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From education to social justice: A regression examination of education and economic inequality effects on property crimes

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Abstract

Brazil has experienced a significant escalation in crime rates, resulting in many municipalities ascending to top positions in international rankings of the most violent cities. Various socioeconomic factors contribute to this surge in crime rates, prompting public policies to address not only policing but also elements such as education and social inequality. This study aims to conduct a regression analysis on education, inequality, and crime indicators in the municipalities of the state of Pernambuco based on the Ordinary Least Squares (OLS) method. The findings provide insights into the interplay between these factors and guide the formulation of more effective, multifaceted public policies, supporting policymakers on the critical importance of integrating educational and social inequality measures into crime reduction strategies. Additionally, by highlighting specific socioeconomic drivers of crime, the research may lead to more targeted and sustainable interventions in the most affected municipalities.

Keywords

crime, socio-economics, socioeconomic analysis, Pernambuco, Brazil, Ordinary Least Squares, policing, public security, regression models, inequality, education.

1. Introduction

Brazil has experienced an increase in urban violence, a fact that has had repercussions in the media and in academic studies with the aim of elucidating the motivators of this increase, in

addition to seeking alternatives to solve this problem. According to Souza and Lima (2006), this increase in violence in Brazil is affirmed through epidemiological and criminal indicators based on lethal and non-lethal events that place the country on the same level as countries in a state of war.

The country's internal development has projected it at a global level, as a prominent actor, but the lack of policies to combat the growing drug trafficking and related crimes may put this position in check (BIATO, 2012). The increase in urban criminal violence is directly due to the actions of organized crime, specifically drug trafficking and the illegal arms trade, which have a high number of crimes involving lethality (SANTOS, 2002).

Several socioeconomic aspects are associated with this increase in crime and consequently urban violence. Seeking a view of the historical conformation of Brazil, Adorno (2002) establishes that several social processes that have occurred have contributed to the growing current urban violence: Since the colonial period with the slave trade and the hierarchization that segregated Brazilian society between whites (descendants of Europeans) heirs of land, the hardworking free man but without his own land, the enslaved African and Afro-descendant population and the indigenous people, passing through oppressive political control by regional oligarchies, the emergence of the urban proletariat with its vigorous will for expansion consecutively dominating the large urban centers and starting to dictate the composition of social classes, formation of trade union movements, socioeconomic crises culminating in economic opening through more recent plans for financial restructuring and globalization.

Emphasizing this multifactorial characteristic of violence, Vial *et al.* (2010) establish that studies related to its understanding are interdisciplinary in nature. The analysis of violence tends to consider factors ranging from those related to individuals in isolation, the way they organize themselves into groups and social classes, and even from the point of view of institutions. The approach to the analysis also varies widely, ranging from purely qualitative or quantitative to a combination of both.

Based on this interdisciplinary and multifactorial characteristic, this article aims to perform a regression analysis between the socioeconomic factors related to educational attainment, income and poverty - synthesized through the Gini Index that measures social inequality (ABRIL *et al.*, 2010) - with the rates of Violent Crimes Against Property (*Crimes Violentos Contra o Patrimônio* - CVP) of the 185 municipalities of Pernambuco with data covering years between 2000 and 2010 from the Atlas of Human Development of the Brazil (BRAZIL, 2013), created by a partnership between the United Nations Development Program (*Programa das Nações Unidas para o Desenvolvimento* - PNUD), the Institute of Applied Economic Research (*Instituto de Pesquisa Econômica Aplicada* - IPEA), the João Pinheiro Foundation and the Federal Government, and the Pernambuco Crime Yearbooks between 2007 and 2012, published by the State Agency for Planning and Research of Pernambuco (*Agência Estadual de Planejamento e Pesquisas de Pernambuco*).

The rest of this work is divided as follows: Section 2 justifies the choice and use of socioeconomic indicators used as independent variables in relation to CVP rates; Section 3 will deal with urban violence and the indicators used in the state of Pernambuco, emphasizing the CVP; Section 4 is intended to present the regression model according to the method of Ordinary Least Squares; Section 5 will present the results obtained with the application of the defined methodology; Finally, a conclusion will be made with the proposition of future works.

