

Economic Analysis of Law Review

Does the new drug law affect the homicide rate? The Brazilian Experience

A nova lei sobre drogas afeta a taxa de homicídios? A experiência brasileira

Mario J.C. Mendonça¹

Instituto de Pesquisa Econômica Aplicada (IPEA)

Tito Belchior Silva Moreira⁴

Universidade Católica de Brasília (UCB)

Paulo R. A. Loureiro²

Universidade de Brasília (UnB)

Michel Constantino⁵

Universidade Católica Dom Bosco (UCDB)

Rosa Meguerian-Faria³

University of Arizona

RESUMO

Este artigo tem como objetivo analisar o efeito da nova lei sobre drogas, em vigor desde 2006, bem como o efeito do encarceramento sobre a taxa de homicídios. Assim, testamos esses efeitos com base em modelos econométricos de dados em painel considerando dados dos estados brasileiros entre 2004 e 2014. Os resultados dos modelos econométricos mostram evidências empíricas de que com a nova lei de drogas houve aumento da eficácia do encarceramento na redução da taxa de homicídio. Além disso, há evidências empíricas de que a taxa de encarceramento causa taxa de homicídio, com base no teste de causalidade de Granger

Palavras-chave: Política de drogas, homicídio, encarceramento, painel de dados, teste de causalidade de Granger

JEL: K14, K42, C33

ABSTRACT

This article aims to analyze the effect of the new drug law, in force since 2006, as well as the effect of incarceration on the homicide rate. Hence, we test these effects based on panel data econometric models considering data from Brazilian states between 2004 and 2014. Results from the econometric models show empirical evidence, that with the new drug law there was increased efficacy of incarceration in reducing the rate of homicide. Besides, there is empirical evidence that incarceration rate causes homicide rate, based on the Granger causality test.

Keywords: Drug policy, homicide, incarceration, panel data, Granger causality test.

R: 05/09/2020 **A:** 02/11/2020 **P:** 31/12/2020

¹ E-mail: mario.mendonca@ipea.gov.br

² E-mail: titoeco@yahoo.com.br

³ E-mail: pauloloureiro@unb.br

⁴ E-mail: michel@ucdb.br

⁵ E-mail: rmfaria@arizona.edu

1. Introduction

Legislations on the consumption and trafficking of illicit drugs have been applied for centuries in several countries. Even though legislation on the subject in Brazil has already been applied since the beginning of the 20th century, we will highlight those applied since the middle of the century. The Law 6.368 enacted in 1976 states, based on Article 16, that “whoever acquires, keeps or brings with him, for his own use, a narcotic substance or that determines physical or psychological dependence, without authorization or in disagreement with legal or regulatory determination, is subject to a penalty with the detention of 6 (six) months to 2 (two) years, and payment of 20 (twenty) to 50 (fifty) fine days”.

In the following decade, the Brazilian Constitution of 1988 determined that drug trafficking is a crime in which the criminal has no right to pay a pecuniary penalty in order to be released even provisionally and, besides, has no right to amnesty. Then, the Heinous Crimes Law (Law 8.072 / 1990) prohibited pardons and provisional release and doubled the procedural deadlines, with the aim of increasing the duration of provisional detention.

However, the last legislation on the Drug Law (Law 11.343 / 2006) eliminated the prison sentence for the user and the dependent, that is, for those who have drugs or plant for personal consumption. The legislation also started to distinguish the professional from the occasional trafficker, who traffics for the need to obtain the drug for his own consumption and who entitled to a significant reduction in sentence. Hence, on August 23th, 2006, Brazil’s drug law was changed, coming into force 45 days after. Among the changes in the new law, a highlight was, for example, the creation of the National System of Public Policies on Drugs (SISNAD), which has the aim of prescribing measures to prevent the misuse of drugs, and in addition to providing care and social reintegration of drug users and addicts. SISNAD also establishes norms to repress the non-authorized production and illegal trafficking of drugs⁶.

Summing up, this new law has distinct penalties for users (which use drugs for personal consumption) and dealers. Unlike the old legislation, in the new drug law, the user cannot be arrested.

