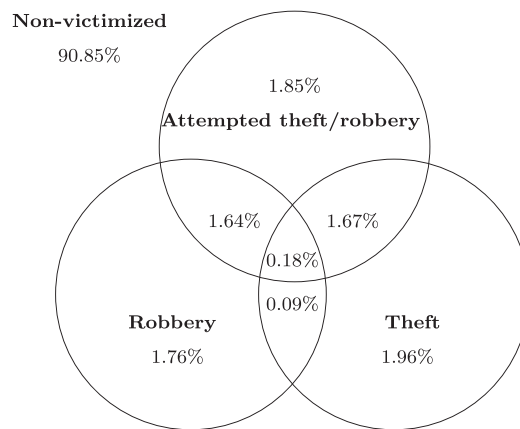


Fig. 1. Percentage of victimization by property crimes.

Source: Prepared with data from 2009 PNAD.

sample of households.⁸ Information is also collected about the general characteristics of the population, including education, labor, income and housing. The survey is representative for the country as a whole and also for units of the federation comprising over 90,000 households. In addition, along with the permanent survey, households are also requested to provide information to be included in a special supplement about temporary issues, including characteristics of victimization and access to justice in Brazil.

We used data provided in the most recent special supplement of the PNAD relating to Victimization and Justice for 2009. In addition to investigating the population's access to justice and sense of security in 2009, IBGE also investigated the individual victimization process for people over 10 years old for four types of crime, three of which are classified as property crimes (theft, robbery and attempted theft or robbery) and one is defined as a crime against persons (physical assault). Explanatory notes contained in the PNAD define the crimes investigated here as follows in [Box 1](#).

A brief descriptive analysis of the sample will be carried out now. Together with the above-mentioned theories and studies, this analysis allows for speculating on the signs of some explanatory variables of interest of the victimization models that will be discussed in the next section.

⁸ A random sample of households is obtained in three selection stages: primary units, municipalities; secondary units, census sectors; and tertiary units, household units (private households and housing units in collective households).

Table 2
Mean characteristics of the victimized and non-victimized individuals.

| Characteristics | Victimized | | | | | Non-victimized | | | | |
|------------------|------------------|------------------|------------------|------------------|----------------------------|------------------|------------------|------------------|------------------|----------------------------|
| | Victim | Physical assault | Theft | Robbery | Attempted theft or robbery | Victim | Physical assault | Theft | Robbery | Attempted theft or robbery |
| Man | 53.65% (0.50) | 58.02% (0.49) | 54.72% (0.50) | 54.07% (0.50) | 52.77% (0.50) | 47.42% (0.50) | 47.94% (0.50) | 47.83% (0.50) | 47.84% (0.50) | 47.82% (0.50) |
| White | 43.86% (0.50) | 36.75% (0.48) | 45.91% (0.50) | 43.03% (0.50) | 47.31% (0.50) | 45.43% (0.50) | 45.40% (0.50) | 45.23% (0.50) | 45.36% (0.50) | 45.13% (0.50) |
| Works | 69.18% (0.46) | 64.61% (0.48) | 70.41% (0.46) | 70.87% (0.45) | 69.78% (0.46) | 54.24% (0.50) | 55.74% (0.50) | 55.28% (0.50) | 55.22% (0.50) | 55.03% (0.50) |
| Less than 30 min | 79.94% (0.40) | 83.81% (0.37) | 82.22% (0.38) | 76.20% (0.43) | 78.83% (0.41) | 86.68% (0.34) | 85.98% (0.35) | 86.10% (0.35) | 86.38% (0.34) | 86.38% (0.34) |
| 30 min to 1 h | 13.81% (0.35) | 11.02% (0.31) | 12.48% (0.33) | 16.35% (0.37) | 14.52% (0.35) | 9.66% (0.30) | 10.10% (0.30) | 10.02% (0.30) | 9.84% (0.30) | 9.85% (0.30) |
| 1–2 h | 5.30% (0.22) | 4.34% (0.20) | 4.32% (0.20) | 6.49% (0.25) | 5.65% (0.23) | 3.01% (0.17) | 3.24% (0.18) | 3.22% (0.18) | 3.12% (0.17) | 3.11% (0.17) |
| More than 2 h | 0.94% (0.10) | 0.83% (0.09) | 0.98% (0.10) | 0.96% (0.10) | 1.00% (0.10) | 0.65% (0.08) | 0.68% (0.08) | 0.67% (0.08) | 0.67% (0.08) | 0.66% (0.08) |
| Migrant | 19.06% (0.39) | 16.29% (0.37) | 20.77% (0.41) | 18.19% (0.39) | 20.51% (0.40) | 17.38% (0.38) | 17.59% (0.38) | 17.43% (0.38) | 17.54% (0.38) | 17.38% (0.38) |
| Single | 54.05% (0.50) | 67.16% (0.47) | 47.37% (0.50) | 58.96% (0.49) | 50.42% (0.50) | 51.47% (0.50) | 51.50% (0.50) | 51.94% (0.50) | 51.43% (0.50) | 51.84% (0.50) |
| Married | 35.72% (0.48) | 24.62% (0.43) | 40.29% (0.49) | 32.62% (0.47) | 38.45% (0.49) | 38.89% (0.49) | 38.77% (0.49) | 38.46% (0.49) | 38.80% (0.49) | 38.54% (0.49) |
| Separated | 6.27% (0.24) | 6.00% (0.24) | 7.12% (0.26) | 5.53% (0.23) | 6.66% (0.25) | 4.38% (0.20) | 4.57% (0.21) | 4.48% (0.21) | 4.55% (0.21) | 4.46% (0.21) |
| Widower | 3.96% (0.20) | 2.21% (0.15) | 5.23% (0.22) | 2.89% (0.17) | 4.48% (0.21) | 5.26% (0.22) | 5.16% (0.22) | 5.11% (0.22) | 5.22% (0.22) | 5.16% (0.22) |
| Urban | 93.59% (0.24) | 90.40% (0.29) | 92.13% (0.27) | 96.18% (0.19) | 94.44% (0.23) | 84.16% (0.37) | 85.12% (0.36) | 84.91% (0.36) | 84.71% (0.36) | 84.63% (0.36) |
| Metropolis | 47.64% (0.50) | 38.57% (0.49) | 36.03% (0.48) | 61.69% (0.49) | 51.12% (0.50) | 36.27% (0.48) | 37.51% (0.48) | 37.59% (0.48) | 36.44% (0.48) | 36.69% (0.48) |
| Schooling | 8.391 (4.180) | 6.910 (4.030) | 8.220 (4.400) | 8.953 (3.890) | 8.744 (4.170) | 7.056 (4.390) | 7.208 (4.400) | 7.160 (4.390) | 7.125 (4.400) | 7.108 (4.390) |
| Income | 0.944 (1.800) | 0.547 (1.040) | 1.105 (2.050) | 0.893 (1.720) | 1.030 (1.790) | 0.701 (1.830) | 0.731 (1.840) | 0.712 (1.820) | 0.720 (1.830) | 0.709 (1.830) |