2. Socioeconomic Factors Influencing Crime

As previously introduced, the history of Brazil is marked by social inequalities. Ehrlich (1973), based on the writings of Becker (1968), was a pioneer in adding socioeconomic issues such as income differential between two activities and unemployment as factors that contribute to the performance or not of a criminal act. Still in relation to Ehrlich (1973), there is a positive relationship between the growth of criminal activities and income inequality.

In a study carried out in the 1990s, Minayo and Souza (1993) identified important factors that were strongly related to crime: (a) Growth of socioeconomic inequalities; (b) low wages and family income that lead to the loss of purchasing power; (c) absence of integrated public policies consistent with the needs of the population in relation to health, education, housing and security; (d) priority of economic development to the detriment of social development, with sacrifice for the population and greater burden for the poor; and (e) intense appeal to consumption, conflicting with the impoverishment of the country.

Schargrodsky and Freira (2023) in their study on inequality and crime in Latin America and the Caribbean point out that variables such as level of education, economic activity, and GDP per capita have a weak relationship with crime, while levels of inequality have a robust relationship.

Sugiharti *et al.* (2022) shows that income inequality is linked to greater criminal activity. Lower unemployment rates, greater investments (internal and external) and more robust human development (in terms of education and health) can help reduce crime. While higher incomes can decrease crimes such as physical abuse and overall crime rates, cases of theft and fraud increase with income growth. Rising unemployment is associated with increases in rape, abuse, robbery, and fraud, but it does not affect homicide rates, suggesting that non-economic factors are more important in explaining homicides and violent crime. In addition, income inequality can increase cases of theft and fraud, although it has no significant impact on homicides, rapes, and abuses.

Among the main indicators of social inequality is the Gini Index, which aims to measure income inequality among the population in percentage terms (ABRIL *et al.*, 2010).

The Gini Index is calculated through Equation 1 and will be one of the variables to be considered for the analysis of this work.

$$G = 1 - \sum_{i=1}^{n} (Y_{i-1} + Y_i)(X_{i-1} + X_i) \qquad (1)$$

Where:

G is the Gini Index;

Y represents the cumulative percentage of income;

X represents the cumulative percentage of the population.

However, income inequality would not be the only determining factor for the occurrence or not

of crime. Oliveira (2005) points out that the absence of schools, whether at the technical or higher level, also has a positive relationship with crime. The author generalizes when he states that schools are not fulfilling their social role and directing people to the job market; on the contrary, they have made it difficult for students to access higher positions in the business hierarchy and high salaries.

Castro (2010) highlights that education in more developed countries is a component of social policies, being the central element of the social promotion system due to its ability to expand opportunities for individuals, in addition to being a strategic element for economic development. The author also demonstrated that, although progress has been made in Brazilian educational development, problems such as regional differentials, greater access to students of a certain race to the detriment of others, difficulties in completing education within the appropriate period and concentration of illiteracy within a certain racial group and in low-income populations still persist.

Ades and Mishra (2021) analyzed the relationship over time between crime levels in several cities, where police departments reported statistics, and the spending of the respective school districts between 2003 and 2018. More than 213 data sets were combined to control for variables such as population, population density, wealth, education, employment, cost of living, race, law enforcement, and electoral history. In addition, they investigated additional factors such as teacher salaries, teacher engagement, and chronic student absenteeism. The results show that law enforcement and unemployment have little influence on crime variance. However, there is a strong relationship between educational funding and crime reduction, taking into account both the amount spent per student and equity in spending.

In the same direction, Huttunen *et al.* (2023) points out the negative relationship between education and propensity to commit crime in Finland, so that the higher the admission rate of students to secondary education, the lower the propensity they have to commit crimes. The authors also state that young people's permanence in school during a critical age generates lasting positive effects, which extend beyond the school years and impact their long-term trajectory.

Wang, Liu, and Yi Zhao (2022) also moved in the direction that higher levels of education lead to lower crime rates in China. In addition, the impact on crime reduction is not limited to post-secondary education but also covers secondary education.

Carvalho and Taques (2014) find evidence of a negative relationship between income inequality and security expenditures in relation to the number of homicide records, and a positive relationship in relation to income. The study refers to data from the federative units of Brazil in the period between 2001 and 2009, based on the panel data methodology.

