

Analysis of the Relationship Between Firearm Possession and Residential Robbery in Brazil

Análisis de la relación entre la posesión de armas de fuego y el robo residencial en Brasil

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Abstract

Introduction

Crime remains a pressing issue in Brazil, and the role of civilian firearm possession in preventing crime is widely debated. A common belief holds that firearms in households could discourage burglary and robbery. However, empirical evidence on this association remains limited and inconclusive.

Objective

This study evaluates whether household firearm possession is associated with a lower probability of victimization through house robbery.

Methodology

The analysis relies on data from the Continuous National Household Sample Survey (PNADC), conducted in the last quarter of 2021. A Probit model was estimated to assess the likelihood that a household's reference person was a robbery victim. Firearm possession was included as the primary explanatory variable, while demographic and socioeconomic characteristics were controls.

Results

The estimations reveal no statistically significant relationship between household firearm possession and the probability of being a victim of house robbery. Thus, firearms do not appear to deter or protect against this type of crime.

Conclusions

The findings suggest that firearm possession at the household level is not an effective strategy to reduce robbery risk in Brazil. These results emphasize the importance of prioritizing structural public security policies and preventive measures over individual armed self-defense.

Keywords:

crime prevention; public safety; property crime; victimization; firearms; firearms regulation; Brazil; Probit model; economics of crime; econometrics; PNADC; household security.

JEL Classification: C25; K42; O12.

Resumen

Introducción

El crimen sigue siendo un problema apremiante en Brasil, y el papel de la posesión civil de armas de fuego en la prevención del delito es ampliamente debatido. Una creencia común sostiene que la presencia de armas en los hogares podría disuadir el robo y el hurto. Sin embargo, la evidencia empírica sobre esta asociación sigue siendo limitada e inconclusa.

Objetivo

Este estudio evalúa si la posesión de armas de fuego en los hogares está asociada con una menor probabilidad de victimización a través de robos en la vivienda.

Metodología

El análisis se basa en datos de la Encuesta Nacional Continua por Muestreo de Hogares (PNADC), realizada en el último trimestre de 2021. Se estimó un modelo Probit para evaluar la probabilidad de que la persona de referencia de un hogar fuera víctima de robo. La posesión de armas de fuego se incluyó como la principal variable explicativa, mientras que las características demográficas y socioeconómicas se emplearon como variables de control.

Resultados

Las estimaciones no revelan una relación estadísticamente significativa entre la posesión de armas de fuego en los hogares y la probabilidad de ser víctima de robo en la vivienda. Así, la presencia de armas no parece disuadir ni proteger contra este tipo de delito.

Conclusiones

Los hallazgos sugieren que la posesión de armas de fuego a nivel de los hogares no constituye una estrategia eficaz para reducir el riesgo de robo en Brasil. Estos resultados enfatizan la importancia de priorizar políticas públicas estructurales de seguridad y medidas preventivas por encima de la autodefensa armada individual.

Palabras clave:

prevención del delito; seguridad pública; delitos contra la propiedad; victimización; armas de fuego; regulación de armas de fuego; Brasil; modelo Probit; economía del crimen; econometría; PNADC; seguridad en el hogar.

Clasificación JEL: C25; K42; O12.

1. Introduction

Criminality imposes various negative consequences on society, including increased government spending on health and social security, unproductive investments in private security, and the loss of human capital due to deaths and the physical and mental effects associated with violence (Cerqueira et al., 2007).

In Brazil, these negative impacts are particularly concerning, as data indicate that crime is an endemic problem affecting society as a whole. In 2020, Brazil was ranked the eighth most violent country in the world, with a homicide rate of 22.45 per 100,000 inhabitants (Fórum Brasileiro de Segurança Pública, 2021). Between 1991 and 2017 alone, the country accumulated 1.2 million victims of malicious murders (United Nations Office on Drugs and Crime, 2019), which demonstrates the magnitude of criminal violence in the country.

Property crimes are also part of Brazil's daily routine and represent a significant concern due to their high incidence. In 2021, approximately 1.5 million households reported that at least one resident had been a robbery victim, corresponding to 2.0% of all permanent private households in the country. Around 1.8 million individuals aged 15 or older were robbed in the same year, representing approximately 1.1% of the total population (Instituto Brasileiro de Geografia e Estatística, 2021).

This data becomes even more concerning as it is verified that individuals do not feel safe inside their homes. Such concern increases when it is observed that 23% of the robbery incidents in the year 2021 took place precisely at the victims' residences (Instituto Brasileiro de Geografia e Estatística, 2021). Such a percentage not only emphasizes the general vulnerability of the population but also highlights the immediate need for the public security issue to be approached in diverse spheres, including the spaces more intimately related to individuals.