Notes: Prepared with data from the sample used in the estimations; the definitions of the variables are reported in Table 1; standard deviation in parentheses.

From September 2008 to September 2009, about 10% of all Brazilians were victims of some type of crime. Among the reports of victimization, almost 90% are related to economically motivated crimes. Fig. 1 shows the percentage of property crimes disaggregated by types of crimes that occurred over that period.

Attempted theft or robbery accounts for most property crimes (5.34%). The overlap of this type of crime with other crimes is the most significant aspect, as 3.49% (1.67% + 1.64% + 0.18%) of the individuals were victims of both attempted theft or robbery and of theft and/or robbery over the period under analysis. Those who reported having been victims of more than one crime in 2009 represent 3.58% of all Brazilians.

Table 2 shows, for each type of crime, the characteristics of the victims and non-victims. The features presented refer to the set of regressors used in the estimations of the risk of being victimized according to the type of crime. The first column shows statistics relating to the fact that a person was victimized by at least one of the crimes, regardless of the modality.

With respect to individual, demographic and environmental characteristics, we observed the following points: (i) the percentage of migrants (citizens who were not born in the same state as the one they reside in) among the victimized population is higher for the crimes of attempted theft or robbery and of theft alone. However, those living in the same

Table 3
Unpaired *t* test between victimized and non-victimized individuals.