Saraiva and Nunes (2011) point out that no country can aspire to development without consistent education, given the growing importance of knowledge as the main resource for development, whether social or economic, and, above all, human. In terms of education, McGavey *et al.* (1981) consider education as an important factor associated with crime due to its relationship with the development of culture in society and because it is also consistent with the level of education that the individual, according to his or her level of education, has to perform social and economic activities (e.g., enter the job market).

Therefore, another variable to be used, therefore, is the percentage of people aged 18 years or

older and with complete high school education, since, from the age of 18 and with complete high school education, the individual has a greater possibility of generating his own income, being able to avoid his insertion in crime.

Based on these findings in the literature and on the choice of the Atlas of Human Development of Brazil (BRASIL, 2013) as one of the data sources, this research applied indicators related to educational background and social inequality, relative to the municipalities of Pernambuco in order to correlate them with the CVP rate.

3. Urban Public Violence and its Indicators in the State of Pernambuco

The concept of violence is often associated with those of crime and aggression, however, even though they may be within the same context and have a strong connection, one should avoid the mistake of considering them as synonyms. According to Ristum and Bastos (2004), violence is a polysemic concept, so it can be conceptualized from different points of view or even according to the objectives of its exploration, which makes it difficult to obtain a comprehensive definition.

Demonstrating the polysemy of violence, Minayo and Souza (1993) classify violence into 3 major groups: A structural one, related to socioeconomic inequalities such as access to the labor market and education; a cultural one, which safeguards aspects related to the way old cultural values still persist, being expressed mainly among peers, such as the exploitation of child labor, racial discrimination, violence against women, etc.; and one that protects aspects related to delinquency, defined by the existence of violence by individuals or groups against public and private property and the citizen himself, such as robberies, depredations, disputes between criminals that affect the community around him, etc.

Pino (2007) establishes that crime is a concept that was based on legal aspects, having as its meaning the transgression of the criminal law, making the transgressor subject to criminal actions that vary according to society, while aggression can be defined from a natural disposition of more evolved organisms to attack and defend according to physical signals emitted by other organisms interpreted as threats to the survival of the former who defends himself.

In Brazil, the fight against violence has led the federal, state and municipal spheres of government to act in the creation of policies to combat crime, in this case understood as a cause of urban violence in the country. In these three spheres, action plans were created in the area of Social Defense or Public Security: At the federal level, for example, the National Program for Public Security with Citizenship (*Programa Nacional de Segurança Pública com Cidadania* - PRONASCI), instituted by Law No. 11,530 of October 2007, can be mentioned (BRASIL, 2007).

At the state levels, each state of the federation seeks to adopt its policies based both on premises established at the federal level and on its internal situation. This work focuses on the state of Pernambuco, whose Public Security Plan (PERNAMBUCO, 2007) stipulated by the Pact for Life (*Pacto pela Vida*) estimates the following values:

a) Articulation between Public Security and Human Rights, in which the guarantee of the right to life is the main goal;

b) Compatibility of the qualification of the repressive and coercive dimension - based on the incorporation of intelligence, information, technology and management - with a strong emphasis on the aspects of specific social prevention of violent crime;

c) Transversality and integrality of public security actions, to be carried out by all State Secretariats in a non-fragmented manner;

d) Incorporation, at all levels of execution of Public Security Policies, of management, monitoring and evaluation mechanisms;

e) Participation and social control from the formulation of strategies to the execution of public security actions.

Among several important definitions for the execution and maintenance of public security is the conceptualization of two indicators related to specific crime rates in the state of Pernambuco: The CVP and the CVLI. Both will be presented and will have their formulation explained below.

The State Plan for Public Security of Pernambuco defines two groups or classes of crimes, as previously presented: The CVP and the CVLI. Each of these classes has specific types of crime, which when accounted for a specific municipality, for example, are included in the general determination of the corresponding rates.

In this study, only the CVP will be considered, since the related crimes are of economic origin. This statement is explained by defining that the final rate related to the CVP, in turn, is composed of: Extortion through kidnapping, robbery of buses, commercial houses, residences, passersby and vehicles (PERNAMBUCO, 2007). Equation 2 is applied to calculate the CVP rate (PERNAMBUCO, 2013).

$$CVP_{k;t} = \left(\frac{\sum_{i=1}^{n} CVP_{k;t}}{\sum_{i=1}^{n} pop_{k;t}}\right) x100.000 \qquad (2)$$

Where:

CVP k;t is the number of violent crimes against property per 100,000 inhabitants, from the reference year t for the federation unit K;

pop is the population of the federation unit k in the reference year t, published by the IBGE.