From the public policies viewpoint, it is fundamental that we understand the manner through which the new drug law affects the prison system. When we compare the new with the old drug legislation, it is observed that the new one shows milder punishment for users. At least it was the legislator’s original intention. In this context, what would be the effect of the incarceration rate on the evolution of the homicide rate, considering the new anti-drug law?

It is worth highlighting the possible effects of the incarceration rate on the crime rate. The basic idea in incarcerating a criminal lies in two points: a) while incarcerated the criminal cannot commit new crimes against people that are outside of prison (incapacitation effect); b) the punishment to the criminal works as a warning to the others in showing that the possibility of them being sentenced is real, thus discouraging crime (deterrence effect).

There are articles that show empirical evidence which incarceration rate contributes to a reduction in the homicide rate. In other words, arresting more delinquents can imply lower homicide rates. On the other hand, many papers display that the incarceration rate doesn’t contribute to a reduction in the homicide rate. In this context, our contribution is to insert one more ingredient in this discussion, i.e., the new Brazilian anti-drug law effect on the homicide

⁶ Access to the drug law of 2006 can be obtained at https://sherloc.unodc.org/cld/document/bra/2006/law_no_11.343_of_23_august_2006.html?

rate. Considering this controversial discussion, this article aims to analyze the effect of the new drug law, in force since 2006, as well as the effect of incarceration on the homicide rate. We test these effects based on panel data econometric models considering data from Brazilian states from 2004 to 2014.

Since there is no systematic database available on crimes related to illicit drug use or trafficking, although it may exist for a few states, we cannot infer the effects of such crimes directly on incarceration. In fact, we study the effects of the new drug law considering the connection between incarceration and homicide rate, instead of crime rates in general or even drug crimes. In addition, there is no data available for these last two variables per Federation Unit and in the analyzed period. One of the causes of the high homicide rate in Brazil is associated with traffic drugs, which is one of the most complex problems to face in this country. This is the main motivation to choose the homicide rate instead of the other criminal indicators, once in an ultimate instance, this indicator is one of the most worrying for the Brazilian people once strongly reduce the population's welfare. According to the World Bank's database, considering intentional homicides per 100,000 people, Brazil ranks fifth in the list of countries with the most homicides in the world, with the murder index of 30.5 in 2017. Only four countries are more violent than Brazil, The Bahamas (30.9), South Africa (35.9), Belize (37.9), and El Salvador (61.8).

In addition to this introduction, section 2 presents a brief review of the literature on the relationship among the incarceration rate, the homicide rate, and the connection with drug dealing crimes. Section 3 shows the econometric model used to test the hypotheses that the change introduced in the anti-drug law and the incarceration rate affect the homicide rate. This section also describes the database used to estimate the econometric models. The econometric results are discussed in section 4. At last, the final comments appear in section 5.

2. Relationship Between Incarceration, Homicide Rate And The New Drug Law

This topic shows a concise literature review, which discusses the effectiveness of the incarceration rate in fighting criminality, here represented by the homicide rate. At first, considering that the theme of this article is within the scope of crime economics, it is worth reading Shikida (2010), who makes a good explanation of Brazil's crime economics.

As regards the relationship between incarceration rate and homicide rate, there are at least four social benefits resulting from incarceration: a) retribution (imprisoning a delinquent is a form of punishment, and expresses the desire of society to do justice); b) detention (the possibility of being arrested may prevent future crimes); c) rehabilitation (while in custody it is possible that the offender engages in treatment to avoid drug use or be trained in a specific training program, which reduces his chances of returning to criminal activity when released); and d) incapacitation (while imprisoned the offender cannot commit crimes against persons from outside of prison) (DiIulio Jr., 1996).

Levitt (1996) shows that the increment in the amount of police officers in the United States and the increase in incarceration rates were important factors for reducing criminality. He estimated that the prisoner's additional incarceration reduced the number of crimes committed to 13 per year (this number was close to the level of criminal activity reported for the average prisoner). In the same line of study, Marvell and Moody (1994, p.136) suggested that between the

decades 1970 and 1980, the estimated number for crime reduction per year per additional prisoner was 17.