From the evidence relating to the dynamics of property crimes, establishing concrete measures for combating criminality would be cru-

cial, beginning with creating and maintaining effective public security policies. Thus, it is unsurprising that criminality is an object of great attention for policymakers, just as it is the focus of research in several sciences. In this last aspect, it is possible to affirm that the Economic Sciences have been of great value to works on criminality, particularly in the scope of the "Economy of Crime".

More notably developed from the seminal work of Becker (1968), the Economy of Crime has been important in elaborating works whose results have effectively found and assessed the interactions between different elements, such as in the depiction of possible explanations for criminal conduct. In this context, a series of factors have been related to the progress of criminality, among which the possession of firearms by individuals can be highlighted.

In the context of property crimes, particularly house robberies, the possession of firearms is a relevant element that may have a significant impact on criminal activity. For objects with high power of injury, firearms have the capacity to alter the interrelation between offender and victim to affect the outcome of the criminal action. Nevertheless, as highlighted by Cerqueira and Mello (2012), it has not yet been possible to reach a consensus on the relation between firearm possession and criminal activity. This scenario probably results from the methodological complications that arise, mainly from the difficulty in finding an accurate way to measure the presence of firearms in urban areas.

Moreover, besides methodological complications, the relation between firearms and crime is theoretically ambiguous. As highlighted by Cerqueira and Mello (2012), a higher presence of firearms in a particular region can provoke a rise in the cost of committing criminal acts, since the high probability of finding an armed victim should be considered, which creates the effect called deterrence. On the other hand, the enlarged presence of weaponry in certain localities makes the acquisition of weapons more accessible, resulting in the decline of

their cost for potential criminals – the price effect. The net impact will be determined by the relative assessment of these two forces on the perpetrator's part.

Particularly with respect to house robbery, the relation is also ambiguous. According to Cook and Ludwig (2002), if, on the one hand, the presence of firearms in the household might represent a threat to the invaders, which would allow the deterrence effect, on the other, it might serve as an incentive, considering that weapons have a relatively high cost. Thus, a community where firearm possession is common might offer more lucrative opportunities for robbery compared to locations where weapons are less prevalent.

For that matter, it is possible to deduce that the connection between the presence of firearms and criminality is ambiguous and open to diverse interpretations, depending on the theory adopted, which is also valid for the relation between firearm possession and house robbery crimes in Brazil. Despite this controversy, several studies have been conducted in recent decades, although the results have not been unequivocal. In international literature, some works have not found statistical evidence for the relation between firearms and certain property crimes (Southwick, 2000), which may be a direct result of the deterrence effect of weapons. In turn, Cook and Ludwig (2002) found that having more weapons in the house increases the chances of house robbery and invasion.

In the context of the national literature, the analysis conducted by Cerqueira and Melo (2012) did not find evidence of a significant effect of firearms on economically motivated crimes. On the other hand, the study by Abras et al. (2014) presented a different perspective. According to the results of that research, it was found that the decrease in the availability of firearms was associated with an increase in the index of violent property crimes.

Given the above, this study's core purpose is to investigate the relationship between the possession of firearms and house robbery crimes

in Brazil. Specifically, the purpose is to verify whether firearm possession in a condominium or residence influences the probability of victimization by house robbery. The data were obtained from the Continuous National Household Sample Survey (PNADC) for the fourth quarter of 2021.

The main contribution of this work lies in its potential to fill an important gap in the literature, as there is no consensus on the relation. Moreover, analyses focusing on house robbery and firearm possession from the perspective of the potential victim are scarce, especially in national studies, where similar works have not yet been found.

In addition, the present study is divided into four other sections. The second section will analyze the theoretical and empirical evidence concerning the relation between firearm possession and criminality. In the third section, the methodology used is presented, followed by the results and discussion. Finally, the fifth section provides the final considerations.

2. Theoretical and empirical evidence

The alarming statistics concerning the increase in criminality in most countries have long sparked extensive debates on public security policies. In this scenario, discussions about the spread of firearms and their impacts on criminality have persisted over the last decades. Despite the significant amount of research conducted, a consensus has not yet been reached on this relation. As Cerqueira and Melo (2012) point out, this lack of agreement may be largely attributed to methodological issues in studies on the topic. Along these lines, certain difficulties are noteworthy, such as the complexity involved in establishing an appropriate proxy for the presence of firearms or even problems of simultaneity and omitted variables (Cerqueira & Lobão, 2012).

Such methodological complications result in the inability to establish definitive answers on the topic and reinforce the ambiguous relation

between firearm possession and crime. This ambiguity is also evident in crimes against property –the focus of the present work. Notably, the effect of firearms on crimes against property depends on the relative valuation the criminal assigns to the costs and benefits of his acts. In this regard, two main effects of firearm possession on crimes against property may be highlighted: the deterrent effect and the price effect (Cerqueira & Lobão, 2012).