The numbers referring to the crimes that make up this indicator are extracted from systems such as the Mortality Information System of the Ministry of Health (*Sistema de Informações sobre Mortalidade do Ministério da Saúde* - SIM/MS) or the Police Information System of the Secretariat of Social Defense of Pernambuco (*Sistema de Informações Policiais da Secretaria de Defesa Social de Pernambuco* - INFOPOL/SDS/PE), filtered according to the period in which the data are to be obtained.

4. Application of Ordinary Least Squares

For the present study, data from databases related to the Federal Government and the state of Pernambuco were considered, from the year intervals between 2000 and 2010 and 2007 to

2012. The adoption of these intervals was due to the limitation of the available data: The first interval was used by independent variables and extracted from the Atlas of Human Development of Brazil (*Atlas de Desenvolvimento Humano do Brasil*), which uses data from the IBGE Demographic Censuses of the years 1991, 2000 and 2010; the second interval was used for the dependent variable and collected from the Crime Yearbooks of the Government of Pernambuco (*Anuários de Criminalidade do Governo de Pernambuco*). All data used refer to the municipalities of the state of Pernambuco.

These differences in the intervals between independent and dependent variables were important because they made it possible to visualize the medium-term effects with regard to the increase or decrease in the rate of the dependent variable. Table 1 shows the list of indicators that were used in the data analysis.

Table 1 - Model-independent and model-dependent variables.

Type	Indicators	Description
Independent	(X_1) Gini Index	Index that measures income inequality through formula 1
	(X2) % of people aged 18 and over with secondary or higher education	Percentage of the municipal population aged 18 and over who have completed high school
Dependent	(Y) CVP rate	Rate calculated based on gross CVP per 100,000 inhabitants. View formula 2

For each of the indicators, an absolute variation between the start date and the end date was calculated in order to obtain a new indicator that allows the analysis of the trends of increase or decrease of each initial indicator. For this, Formula 3 was used.

$$\Delta = t_2 - t_1 \qquad (3)$$

Where:

Δ is the absolute variation;

t1 is the value of the indicator for the last year considered;

t2 is the value of the indicator in the first year considered.

With all the necessary data, the Ordinary Least Squares (*Mínimos Quadrados Ordinários* - MQO) method was applied to obtain a multiple linear regression model to be used in the correlation analysis between the independent variables (X1 and X2) and the dependent variable (Y), also making it possible to generate an equation that can help in later predictions.

According to Gujarati (2000), the MQO method has statistical properties that make it one of the most powerful and popular methods of regression analysis. According to the population regression function (*Função de Regressão Populacional* - FRP), it is assumed that the dependent variable Y is related to a set of predictors or explanatory variables (X1, X2, ..., Xn). Equation 4 describes FRP.

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_n X_{ni} + u_i \qquad (4)$$

Where:

Yi is the dependent variable;

β1 is the intercept;

β2, β3, ..., βn are the partial regression coefficients;

X2i, X3i, ..., Xni are the independent variables;

ui is the term of stochastic disturbance.

For the analysis of this study, two independent variables will be considered, so that FRP is represented in Equation 5.

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + u_i \qquad (5)$$

In the case of multiple linear regression, 10 elementary assumptions are considered, which represent the classical model or Gaussian pattern of linear regression (GUJARATI, 2000). These 10 assumptions are as follows:

(1) Assumption of linearity of parameters: The relationship between the dependent variable and the independent variables must be linear;

(2) Regression values in repeat sampling should be non-stochastic;

(3) Zero average value of disturbances;

(4) Homoscedasticity or identical ui variances;

(5) There is no autocorrelation between the disorders;

(6) Independent variables should not be correlated with disturbances;

(7) The total number of parameters must be less than the number of observations;

(8) The values of the regressors must have variability;

(9) The regression model must be correctly specified because it does not have any bias or error in the model used;

(10) There must be no perfect multicollinearity, that is, there can be no relationships between the explanatory variables.