| Characteristics | Victim | Physical assault | Theft | Robbery | Attempted theft or robbery |
|------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Man | 0.06 ^{***} (0.00) | 0.10 ^{***} (0.01) | 0.07 ^{***} (0.00) | 0.06 ^{***} (0.00) | 0.05 ^{***} (0.00) |
| White | −0.01 ^{***} (0.00) | −0.08 ^{***} (0.01) | 0.01 ^{**} (0.00) | −0.02 ^{***} (0.00) | 0.02 ^{***} (0.00) |
| Works | 0.14 ^{***} (0.00) | 0.08 ^{***} (0.01) | 0.14 ^{***} (0.00) | 0.15 ^{***} (0.00) | 0.14 ^{***} (0.00) |
| Less than 30 min | −0.07 ^{***} (0.00) | −0.02 ^{***} (0.00) | −0.04 ^{***} (0.00) | −0.10 ^{***} (0.00) | −0.08 ^{***} (0.00) |
| 30 min to 1 h | 0.04 ^{***} (0.00) | 0.01 ^{**} (0.00) | 0.02 ^{***} (0.00) | 0.07 ^{***} (0.00) | 0.05 ^{***} (0.00) |
| 1–2 h | 0.02 ^{***} (0.00) | 0.01 ^{***} (0.00) | 0.01 ^{***} (0.00) | 0.03 ^{***} (0.00) | 0.03 ^{***} (0.00) |
| More than 2 h | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| Migrant | 0.02 ^{***} (0.00) | −0.01 ^{**} (0.01) | 0.03 ^{***} (0.00) | 0.01 [*] (0.00) | 0.03 ^{***} (0.00) |
| Single | 0.03 ^{***} (0.00) | 0.16 ^{***} (0.01) | −0.04 ^{***} (0.00) | 0.07 ^{***} (0.00) | −0.01 ^{***} (0.00) |
| Married | −0.03 ^{***} (0.00) | −0.15 ^{***} (0.01) | 0.02 ^{***} (0.00) | −0.06 ^{***} (0.00) | −0.00 (0.00) |
| Separated | 0.02 ^{***} (0.00) | 0.02 ^{***} (0.00) | 0.03 ^{***} (0.00) | 0.01 ^{***} (0.00) | 0.02 ^{***} (0.00) |
| Widower | −0.01 ^{***} (0.00) | −0.03 ^{***} (0.00) | 0.00 (0.00) | −0.02 ^{***} (0.00) | −0.01 ^{***} (0.00) |
| Urban | 0.10 ^{***} (0.00) | 0.05 ^{***} (0.00) | 0.07 ^{***} (0.00) | 0.12 ^{***} (0.00) | 0.10 ^{***} (0.00) |
| Metropolis | 0.11 ^{***} (0.00) | 0.01 (0.01) | −0.01 ^{***} (0.00) | 0.25 ^{***} (0.00) | 0.14 ^{***} (0.00) |
| Schooling | 1.33 ^{***} (0.02) | −0.31 ^{***} (0.06) | 1.06 ^{***} (0.04) | 1.80 ^{***} (0.04) | 1.62 ^{***} (0.03) |
| Age | −0.85 ^{***} (0.10) | −5.32 ^{***} (0.25) | 2.00 ^{***} (0.16) | −2.48 ^{***} (0.13) | 0.38 ^{***} (0.13) |
| Income | 0.26 ^{***} (0.01) | −0.18 ^{***} (0.02) | 0.40 ^{***} (0.02) | 0.19 ^{***} (0.02) | 0.34 ^{***} (0.01) |

Note: Standard errors in parentheses.

* Significance at 10%.

** Significance at 5%.

*** Significance at 1%.

state where they were born account for almost 80% of the population victimized by property crimes; (ii) those living in rural areas correspond, at most, to 10% of the victims; (iii) the percentage of men is at least 5 percentage points higher in the victimized population in relation to those who have not been victims of crime; (iv) the majority of victims are people of African descent, especially for crimes of physical assault (63%), for which this percentage is higher than that of black and brown people in the Brazilian population (50.7%); (v) the percentage of workers among victims is 15 percentage points higher than that recorded for non-victims; (vi) education and income levels are higher among victims, except for the crime of physical assault.

The points highlighted above are corroborated in Table 3, which shows results of unpaired (two sample) *t* tests on the equality of means specified for two groups (victimized and non-victimized). Highly significant differences were recorded between victims and non-victims in almost every case.

3. Results and discussion

The marginal effects estimated by type of crime are presented in Table 4. The estimations were performed using the design of complex surveys, since the actual variance tends to be underestimated when such sample design is ignored.

Table 4
Marginal effects (at the means of regressors) by type of crime.