The deterrent effect relates to the potential ability of firearms to dissuade criminal behavior. In this context, an increase in the dissemination of firearms could raise the expected cost of crime, as there would be a greater probability of victims being armed (Cerqueira & Lobão, 2012). According to Abras et al. (2014), a possible explanation for the deterrent effect is that, in committing crimes against property, criminals have limited visibility regarding whether the victim is armed and ready to react. This uncertainty makes criminals avoid this type of offense because the potential cost of encountering an armed victim is perceived as higher.

Moreover, Cook and Ludwig (2002) affirm that if potential criminals lack inside information about which families are armed, this positive effect on crime reduction is limited to the residences that have readily available weapons and benefits the entire community. Therefore, having a weapon at home for self-defense may create a positive externality, contributing to the overall security of the neighborhood.

On the other hand, the relationship between firearms and crimes against property may be positive since the increase in firearm possession is associated with a price effect. In this scenario, the greater availability of weapons facilitates their acquisition, minimizing the costs for potential criminals to obtain them (Cerqueira & Lobão, 2012). It is important to highlight that, besides the greater ease of acquisition in the illegal market, the increase in firearms tends to raise the number of stolen weapons (Donueh et al., 2019). This issue is particularly relevant when analyzing the impact of firearm possession in residences on crimes against property, a relationship explored in this study.

Thus, increasing the number of weapons in residences may stimulate robbery, allowing criminals to acquire more weaponry.

In this line, Cook and Ludwig (2002) affirm that, although weapons at home may threaten criminals, they may also encourage them, as firearms are high-value objects and, therefore, targets for robbery. Thus, when all other factors are kept constant, a community with more weapons offers more lucrative robbery opportunities compared to one where weapons are less common. The authors highlight that the overall result of robbery rates partly depends on the ability of robbers to distinguish between occupied and vacant houses and how they assess the relation between the risks and rewards involved in robbery. Such factors support the existence of ambiguity regarding the relation between firearm possession and crimes against property.

Given the controversy, several studies have been conducted over the last decades, especially in international literature. The work of Cheng and Hoekstra (2013) examines the impact of the Castle Doctrine laws, or Stand Your Ground laws, enacted in more than 20 states in the United States between 2000 and 2010. Using data from the FBI Uniform Crime Reports (UCR), the authors applied the difference-in-differences method to determine whether the results varied more in the states that adopted the laws than those that did not. The results indicate that the laws did not have a significant impact on the prevention of crimes such as robbery, assault, or aggravated assault.

On the other hand, Hamill et al. (2013) did not find a significant association between firearms and criminality, including crimes against property. In this study, criminality and homicide rates were analyzed at the national and state levels from 1999 to 2015. The data was obtained from the United States Department of Justice and the Centers for Disease Control and Prevention. A multiple linear regression model was applied to assess the impact of legal firearm sales on crime rates. The results did not identify a significant association between the increase in legal firearm sales and crime rates.

In contrast, Southwick (2000) found an inverse relation between firearms and crimes against property, at least regarding the potential losses victims may suffer. The study used national data on crime and victimization to assess choices about victims and criminal weapons between 1979 and 1987, as well as in 1991. Data from the National Crime Survey indicated that victims of crimes who owned and used firearms experienced lower losses and injury rates due to violent crimes. Based on these findings, the implications of a greater proportion of potential victims being armed were analyzed. The results showed that this would reduce both losses and injuries resulting from crimes, in addition to diminishing the incentive for criminals to commit violent crimes and carry weapons.

Conversely, Cook and Ludwig (2002) found a significant and negative relation between firearms and crimes against property. The authors used two different data sources, the Uniform Crime Report (UCR) and the National Crime Victimization Survey (NCVS), to collect information on house robbery and invasion. To measure access to weapons, they used the proportion of suicides committed with firearms as a proxy. The study demonstrated that, contrary to the idea that having weapons at home would create a deterrent effect, this increased the probability of house robbery and invasion, with the estimated relation between firearm presence and these crimes ranging from 0.3 to 0.7.

Regarding the national literature, Cerqueira and Melo (2012) developed an identification strategy to estimate the impact of firearms on the occurrence of violent crimes and crimes against property in cities of the state of São Paulo from 2001 to 2007. The instruments were designed to capture cross-sectional and temporal variations, using information from the Statute of Disarmament. The authors did not find evidence that this policy affected other economically motivated crimes. This suggests that the deterrent effect of armed potential victims may not have been relevant in these specific cases.