5. Data Analysis

For the study, data in the interval between 2000 and 2010 were considered for the variables X1, X2 and the interval between 2007 and 2012 for the variable Y, corresponding to the 185 municipalities in the state of Pernambuco. These data were organized and tabulated in electronic spreadsheets and later migrated to Statsoft Statistica 10 in order to obtain the necessary statistical analyses.

Still in the process of organizing and tabulating the data, the variations for each of the indicators used were calculated, in order to obtain a new indicator that represents a positive or negative variation between the periods surveyed. With these indicators of variation it was possible to carry out statistical analyses to corroborate the use of the MQO.

In the first analysis performed, it was possible to visualize the normality of each of the indicators through the Kolmogorov-Smirnov test, where the results corroborated this normality.

To evaluate the significance of the indicators in the regression model, the t-test was used, resulting in a good significance of the predictors, but the intercept did not obtain the necessary significance for the model. Table 2 presents the results of the significance test.

Table 2 - Significance test results.

	t(182)	**p-value**
Intercept	1,55463	0,121791
X1	-2,764114	0,006301
X2	-9,52578	0,000000

Next, a Durbin-Watson autocorrelation test was performed on the residuals to validate the assumption that there is no autocorrelation between the perturbations of the independent variables. In the test statistics, a value of 1.96 was found, which is very close to the ideal value that defines that there is no autocorrelation between the disorders.

It was possible to determine the regression statistics, resulting in an Adjusted R^2 of approximately 0.36, which determines that approximately 36% of the dependent variable is explained by the independent variables, in addition to which a high significance was found as presented by the very small value of the p-value statistic. Thus, we can say that the regression model fits the need explained by this work. Table 3 shows the regression statistics.

Table 3 - Regression statistics.

Estatistics	**Values**
R	0,60859
R^2	0,37038
R^2 adjusted	0,36338
F	52,94321
p-value	0,00000

In addition to the independent variables studied - Gini Index and percentage of people aged 18 years or older and with complete high school education - there are others that have direct influences on crime or even random variables over which there is no control other than the error itself (ui) present in the regression model (see Equations 4 and 5). Other variables, as presented in the specialized literature, were tested, but did not present significance for the model or did not meet the assumptions of the MQO. Thus, these other variables were disregarded for the regression model.

Finally, with the statistics obtained, it was possible to determine the equation of the regression

model represented by y = -0,16x1 – 0,57x2. The absence of the intercept is justified by its non-significance to the regression model.

The results observed in the study and mentioned above go together with the literature presented, evidencing the positive relationship that social inequality and low levels of education have with crime. However, it is necessary to broaden the scope of research with the addition of other indicators to characterize educational level and inequality, as well as to detail the types of crimes and their interrelations.

6. Conclusion

In view of the results obtained, it is possible to analyze that the negative variation of the Gini Index represents a decrease in social inequality. This variation, however, when analyzed from the point of view of its impact on crime against property, has an inverse relationship since in the regression equation the sign of its coefficient is negative, which means that for each 1% increase in the Gini Index generates an increase of 0.16 in the CVP rate.

This finding may be related to the fact that crimes against property have economic origins, which would be consistent with the reasoning that crime tends to increase with improvements in income distribution among the local population, thus increasing the range of possibilities in variables related to socioeconomic aspects such as income distribution, poverty/wealth, job offers, number of people employed in the formal and informal market, among countless others.

In relation to the percentage of persons aged 18 and over with complete secondary education, the relationship with crime is inverse, with an increase of one unit in the variation of persons aged 18 and over with complete secondary education causing a reduction of 0.57 in the CVP rate. This fact can be explained by the opening of possibilities for high school graduates since the improvement in their qualifications causes more chances in the job market or even the continuity of studies and training through access to higher education.

For future studies, it is suggested to increase the number of independent variables that have a correlation with crime, using geo-referenced data analysis such as in Nepomuceno and Costa (2019) and de Carvalho et al. (2020) in addition to collecting data or aggregating indices that may be significant in a new regression model that explains more properly the influence that these variables have on the object of study.

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Conflict of Interest Declaration

The authors have no conflicts of interest to declare.

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