D'Alessio and Stolzenberg (1998) found a negative effect of imprisonment rates on criminality. But they highlight the importance of considering the delay in the time between arresting offenders and such arrestment resulting in a drop in overall criminality rates. According to the authors, today's increase in the number of incarcerations has substantially increased the number of crimes reported to police the following day. However, they highlight that the contemporary correlation between criminal activity and number of arrests is positive. That is, there is a positive association between the number of arrests and criminal activity when they are considered for the same period. This stems from the evident fact that a higher crime rate implies that more crimes are being committed. If police efficiency is maintained at the same level, and if there is a rise in the number of crimes, the number of arrests performed will increase as well.

Corman and Mocan (2000) used monthly data from a period of almost 30 years for the city of New York. They found strong evidence in favor of the deterrence effect of arrests and of policing. Murders, robberies, and car theft declined as a result of an increment in the amount of arrests. An increase in policing, in turn, decreased the incidence of robberies and thefts. They found a positive relationship between drug use and robberies and thefts. Finally, an increase in poverty rates increased homicide and mugging rates.

Nadanovsky (2009) reports that São Paulo state's homicide rate increased from 36 per 100 thousand inhabitants in 1996 to 44 in 1999. This rate decreased until 21 per 100 thousand in 2005. In this period, the number of people in prison for each 100 thousand inhabitants increased constantly from 182 in 1996 until 341 in 2005. The author suggests that

"In spite of not being possible to conclude that this relationship is causal, there was a clear temporal association compatible with the interpretation that the increase in the incarceration of criminals exerted its incapacitating and/or deterrent effect on crime in São Paulo."

Cerqueira (2014) assesses the factors that explain the evolution of the homicide rate in Brazil in several periods. In the period from 1981 to 1990 the results show that the incarceration rate reduces the homicide rate. The same result occurred in the periods from 1990 to 2001 and from 2001 to 2007. Thus, the empirical results show a negative and significant relationship between the incarceration rate and the homicide rate.

ARAUJO Jr. *et.al.* (2014) analyze the effect of the incarceration of criminals on the homicide rate in Brazil in the period from 2005 to 2010 by units of the federation. The results indicate that incarceration has a significant effect and also a negative relationship on homicide rates based on regression via GMM. However, this issue is controversial. Gaulez, Ferro, and Moreira (2018) analyze, empirically, if there is the incarceration effect on homicides in Brazil, being evaluated the relationship between the number of individuals arrested by homicide and homicide rates. Based on several estimates, the investigated relationship was not statistically significant, and it was concluded that the incarceration of homicides did not act as a mechanism to reduce the homicide rate in Brazil during the analyzed period.

Nevertheless, there are other relevant aspects in the literature on the relationship between incarceration rate and a homicide rate that can be evaluated, for instance: i) the determinants of criminal recidivism of defendants already found guilty by economic crimes (Gonçalves Jr. and Shikida, 2013), ii) a discussion about a possible optimum criminal penalty, constituting bases for the balance of costs of criminal sentences and deterrence of the criminal agent in the practice of criminal offense (Botelho e Ramos, 2019) and iii) the trade-off between the security of citizens

and mistakes made through the state apparatus due to problem of incentives facing society is (Meneguín and Bugarin, 2011).

Katz, Levitt, Shustorovich (2003) argues that the quality of life in prison is likely to have a greater impact on criminal behavior than the death penalty. The author demonstrates that the death rate among prisoners (the best available proxy for prison conditions) is negatively correlated with crime rates, consistent with deterrence. On the other hand, there is little systematic evidence that the execution rate influences crime rates in the time period evaluated.

As regards specifically drug dealing crimes, Boiteux (2009) argues that the number of arrested persons accused of trafficking increased after 2006, that is, after the new law came into force. On the basis of legal decisions issued between October 2006 and May 2008, Boiteux (2009) shows that more than 90% of those sentenced for drug dealing was in custody while their cases were judged by the High Court of Justice. Boiteux's (2009) study concludes that the new law suffers from the same problem as the old one, that is, from its inefficacy in punishing big traffickers. As for the old drug law, Raupp (2005) had already concluded that it was not effective for punishing big traffickers.