| Variables | Victim | Physical assault | Theft | Robbery | Attempted theft or robbery |
|--------------------------|----------------------|----------------------|----------------------|----------------------|----------------------------|
| Man | 0.022*** (0.001) | 0.005*** (0.001) | 0.009*** (0.001) | 0.008*** (0.001) | 0.010*** (0.001) |
| White | -0.001 (0.001) | -0.002*** (0.001) | -0.002** (0.001) | 0.002*** (0.001) | 0.004*** (0.001) |
| Works | 0.033*** (0.002) | 0.005*** (0.001) | 0.014*** (0.001) | 0.013*** (0.001) | 0.015*** (0.001) |
| 30 min to 1 h | 0.002 (0.002) | -0.001 (0.001) | -0.001 (0.001) | 0.003*** (0.001) | 0.002 (0.002) |
| 1–2 h | 0.018*** (0.004) | 0.001 (0.001) | 0.001 (0.002) | 0.009*** (0.002) | 0.011*** (0.003) |
| More than 2 h | 0.011 (0.007) | -0.001 (0.003) | 0.005 (0.005) | 0.005 (0.004) | 0.011** (0.006) |
| Migrant | 0.007*** (0.002) | -0.000 (0.001) | 0.001 (0.001) | 0.006*** (0.001) | 0.005*** (0.001) |
| Married | -0.019*** (0.002) | -0.008*** (0.001) | -0.005*** (0.001) | -0.009*** (0.001) | -0.005*** (0.001) |
| Separated | 0.019*** (0.003) | 0.005*** (0.002) | 0.009*** (0.002) | 0.001 (0.002) | 0.011*** (0.002) |
| Widower | 0.014*** (0.005) | -0.003 (0.002) | 0.010*** (0.003) | 0.000 (0.003) | 0.014*** (0.004) |
| Urban | 0.052*** (0.003) | 0.008*** (0.001) | 0.019*** (0.001) | 0.018*** (0.002) | 0.028*** (0.002) |
| Metropolis | 0.045*** (0.003) | 0.003*** (0.001) | -0.001 (0.001) | 0.039*** (0.002) | 0.029*** (0.002) |
| Schooling | 0.004*** (0.000) | -0.001*** (0.000) | 0.001*** (0.000) | 0.002*** (0.000) | 0.003*** (0.000) |
| Income | 0.004*** (0.001) | -0.001*** (0.000) | 0.003*** (0.001) | -0.001** (0.000) | 0.003*** (0.001) |
| Age ($\times 10^{-3}$) | 0.275*** (0.059) | -0.146*** (0.023) | 0.342*** (0.037) | 0.001 (0.028) | 0.314*** (0.041) |

Notes: $n = 308,760$; standard errors in parentheses; the definitions of the variables are reported in Table 1; dummy variables for state were used.

* Significance at 10%.

** Significance at 5%.

*** Significance at 1%.

As for the quality of the adjustment made in the models, the percentage of correct predictions (PCP) remained between 88% and 98% (see Table A.1). The risk of being victimized, regardless of the type of crime, as shown in the first column, is influenced by characteristics of the individual, such as by factors related to the environment in which he or she lives. For example, the risk of victimization for men is almost 2 percentage points (p.p.) higher than for women. Regarding marital status, we observed that married people are less likely to become victims of crime. If someone spends between 1 h and 2 h from house to work his or her risk of victimization increases by 1.8 p.p. as compared to a person who spends less than 30 min.

The risk of physical assault is higher for men, for those who have a job and for people residing in urban areas or in a metropolis. This risk decreases slightly as years of education and income increase, that is, more educated or richer people are less likely to be assaulted. On the other hand, the effect is opposite for theft and attempted theft or robbery. This result has also been reported by Gianini et al. (1999), Gomes and Paz (2008), Zaluar (2009), Justus et al. (2015), for example, and may indicate that economic reasons are not the most important determinants for physical assault. Furthermore, crime against persons has little economic motivation for two main reasons: (i) 73.4% of assaults occur at one's home or in educational establishments and (ii) 56.6% of them are committed by people who were well known by the victim (friends and acquaintances, spouses, former spouses, or relatives). It can therefore be deduced that this type of crime is motivated by misunderstandings or by passion and that they are not particularly related to economic conditions or home security.

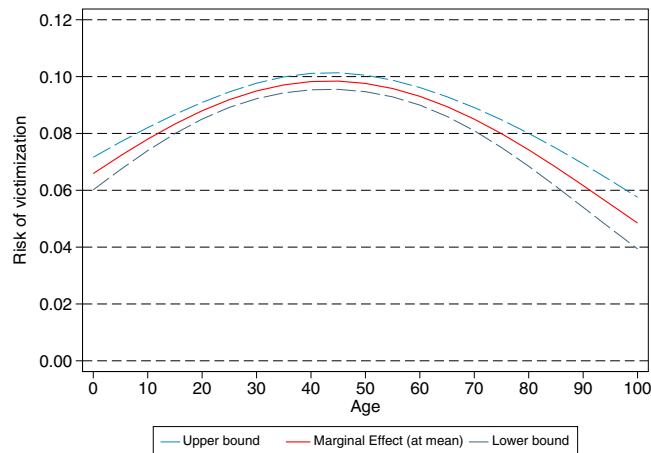


Fig. 2. Marginal effect (at the means of regressors) of age on victimization risk (physical assault, theft, robbery and attempted theft or robbery).

The results for theft crimes show that skin color, gender and residing in urban areas have a bearing on the risk of victimization. The characteristics of the region one lives in play a prominent role in robbery crimes. The risk of a person being robbed is about 4 p.p. higher in metropolitan regions and 2 p.p. higher in urban areas. This risk is lower for married individuals, but there is no difference among single, separated or widowed individuals. There is no doubt that young and single men expose themselves more to risk factors that lead to the occurrence of such crimes. Older and married people are usually more cautious in their day-to-day activities.