Conversely, the study conducted by Abras et al. (2014) identified an inverse relation between the presence of firearms and the incidence of

crimes against property. The researchers conducted a comprehensive analysis using data from Datagerais and the Mortality Information System for the period between 2000 and 2010, covering the 66 microregions of the state of Minas Gerais. Applying a panel data methodological approach, the authors reached conclusions contrary to those of the previous study, suggesting that a lower presence of firearms was associated with an increase in the occurrence of violent crimes against property.

In conclusion, the assessed literature reveals diverse results, indicating that the impact of firearms on property crimes remains controversial. Moreover, the literature on this topic is far from exhaustive, particularly regarding specific aspects such as the impact of firearm possession in residences on house robbery, which is the focus of this study.

3. Methodology

The purpose of this section is to present the database used in this work, as well as the methodological strategy adopted.

3.1 Database

Data from the Continuous National Household Sample Survey (PNADC), conducted in the fourth quarter of 2021, were used for this study. Permanently established in January 2012, the PNADC is a comprehensive survey that collects household-level information nationwide. Its main purpose is to monitor quarterly changes and long-term trends of key variables for economic development, including those related to the labor market (Instituto Brasileiro de Geografia e Estatística, 2023). The choice of PNADC 2021 was based on the availability of recent data, as this baseline includes information on robbery and firearms possession victimization, along with other essential variables for the development of this study.

3.2 Methodological strategy

A qualitative selection model is employed to examine the relationship between residents' possession of firearms and house robbery

crimes, where the dependent variable is binary, specifically a Probit model. As Silva et al. (2019) pointed out, this model is suitable for situations where the dependent variable assumes a value of 1 when the event occurs and 0 otherwise, ensuring that the estimated probability of the event lies between 0 and 1. Thus, for this study, the dependent variable takes the value of 1 when the individual had belongings stolen from their residence or condominium through threat or aggression, and 0 otherwise.

Thus, as highlighted by Madalozzo and Furtado (2011), the Probit model is derived from the cumulative distribution function of probability of the standard normal variable, as represented by equation [1] below:

$$Pr(y_i = 1) = \Phi(X_i \beta) = \int_{-\infty}^{X_i \beta} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right) dz \quad [1]$$

Where $Pr(y_i = 1)$ represents the probability that the agent is a victim of a given category of crime; $\Phi(X_i \beta)$ is the cumulative distribution function of the normal standard; X is the vector of explanatory variables; β 's are the coefficients of the explanatory variables; and Z is the standard normal variable, which follows a normal distribution with a mean of 0 and a variance equal to 1 (Madalozzo & Furtado, 2011).

For interpreting the model, it is necessary to estimate the marginal effects, given that the model coefficients are not directly interpretable. According to Alves et al. (2022), both the marginal effects for continuous variables and for discrete variables must be estimated. In this regard, the marginal effect for continuous variables is given by equation [2]:

$$EMx = f(X_i \beta) \cdot \beta_x \quad [2]$$

Where $f(X_i \beta)$ is the cumulative distribution function of the normal standard, and β_x is the coefficient. In turn, for discrete variables, the formula is given by equation [3]:

$$EMxk = P[Di = 1 | xk = 1] - P[Di = 1 | xk = 0] \quad [3]$$

Where $P[Di = 1 | xk = 1]$ is the probability of the individual suffering some category of crime against property when $xk = 1$, and $P[Di = 1 | xk = 0]$ is the same probability when $xk = 0$.

To empirically test the relationship between firearm possession and household robbery victimization, the specification of the Probit model estimated in this study is presented in equation [4] below. The selection of control variables was rigorously guided by the consolidated literature in the Economics of Crime and by empirical studies on the determinants of victimization. The aim was to include a set of factors identified in the literature as relevant, covering three main dimensions: (i) demographic and socioeconomic characteristics of the reference individual; (ii) attributes of the household and its surroundings that may influence the perception of security; and (iii) the spatial context in which the household is located:

$$\begin{aligned} \text{Robbery}_i = & \beta_1 + \beta_2 \text{weapon}_i + \beta_3 \text{lightingquality}_i + \beta_4 \text{gender}_i \\ & + \beta_5 \text{police}_i + \beta_6 \text{electricfence}_i + \\ & \beta_7 \text{color}_i + \beta_8 \text{south}_i + \beta_9 \text{northeast}_i + \beta_{10} \text{southeast}_i + \beta_{11} \text{centerwest}_i \\ & + \beta_{12} \text{vacant}_i + \beta_{13} \text{householdincome}_i + \\ & \beta_{14} \text{urban}_i + \beta_{15} \text{educ1}_i + \beta_{16} \text{educ2}_i + \beta_{17} \text{educ3}_i + \epsilon_i \end{aligned} \quad [4]$$

Where the index “i” represents the reference person in the household. The choice of considering only the reference individuals is justified because the dependent variable refers to victimization by crimes occurring specifically in residences. Finally, it is important to note that the complexity of the sample was considered through the weight variable in the estimation, and a household identifier was created to avoid duplicate entries from the same residence.