Draca, Machin and Witt (2011) verified what occurred in London before and after the terrorist attacks of July 2005. In the end, such attack caused an exogenous change in the police officers' position. The authors used this change as an identification strategy and concluded that the elasticity of crime in relation to police force was of approximately -0.3, that is, an increase of 10% in policing would reduce the number of crimes by 3%. This is a strong indication that police force size is an important instrument to fight criminality.

Harcourt (2011) made use of state panel data for the United States with data between 1934 and 2001 and found a strong and robust relation between incarceration and homicide rates. The novelty here is that both prisoners imprisoned in prisons and those in mental treatment institutions (sanatoriums) are included in the incapacitation effect. The author argues that excluding prisoners that are in mental hospitals from the incapacitation effect has the potential to bias downward the incarceration effect on criminality.

Fagan and Catalano (2012) stress that the prevention regarding to violent behavior is very important mainly in terms of public police, taking into account the elevated rates of young that are involved in violence and the strong connection between adolescent and adult violence. Moreover, it must be considered the social costs of violence, besides the financial costs. The authors examining young' problem behaviors, such as delinquency, drug abuse as well as problems of mental health.

Since we evaluate the connection among incarceration, user and drug dealers, and homicide rates, it is important to discuss the social costs of violence. In this context, the Forum on Global Violence Prevention analyzes the successes and challenges of estimates direct and indirect violence costs, as well as the potential cost-effectiveness of the intervention. However, it is not easy measuring the social and economic costs regarding violence. At first, most empirical estimates take into account just direct economic effects, such as the use costs of health care services as well as the reduction of productivity. Moreover, the citizens are affected by the violence effects via the social cohesion loss, financial divestment, and the higher burden on the systems of justice and healthcare. Empirical results from literature reveal that early violence prevention intervention has economic benefits. (Patel and Taylor, 2012).

Gaston et al. (2019) show that in 2015 and 2016, U.S. homicide rates increase strongly, and their empirical results reveal that police illegitimacy, as well as the drug epidemic, contributing to White and Black homicide increase. In this context, the literature of violence associates the expanding drug markets with violence (Baumer, Lauritsen, Rosenfeld, & Wright, 1998; Blumstein, 1995; Cork, 1999; Goldstein, 1985; Martínez, Rosenfeld, & Mares, 2008; Ousey & Lee, 2002). Moreover, newfound papers show high rate in drug-related homicides than in homicides of other types (Rosenfeld & Fox, 2019; Rosenfeld et al., 2017). Based on data from the FBI's Supplementary Homicide Reports (SHRs), homicides associated with drugs raised by 33% from 2014 to 2016 (Rosenfeld & Fox, 2019). Researchers have estimated that the great rise in homicides linked with drugs is responsible for roughly 22% of the total homicide in the country rises in 2015 (Rosenfeld et al., 2017).

3. Econometric Model

The statement that a result originates from a certain public policy must be based on some assessment method that allows verifying if an action will produce a given effect. In our case, this action is the mentioned law change, whose effect, by hypothesis, translates into the change of homicide rates. It is through this assessment that we can check if a policy generates its expected result or effect. We then must isolate the impact that, for example, an event $\mathcal{A}$ has on B . Hence, we must control all other factors causing B , so that one can measure accurately the influence that $\mathcal{A}$ exerts on B .

To analyze this in the context of an econometric model, we should estimate the relationship between the dependent variable of homicide rate (HOMICIDES) and the incarceration rate (PRISONERS). Naturally, we know that there are other factors acting directly on the control of criminality, such as those linked to the structure of policing, such as the contingent of military⁷ and civilian police, public expenditure on safety, etc.

In order to complete the equation, we must include another set of variables that also exert influence on criminality, such as unemployment, inequality, poverty, etc. We denote by control variables both set of variables except the PRISONERS (offenders) variable. Thus, we have that the basic econometric model to treat homicide rates must be represented by the following equation:

$$homicides = \alpha_i + \beta_1 offenders_{it} + \sum_{j=1}^K \delta_j x_{i,t,j} + \varepsilon_{i,t} \quad (1)$$

where:

i , for $i = 1, \dots, N$ is the index of units (states);

t , for $t = 1, \dots, T$ is the time index;

J is the index relative to the x_{ij} control variable.