With respect to attempted theft or robbery, we found that almost all explanatory variables were statistically significant and that the effect remained within the expected range. Living in an urban area, for example, increases the probability of a person becoming a victim of attempted theft or robbery by almost 3 p.p.

Up to this point, we have seen the robust effect of variables linked to marital status and to the urban variable, which is in accordance with the literature. We also showed that men are always more likely to become victims than women whatever the crime, and that race displays no clear pattern. What remains to be investigated is the relationship between income and age in relation to the risk of victimization, that is, the shape of the income–victimization risk curve and that of the age–victimization risk curve.

The results in Fig. 2 suggest that the relationship between age and victimization has an inverted U-shape. Children and elderly people tend to be less risk-prone; people at intermediate ages are in turn more exposed to any of the types of crime analyzed here.

Fig. 3 and Table A.2 show that the age–victimization risk curve reaches its peak at different ages for each type of crime. The maximum age risk for robbery occurs at the age of 38; for physical assault, at the age of 27; and for theft, at the age of 58. The result for assault corroborates the literature: young people are more daring and therefore take more risks. As for theft, the estimated age may reflect the fragility and vulnerability of elderly people, as well as the fact that they have more goods than young people.

On the other hand, the relationship between income and victimization risk is statistically significant in all the estimated models. At means of regressors, increased income raises the victimization risk by 0.4 p.p. However, this effect is not the same for all income levels. As a result, for people with a monthly income of less than approximately 15.4 thousand reals, any marginal increase in income will increase the risk of victimization (see Fig. 4). For those who earn more, increases in income reduce the risk because they have the means to invest more in goods that ensure greater security. This figure means that, considering income distribution in Brazil, an increase in income leads to a lower risk of victimization for less than 1% of all Brazilians.

Considering each type of crime separately, Fig. 5 and the coefficients in Table A.1 show that: (i) the income–victimization risk curve is nonlinear (inverted U) for theft and for attempted theft and robbery and that the risk of victimization reaches its peak at income levels of 18.7 and 8.4 thousand reals, respectively; and (ii) for the crimes of physical assault and robbery, this relationship is negative.

This piece of evidence (except for robbery) is consistent with the results found in Gomes and Paz (2008) and Justus and Kassouf (2013) with data for municipalities located in the state of São Paulo and for the city of São Paulo. The

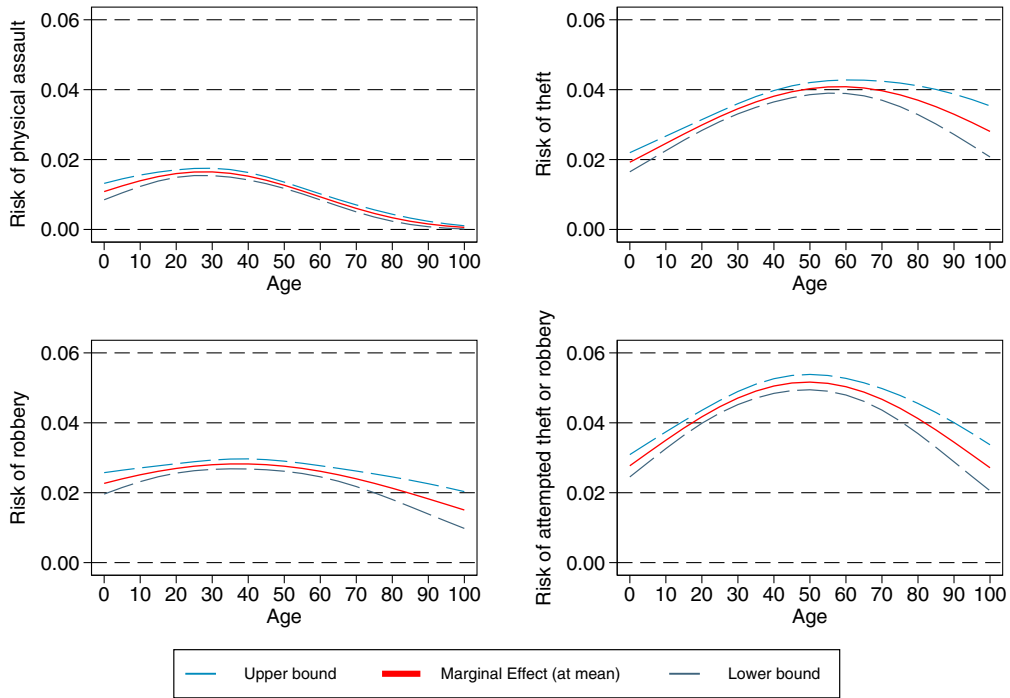


Fig. 3. Marginal effect (at the means of regressors) of age on victimization risk by types of crime.

higher the income of a potential victim, the greater his or her attractiveness to crime and, on the other hand, the greater the willingness of the individual to spend more in ensuring his or her own security. The combination of these two factors leads the risk of victimization to be higher for people with intermediate levels of income.