In the analysis of the main variable of this study, which concerns the possession of firearms by residents (*weapon*), a dummy variable was employed to indicate its presence. This variable takes the value 1 if there is a weapon in the resident’s household or condominium, and 0 otherwise. The expected outcome for this variable is ambiguous. As mentioned earlier, on the one hand, there is a deterrent effect associated with firearm possession, since an increase in the number of firearms may elevate the expected cost of committing a crime due to the higher probability of victims being armed (Cerqueira & Lobão, 2012). Thus, by committing crimes against property, criminals face uncertainty in determining whether a victim is armed and willing to react. This may lead them to avoid such offenses due to the perceived cost of confronting an armed resident (Abrás et al., 2014).

On the other hand, it can be argued that the increase in the availability of firearms may be associated with a rise in crimes against property due to the price effect. This occurs because greater availability facilitates acquisition by potential offenders, reducing the cost associated with obtaining firearms (Cerqueira & Lobão, 2012). Furthermore, it is important to note that, in addition to the easier access to weapons in the illegal market, the increased circulation of firearms also tends to result in a higher number of stolen weapons (Donohue et al., 2019).

The economics of crime literature highlights that the immediate physical environment significantly influences the likelihood of victimization. In this context, the quality of public lighting emerges as a particularly relevant en-

vironmental variable and represents a central instrument in situational crime prevention policies. To capture this effect, this study employs the dummy variable *lightquality*, which takes the value 1 when public lighting is classified as excellent, good, or fair, and 0 when considered poor or very poor. The expected sign of this variable is ambiguous: on the one hand, greater visibility and a stronger perception of safety may deter offenders and reinforce social control within the community; on the other hand, excessive lighting may also attract offenders by facilitating the observation of potential victims and increasing crime incidence, particularly when households are unoccupied during nighttime leisure activities (Welsh & Farrington, 2008; Fotios et al., 2021; Welsh et al., 2022).

Regarding the individual characteristics of potential victims, a negative coefficient is expected for the dummy variables *white* (value 1 for Whites or Asians) and *gender* (value 1 for females). This expectation indicates a lower probability of victimization for both groups, supported by literature highlighting the greater vulnerability of Black, mixed-race, and Indigenous individuals to crime (Silva, 2015), as well as the higher exposure of men to risk in property crimes (Salvato & Junior, 2016).

The literature highlights that geographical space significantly influences crime distribution, necessitating the inclusion of spatial variables in the model. For the dummy variables that capture regional aspects, such as the location of the head of the household (South, Northeast, Southeast, and Center-West), a negative sign is expected. This is because living in these regions is associated with a lower probability of victimization by property crimes compared to the North region, which has a high concentration of this type of crime relative to its population (Instituto Brasileiro de Geografia e Estatística, 2017). Furthermore, living in urban areas tends to increase the probability of residential robberies since, as highlighted by Silva et al. (2019), residing in urban zones is associated with greater exposure and proximity to offenders. Therefore, a positive sign is expected for the *urban* variable, which takes

the value 1 if the individual resides in an urban area and 0 otherwise.

Socioeconomic variables are crucial for understanding the dynamics of property crime, as they serve as indicators of a household's attractiveness to criminals and influence the expected return of the crime. Regarding these variables, a higher income level is expected to be associated with a higher probability of the residence being robbed, as a higher income level increases the expected return from the crime (Souza & Cunha, 2015). Thus, the expected sign for the continuous variable *householdincome* is positive. Additionally, a negative sign is expected for variables related to the level of education. Specifically, individuals with a higher level of education are more attractive targets for criminals due to a higher expected return (Souza & Cunha, 2015). Therefore, it is expected that individuals with no education or incomplete elementary education (*educ1*), with complete elementary education or incomplete high school education (*educ2*), and with complete high school education or incomplete higher education (*educ3*) would have a lower probability of being victims of home robbery compared to those with complete higher education (*educ4*).

The characteristics of the area surrounding the dwelling, which reflect both the physical environment and security measures, are crucial for analyzing victimization. Regarding neighborhood features, vacant lots are expected to increase the likelihood of the dwelling being robbed. Thus, a positive sign is expected for the dummy variable *vacant* (1 if there are vacant lots, 0 otherwise). On the other hand, a negative sign is expected for the variable *electricfence* (1 if there is an electric fence, 0 otherwise). Since property protection systems have proven effective in reducing crime, as Garcia (2010) indicated, it is reasonable to anticipate a negative impact for this variable. This means that electric fencing systems tend to decrease the crime rate in a given area.