The α_i parameter indicates the individual effect or specific effect concerning state i , capable of contemplating the heterogeneity present among municipalities, while $\varepsilon_{i,t}$ is the idiosyncratic error.

⁷ "Military police" is a term used in Brazil for a police force that operates not only within the armed force, but also in prevention and other forms of policing.

It is relevant to proceed to the discussion of how we can test the hypothesis which the effect of the new drug law from 2006 has decreased the capacity of incarceration to reduce crime. For such purpose, we must include a dummy D07 variable to identify if any structural change occurs in the model from 2007 because of the law change in August 2006.⁸

The next step is to include a regression term aiming to capture the effect of the law change on the effectiveness of incarceration. This is done through the inclusion of the interactive variable D07*prisoners, which is simply the product of dummy D07 by the prisoner's variable, so that equation (1) assumes the following form:

$$homicides = \alpha_i + \beta_0 D07 + \beta_1 prisoners_{it} + \beta_2 D07 * prisoners_{it} + \sum_{j=1}^K \delta_j x_{i,t,j} + \varepsilon_{i,t} \quad (2)$$

In equation (2), β_0 captures changes in homicide rates as of 2007, while the parameter β_2 measures the effect of the interactive variable, given the introduction of the new anti-drug law, assuming that the effect of other variables remains unchanged. Furthermore, we can say that there will be a reduction in the efficacy of incarceration on homicide cases if, in module, the sum $\beta_1 + \beta_2$ is lower than β_1 .

We have seen above that the criminality measured from rates of violent deaths must be explained, too, by several concurring causes. Based on the description of the variables from Table 1, that show the variables that can be used in the empirical models, we try to explain the effect of them on the phenomenon of crime. Bearing this in mind, we divide them into two groups. Initially, we have a set of variables of policing, whose effect in reducing crime happens more directly. Here we have the total number of military (MILITARY) and civilian (CIVIL) police officers as well as the total expenditure (EXPENDITURE) in safety effected by the state. We have the expectation that all of these have the capacity to restrict crime and, therefore, the number of homicides.

Finally, we must include the other set of variables that somehow have the potential to impact homicide rates. We can include here the indices of poverty (POVERTY) and of Gini inequality (GINI), the unemployment rate (UNEMP), the schooling rate (SCHOOLING), the average income of the state measured by GDP per capita (GDP_PC) and the percentage of males between 18 and 24 years old (M18/24). Regarding the variables mentioned for this last group, it is not easy to establish a priori the effect of them.

Based on literature, schooling usually revels relevant effects on crime. Nevertheless, the expected sign between both variables is controversy. It is possible that education reduces criminal activities, since it contributes to increases the cost of opportunity to engage in an illegal activity. Thus, an inverse correlation between both variables may take place. Nonetheless, higher schooling increases the capacity to commit crimes efficiently. Therefore, the effect of schooling on criminality may show a positive sign. Most crime cases are carried out by men. It is then fair to suppose that the impact of schooling on criminality is more important for men than for women. Schooling is represented by the mean of years of study for citizens with age higher than 25 years.

The poverty measured by the percentage of population below the poverty line appears in literature among variables that explain crime. Poverty reduces the opportunity cost to enter illegal

⁸ The dummy variable is considered equal to 1 since 2007 because we work with annual data.

activity. Extremely poor people may not see any great cost in being caught and going to prison when the only available alternative is misery. Moreover, some researchers associate poverty with social disorganization. If we accept that social disorganization makes it harder to find and punish criminals, consequently poverty increases crime.

Becker (1968) points out that criminal behavior can be well represented by a situation of choice involving risk. In this case, income can be used as a proxy for return. The greater the income of people from a locality the greater the likelihood of them participating in illicit activity. Therefore, one can expect a positive correlation between income and crime. Unlike, the greater an individual's income the greater the opportunity cost to enter into illegal activity. Then we cannot affirm a priori the expected sign of this variable.