We also investigated the relationship between the use of domestic security items and level of income for the Brazilian population to check the hypothesis that higher-income households invest more in security than the rest. This can be clearly seen in Fig. 6, which shows that higher-income Brazilian households are fitted with more security items, while less than half of poorer households use a security device of some kind and almost 100% of the homes of the rich have extra locks and bolts, electrified fences and walls.

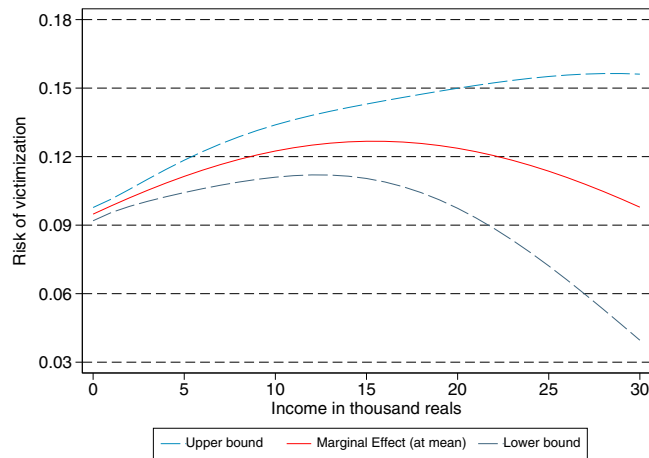


Fig. 4. Marginal effect (at the means of regressors) of income on victimization risk (physical assault, theft, robbery and attempted theft or robbery).

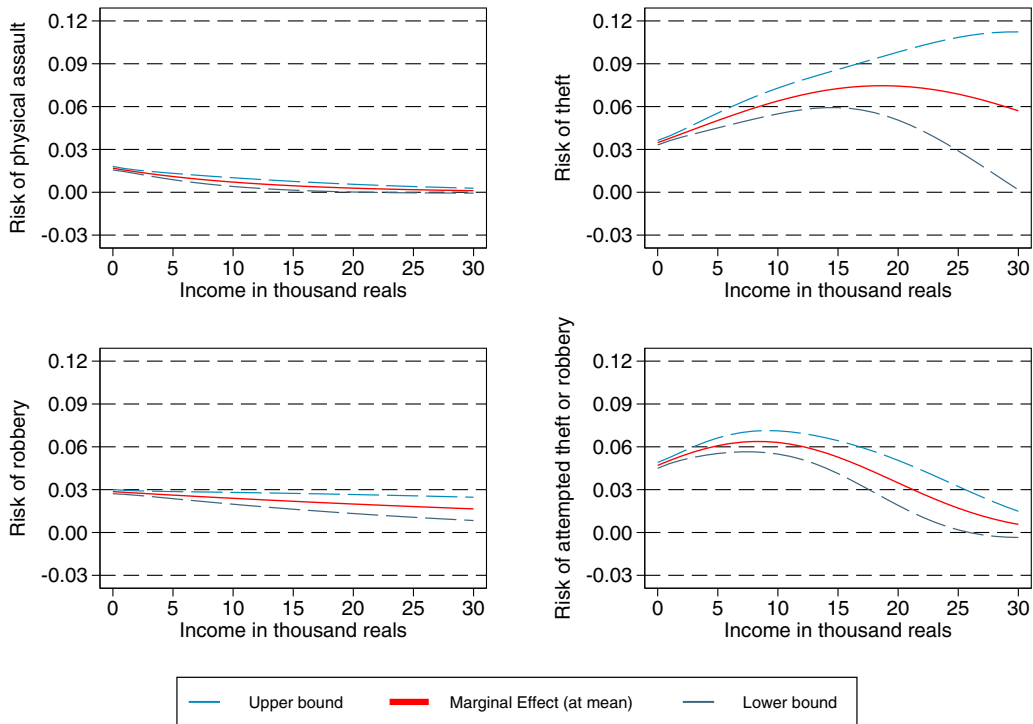


Fig. 5. Marginal effect (at the means of regressors) of income on victimization risk by types of crime.