Finally, the existence of policing in the surroundings of the residence may reduce the

probability of being a crime victim. According to Becker's (1968) theory, a negative result is anticipated for the dummy variable *police* (1 if policing is present, 0 otherwise), since it is related to the deterrent effect caused by policing. This means that the effective presence of police tends to discourage the occurrence of crimes, thereby reducing the crime rate.

4. Results

This section presents the descriptive statistics of the dependent variables and the econometric results of the estimated model.

4.1 Descriptive analysis

Regarding the descriptive statistics of the variables, as shown in Table 1, it is observed that among the 62,019 reference individuals that form the sample, only 0.23% reported being robbery victims in their residences. As for the main explanatory variable, firearm possession, 2.40% reported having firearms in their residences or condominiums to gain security.

Regarding the characteristics of the household reference persons, the sample is predominantly female (52.64%), and 45.53% identify as White or Yellow. Regionally, most reside in the Southeast (45.93%), followed by the Northeast (24.35%), South (15.99%), and Center-West (8.01%), with 93.13% living in urban areas. Educational attainment varies: 32.24% have up to an incomplete basic education or none, 13.51% completed basic education or have incomplete high school, and 21.07% hold higher education degrees. The average household income is R\$1,910.42.

Regarding the characteristics of the residence or its surroundings, it is verified that 88.61% of the sample considers public lighting great, good, or regular, while 11.39% consider it bad or terrible. Moreover, 31.33% affirmed there were vacant lands or abandoned lots in the surroundings of their households. In turn, the presence of policing in the areas near the residence was reported by 76.92% of the sample. Similarly, 10.94% affirmed having electric fences in their residences.

Table 1. Descriptive statistics of the variables included in the econometric model

Variable	Observations	Average	Standard Deviation
robbery	62,019	0.0023	0.0003
weapon	62,019	0.0240	0.0009
lightquality	62,019	0.8861	0.0018
gender	62,019	0.5264	0.0028
policing	62,019	0.7692	0.0023
vacant	62,019	0.3133	0.0026
electricfence	62,019	0.1094	0.0019
north	62,019	0.0661	0.0052
color	62,019	0.4593	0.0027
south	62,019	0.1599	0.0008
northeast	62,019	0.2435	0.0010
southeast	62,019	0.4503	0.0013
center-west	62,019	0.0801	0.0005
householdincome	62,019	1910.418	15.3599
urban	62,019	0.9313	0.0006
educ1	62,019	0.3224	0.0024
educ2	62,019	0.1351	0.0019
educ3	62,019	0.3318	0.0027
educ4	62,019	0.2107	0.0024

Source: own elaboration.

In addition to those statistics, Table 2 presents the averages of the variables conditioned on the house robbery crime. These statistics are important since it is possible to identify patterns or tendencies that may go unnoticed when only the total average is observed. Thus, it is better understood how the explanatory variables relate to the dependent variable in different groups or contexts.

Particularly, it can be observed that the average value of the variable *weapon* is higher among individuals who reported being victims of house robbery compared to those who did not. Accordingly, those who experienced asset robbery reported firearm possession in their residence or condominium more frequently. In this sense, *a priori*, the evidence may suggest the existence of a positive relationship between house robbery and residents' firearm possession. This result can be verified through the econometric model.

The positive relation is also evidenced in other variables, as they show a higher average

among those who reported having been victims of house robbery. This applies particularly to *gender*, *police*, *vacant*, *north*, *south*, *northeast*, *centerwest*, *urban*, *educ1*, *educ2*, and *educ3*. Since the average of these variables was higher among the victims of house robbery compared to those who were not, this suggests that they can be associated with a higher risk of victimization. Conversely, the variables *lightquality*, *electricfence*, *color*, *southeast*, *householdincome*, *educ1*, and *educ4* seem to be associated with a lower probability of victimization by robbery, as they show a lower average among those who reported having been victims.

4.2 Econometric results

This section shows the results of the estimated econometric model, as presented in Table 3. To demonstrate the robustness of the results, three specifications were estimated with progressive insertion of the explanatory variables (stepwise). The first specification only included the main explanatory variable of the study,

Table 2. Average of the variables conditioned upon the crime of house robbery

Variable	Robbery	
	0	1
weapon	0.0240	0.0364
lightquality	0.8864	0.7724
gender	0.5261	0.6890
police	0.7691	0.7949
vacant	0.3131	0.4206
electricfence	0.1096	0.0355
color	0.4594	0.4449
north	0.0660	0.1420
south	0.1599	0.1746
northeast	0.2433	0.3186
southeast	0.4507	0.2753
center-west	0.0801	0.0895
householdincome	1911.47	1452.29
urban	0.9312	0.9498
educ1	0.3225	0.2666
educ2	0.1350	0.1699
educ3	0.3316	0.4477
educ4	0.2109	0.1158

Source: own elaboration.

weapon. The other explanatory variables were added in the second specification, except for the regional dummies incorporated in the third specification. Moreover, the marginal effects of Specification 3 are presented, encompassing the complete model. The results are similar across specifications, which indicates their robustness.