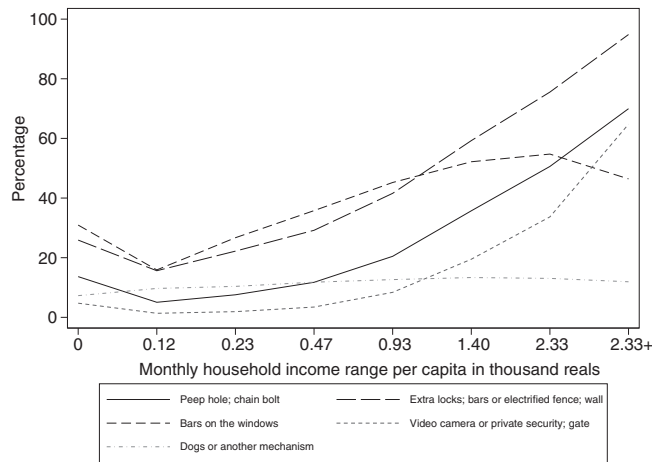


Fig. 6. The relationship between home security devices and monthly household income range per capita in thousand reals.

4. Concluding remarks

Our main contribution was that of identifying the effects of personal income and age on the risk of victimization using a sample of representative data for the Brazilian territory as a whole. These data made it possible for us to validate the results found in previous studies that were mostly performed with limited geographic samples.

Among other relevant results, special mention must be made of the evidence found that the relationship between income and the risk of victimization for property crimes in Brazil has an inverted-U shape. Our evidence based on comprehensive geographical coverage data is in line with the results obtained by [Gomes and Paz \(2008\)](#) and [Justus and Kassouf \(2013\)](#). We found that as the income of an individual increases, the risk of victimization increases to a certain point, from which it decreases as the income rises.

One justification for this type of relationship is that middle-income individuals generate a positive return on crime; however, these people do not invest as much in private security equipment. Wealthier people, in turn, despite the fact that they are more attractive to criminals, use private security equipment and services that, comparing expected costs and benefits, end up making them less attractive to criminals due to their higher risk of failure in committing a crime.

Despite the existence of an inverted U-shape relationship between income and victimization risk and, consequently, of an income level at which the risk of victimization reaches its peak, this level corresponds to the income earned by the wealthiest 1%. In other words, for 99% of the Brazilian population, increases in income are associated with increased victimization by theft and attempted theft or robbery. For the crime of robbery, the relationship between the risk of victimization and personal income appears to be negative, which conflicts with the initial conjecture and some of the results found in the literature (Justus et al., 2015). However, data from the PNAD 2009 suggests that most robberies occur outside one's home, on the street (70.48%). We therefore believe that the chance of falling victim to robbery is more related to the individual's behavior (routine activities) and to public security policies than to personal income level (attractiveness).

Finally, the data used here does not allow one to infer causality concerning income and age on the one hand and victimization on the other. This is certainly a limitation of our study, but we have shed light on a major relationship that has now been documented.

Appendix A.

Table A.1
Probit estimates.

| Variable | Victim | Physical assault | Theft | Robbery | Attempted theft or robbery |
|--------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Man | 0.071 ^{***} (0.011) | 0.136 ^{***} (0.020) | 0.025 (0.016) | 0.097 ^{***} (0.015) | 0.046 ^{***} (0.014) |
| White | -0.009 (0.011) | -0.037 [*] (0.021) | -0.048 ^{***} (0.015) | 0.051 ^{***} (0.015) | 0.030 ^{***} (0.013) |
| Man × white | 0.001 (0.014) | -0.041 (0.026) | 0.039 ^{**} (0.018) | -0.027 (0.020) | 0.020 (0.017) |
| Works | 0.195 ^{***} (0.010) | 0.134 ^{***} (0.019) | 0.177 ^{***} (0.013) | 0.201 ^{***} (0.014) | 0.153 ^{***} (0.012) |
| 30 min to 1 h | 0.014 (0.012) | -0.017 (0.024) | -0.012 (0.016) | 0.044 ^{***} (0.016) | 0.017 (0.015) |
| 1–2 h | 0.099 ^{***} (0.019) | 0.028 (0.034) | 0.010 (0.026) | 0.123 ^{***} (0.024) | 0.096 ^{***} (0.023) |
| More than 2 h | 0.063 (0.039) | -0.016 (0.073) | 0.054 (0.051) | 0.077 (0.053) | 0.103 ^{**} (0.047) |
| Migrant | 0.041 ^{***} (0.011) | -0.008 (0.020) | 0.011 (0.014) | 0.082 ^{***} (0.015) | 0.048 ^{***} (0.013) |
| Married | -0.182 ^{***} (0.013) | -0.237 ^{***} (0.025) | -0.138 ^{***} (0.018) | -0.185 ^{***} (0.017) | -0.110 ^{***} (0.015) |
| Separated | 0.124 ^{***} (0.021) | 0.174 ^{***} (0.036) | 0.104 ^{***} (0.028) | 0.023 (0.030) | 0.129 ^{***} (0.026) |
| Widower | 0.047 ^{**} (0.022) | -0.094 [*] (0.055) | 0.063 ^{**} (0.028) | -0.037 (0.035) | 0.108 ^{***} (0.027) |
| Man × married | 0.138 ^{***} (0.015) | 0.046 (0.031) | 0.150 ^{***} (0.021) | 0.084 ^{***} (0.020) | 0.116 ^{***} (0.018) |
| Man × separated | -0.056 [*] (0.032) | -0.159 ^{***} (0.057) | -0.009 (0.042) | -0.027 (0.045) | -0.068 [*] (0.038) |
| Man × widower | 0.059 (0.041) | 0.073 (0.091) | 0.099 ^{**} (0.049) | 0.089 (0.072) | 0.032 (0.050) |
| Urban | 0.393 ^{***} (0.030) | 0.293 ^{***} (0.044) | 0.314 ^{***} (0.027) | 0.387 ^{***} (0.050) | 0.365 ^{***} (0.031) |
| Metropolis | 0.341 ^{***} (0.053) | 0.234 ^{**} (0.095) | 0.063 (0.050) | 0.608 ^{***} (0.069) | 0.367 ^{***} (0.055) |
| Urban × metropolis | -0.115 ^{**} (0.053) | -0.200 ^{**} (0.096) | -0.091 [*] (0.051) | -0.134 [*] (0.069) | -0.123 ^{**} (0.055) |

Table A.1 (Continued)

| Variable | Victim | Physical assault | Theft | Robbery | Attempted theft or robbery |
|---------------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Schooling | 0.021 ^{***} (0.001) | -0.015 ^{***} (0.002) | 0.014 ^{***} (0.002) | 0.032 ^{***} (0.002) | 0.026 ^{***} (0.001) |
| Gini index | 0.796 (0.682) | 0.410 (0.908) | -0.145 (0.595) | 1.743 (1.066) | -0.225 (0.617) |
| Income | 0.022 ^{***} (0.005) | -0.034 ^{***} (0.009) | 0.040 ^{***} (0.008) | -0.008 [*] (0.004) | 0.036 ^{***} (0.007) |
| Income ² | -0.001 ^{**} (0.000) | 0.000 ^{***} (0.000) | -0.001 ^{**} (0.000) | 0.000 (0.000) | -0.002 ^{***} (0.001) |
| Age | 0.010 ^{***} (0.001) | 0.012 ^{***} (0.002) | 0.011 ^{***} (0.001) | 0.005 ^{***} (0.002) | 0.012 ^{***} (0.001) |
| Age ² ($\times 10^{-3}$) | -0.115 ^{***} (0.013) | -0.212 ^{***} (0.030) | -0.097 ^{***} (0.017) | -0.067 ^{***} (0.020) | -0.116 ^{***} (0.015) |
| Constant | -2.524 ^{***} (0.445) | -2.614 ^{***} (0.587) | -2.244 ^{***} (0.390) | -3.803 ^{***} (0.690) | -2.181 ^{***} (0.407) |
| CPP | 88.97 | 98.36 | 95.98 | 95.71 | 94.17 |

Notes: $n = 308,760$; standard errors in parentheses; CPP is the correctly predicted percentage; dummy variables were used for the states.

* Significance at 10%.

** Significance at 5%.

*** Significance at 1%.

Table A.2

Income and age levels where the risk of victimization will be the highest.

| Crime | Income in thousand reais | Age |
|--------------------------|--------------------------|-------|
| Victim | 15.4 | 43.36 |
| Physical assault | 187.9 | 26.51 |
| Theft | 18.7 | 58.21 |
| Robbery | – | 37.54 |
| Attempt theft or robbery | 8.4 | 49.61 |

Source: Prepared with data from Table A.1.

Table A.3

Reasons for underreporting of victimizations in Brazil.

| | Physical assault | Theft | Robbery |
|---|------------------|-------|---------|
| <i>Has law enforcement been informed? (%)</i> | | | |
| Yes | 43.64 | 36.42 | 47.03 |
| No | 56.36 | 63.58 | 52.97 |
| <i>Reason for not contacting the police (%)</i> | | | |
| Lack of evidence | 06.99 | 26.38 | 10.89 |
| It was not important | 18.11 | 24.99 | 23.42 |
| Did not believe in the police | 13.95 | 23.82 | 38.06 |
| Did not want to involve the police | 16.74 | 08.25 | 07.63 |
| Fear of reprisal | 16.77 | 05.38 | 11.37 |
| Resorted to third parties | 04.36 | 01.84 | 01.61 |
| Took care of the situation him or herself | 18.66 | 06.40 | 03.84 |
| Other reason | 04.42 | 02.94 | 03.19 |

Source: Prepared with data from the 2009 PNAD.

Note: The individual was not questioned as to why he or she did not contact the police after the attempted theft or robbery.

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