It is possible to observe that the variable related to the possession of firearms –*weapon*– was not statistically significant in any of the specifications. This indicates that whether the reference person in the residence possesses a weapon, or whether there is a firearm in the condominium, does not significantly affect the probability of the residence being robbed. This result is consistent with previous studies that have found no significant relationship between firearms and criminality (Cerqueira & Melo, 2012; Cheg & Hoekstra, 2013; Hamill et al., 2023). As highlighted by Cook and Ludwig (2002), overall robbery rates are influenced by how risk and reward are weighed in committing a crime. In this case, potential criminals

may not be sufficiently sensitive to the possibility of facing an armed resident.

This lack of sensitivity among criminals regarding weapon possession by potential victims may be related to several factors. One hypothesis is that criminals underestimate the risks of confronting armed residents. It is also possible that criminals cannot accurately perceive the distribution of firearms among residents, so variations in weapon possession do not translate into variations in crime rates. This argument is relevant because some studies show that individuals do not easily perceive the deterrent effect of firearms (Fortunato, 2015).

Another hypothesis is that the net effect of firearm possession on residents is close to zero. As mentioned previously, the impact of firearms on criminality depends on the price and deterrence effects (Cerqueira & Melo, 2012). From this perspective, it is reasonable to assume that when deterrence (presence of firearms as a discouraging factor) and price

Table 3. Econometric results

Variable	Spec 1	Spec 2	Spec 3	Marginal Effects
weapon	0.14033 ^{NS} (0.2126)	0.2448 ^{NS} (0.2249)	0.2371 ^{NS} (0.2307)	0.0018 ^{NS} (0.0024)
lightquality	-	-0.2463*** (0.0840)	-0.2337*** (0.0854)	-0.0017** (0.0008)
gender	-	0.2193*** (0.0781)	0.2208*** (0.0794)	0.0012*** (0.0005)
police	-	0.0765 ^{NS} (0.0819)	0.0818 ^{NS} (0.0828)	0.0004 ^{NS} (0.0004)
vacant	-	0.1256* (0.0686)	0.1132* (0.0678)	0.0006* (0.004)
electricfence	-	-0.3420*** (0.1335)	-0.3450*** (0.1347)	-0.0013*** (0.0004)
color	-	0.0390 ^{NS} (0.0689)	0.0903 ^{NS} (0.0758)	0.0005 ^{NS} (0.0004)
urban	-	0.0637 ^{NS} (0.1176)	0.1311 ^{NS} (0.1190)	0.0006 ^{NS} (0.0005)
householdincome	-	-9.29e-06 ^{NS} (0.00002)	-1.01e-06 ^{NS} (0.00002)	-5.60e-09 ^{NS} (0.0000)
educ1	-	0.0630 ^{NS} (0.1430)	0.0575 ^{NS} (0.1446)	0.0033 ^{NS} (0.0008)
educ2	-	0.1944 ^{NS} (0.1628)	0.2079 ^{NS} (0.1656)	0.0014 ^{NS} (0.0014)
educ3	-	0.2158 ^{NS} (0.1430)	0.2199 ^{NS} (0.1459)	0.0014 ^{NS} (0.001)
northeast	-	-	-0.1281 ^{NS} (0.0913)	-0.0006 ^{NS} (0.0004)
south	-	-	-0.2106* (0.1132)	-0.0010** (0.0004)
southeast	-	-	-0.3929*** (0.1109)	-0.0022*** (0.0005)
center-west	-	-	-0.2129* (0.1286)	-0.0009* (0.0004)
constant	-2.8406*** (0.0361)	-3.0433*** (0.1700)	-2.9222*** (0.1866)	-

Note: *** significant to 1%; ** significant to 5%; * significant to 10%; NS non-significant.

Source: own elaboration.

(greater availability of weapons) act in opposite directions with relatively equivalent strength, the net result is statistically close to zero. This means that the presence of firearms may, in theory, deter some individuals from committing crimes, but it may also facilitate access to weapons for others. If these effects compensate each other, the total result may be null.

Among the other explanatory variables, the quality of public lighting was significantly associated with a lower probability of robbery. Lighting classified as excellent, good, or fair reduces the probability of robbery by 0.17 percentage points compared to lighting considered poor or very poor. This result corroborates the theory that better visibility and a heightened perception of security can

deter criminal behavior and foster social control within the community (Welsh & Farrington, 2008; Fotios et al., 2021; Welsh et al., 2022).

Regarding the gender of the victim, being female is significantly associated with a higher probability of house robbery across both specifications, which contrasts with the expected sign. Thus, residences where women are the reference persons are more likely to be robbed than those where men are the reference persons. Regarding the marginal effect, identifying as a woman increased the probability of being a victim of house robbery by 0.12 percentage points.

The existence of vacant lots or lands surrounding the residences was associated with a higher probability of individuals having their residences robbed. Specifically, those with vacant lots around their residences faced a 0.06 percentage-point higher probability of being robbed than those without. This result is consistent with the expected sign, given that the presence of abandoned lots or lands generally denotes the deterioration of these regions, and, as highlighted by Ferreira (2019), neighborhoods experiencing neglect and lack of infrastructure tend to become progressively more prone to criminal activity.

On the other hand, the presence of electric fences in residences or condominiums was associated with a lower probability of victimization by robbery. It was observed that those with this protection system experienced a 0.13 percentage-point reduction in the probability of being victims. This result is consistent with expectations, illustrating the effectiveness of property protection systems in reducing property crimes, as highlighted by Garcia (2010).

Regarding the regional dummies, only the variable *northeast* was not statistically significant, suggesting that living in this region does not significantly affect the probability of being a victim of house robbery compared to the North region. In contrast, living in the South region is associated with a 0.10 percentage-point lower probability of being robbed than in the North. Similarly, residing in the Southeast or the Cen-

ter-West is linked to a lower probability of victimization by 0.22 and 0.09 percentage points, respectively, compared to the North. These results can be explained by the fact that the North region shows a significant concentration of property crimes relative to its population, as pointed out by PNAD (2017).

Other variables related to the individual characteristics of residents did not show statistical significance. Thus, education level (*educ1*, *educ2*, *educ3*) and race or color (*color*) did not significantly impact the probability of the reference person reporting a house robbery. Notably, household income (*householdincome*) was also insignificant, suggesting that income does not affect the probability of victimization. Likewise, there was no statistical difference between living in rural or urban areas regarding the likelihood of robbery. Similarly, the variable *police* was not statistically significant in any of the estimated models, indicating that policing in the neighborhood is ineffective in creating a deterrent effect.

5. Final considerations

This study aimed to analyze the impact of firearm possession on property crimes in Brazil. Specifically, it examined whether the presence of firearms in the household or condominium of the reference resident influences the occurrence of house robbery. Data from the Continuous National Household Sample Survey (PNADC) for the last quarter of 2021 was used to achieve this objective. Three distinct specifications of the Probit model were estimated to verify the robustness of the econometric results.

The findings revealed that firearm possession did not have a significant impact on the probability of residences becoming targets of robbery. This result is consistent with previous studies that also found no statistically significant relationship between firearm possession and criminality. Several factors may explain this outcome, such as criminals underestimating the risk of confronting armed residents or lacking an accurate perception of weapon distribution among households. Furthermore,

the effect of firearms on crime involves opposing forces: deterrence (weapons discouraging crime) and facilitation (greater availability of weapons). When these effects offset each other, the overall impact on crime rates tends to be statistically insignificant, as observed in this study.

The analysis also incorporated other control variables. The results indicate that the quality of public lighting is significantly associated with house robbery, with better lighting reducing the probability of victimization. The presence of vacant lots in the surroundings increases this probability, whereas electric fences reduce it. Additionally, households where the reference person is female show a higher likelihood of being victimized. Living in the South, Southeast, or Center-West is associated with a lower probability of robbery than living in the North region.

In view of the above, the results of this study are expected to contribute to the development of public policies aimed at reducing house robbery crimes. Particularly, since firearm possession does not appear to be a determining factor in such crimes, it is recommended that crime prevention and security strategies focus on other aspects, such as improving public lighting and promoting awareness of residential security measures. Although firearms may not have a direct impact on house robberies, their control remains an important issue for reducing violence in general. Therefore, it is advised that firearm control policies be evidence-based and accompanied by continuous efforts to prevent unauthorized access.

Finally, this study has certain limitations. Other cultural and socioeconomic factors are like-

ly to play a relevant role in the occurrence of residential robberies but could not be fully addressed in this analysis. Future research should consider incorporating additional variables to deepen the understanding of the determinants of residential crime.

Author Contributions

Adrian L. P. S. Rocha: conceptualization, investigation, formal analysis, methodology, project administration, writing (original draft), and writing (review and editing).

Evandro C. Teixeira: data curation, supervision, validation, project administration, formal analysis, software, visualization, writing (review and editing).

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Conflicts of Interest

The authors declare no conflicts of interest regarding this article's writing and publication.

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