Many studies indicate the existence of a positive relation between unemployment and criminality [Erlach, (1973), Trumbull, (1989), Gould et al. (1997)]. The literature points out that unemployment has two distinct effects on crime. The first, effect on the opportunity cost, refers to the negative influence that unemployment exerts on crime due to the decrease of available wealth, which results in a lower economic return which is generated by illicit activity. The second effect is known as criminal motivation. This effect is brought about by a reduction in the offender's return, as well as by human capital depreciation associated with the period of withdrawal from the labor market. Thus, the more time the individual remains unemployed, the greater his probability of participating in crime (Erlach, 1973). Table 1 shows the variables collected for the present study, informing the source of the data and their respective description.

Table 1: Sources and Definitions of the Adopted Data

Variable	Source**	Description
Total population	DATASUS	Total number of people resident in the respective state.
Unemployment Rate (UNEMP)	PNAD/IBGE	Unemployment rate for each 100,000 inhabitants of the state. It was considered, for this purpose, people who looked for, but did not find paid professional jobs among all those considered "active" in the labour market. In this case, it is understood as "active" in the market, the group including all people 10 years of age or older that were looking for an occupation or working in the reference week of PNAD.
Inequality Rate (GINI)	IPEA	Gini coefficient of the state. This index measures the degree of inequality in the per capita household income distribution between individuals. Its value may theoretically vary from 0, when there is no inequality, until 1, when inequality is maximum. It was calculated from answers to PNAD.
Poverty Rate (POVERTY)	IPEA	Percentage of people of the state with per capita household income lower than the poverty line. The poverty line considered here is double the extreme poverty line, an estimate of the value of a food basket with the minimum calories needed to adequately supply a person on the basis of the recommendations of FAO and WHO. It was calculated from answers to PNAD.
Homicide Rate (HOMICIDES)	DATASUS	State homicide rates for each 100,000 inhabitants. Homicide rates were calculated considering the victim's place of residence. Both deaths usually classified as homicide (X85 to Y09 of ICD-10) and deaths by firearms and cold weapons whose intention was not determined (Y22 to Y24 and Y28 and Y29 of ICD-10) were counted. This pattern was the same used in the study of Monteiro de Castro, Assunção and Durante (2003).
M18to24_Percentage (M1824)	DATASUS	Mean percentage of men from 18 to 24 years old resident in the state with regard to the total number of inhabitants of the state.
Prisoners_Rate (PRISONERS)	INFOPEN/MJ	Number of prisoners in the prison system per 100,000 inhabitants in the state. People imprisoned in closed or semi-open conditions, or temporarily, and those under security measures, were considered for 2003 and 2004. As of 2005, those found in open conditions were included. Information are available by the Integrated System of Prison Information (InfoPen) of the Ministry of Justice.
GDP per capita (GDP_PC)	IBGE	Monthly average income, in <i>reais</i> of 2000, of people 10 years or older in the state. As the information were obtained through PNAD, which considers September as the base month, wages were deflated by the Broad Consumer Price Index (IPCA) of this month.

Does the New Drug Law Effect The Homicide Rate? Brazilian Experience

Military police officers' rate (MILITARY)	RAIS	Military police officers' rate per 100,000 inhabitants in the state. Those which exercised such function as their main activity in the reference week were considered. The associated ranks were the following: colonels, lieutenant colonels, majors, captains, lieutenants, sublieutenants, sergeants, corporals and soldiers.
Civilian police officers' rate (CIVIL)	RAIS	Civilian police officers' rate per 100,000 inhabitants in the state. Those that exercised such function as their main activity in the reference week were considered. The functions considered in the analysis were the following: police chiefs, inspectors and detectives.
Mean of Years of Study (SCHOOLING)	PNAD/IBGE	Mean of years of study of people 25 years of age or older in the state.
Expenditure in safety (EXPENDITURE)	STN	Total expenditure effected in the state in national security and public defense.

* When a given information about an intermediate year was missing, it was obtained by simple interpolation. ** PNAD: National Survey by Household Sample; RAIS: Annual Social Information Report; IBGE: Brazilian Institute of Geography and Statistics; IPEA: Institute of Applied Economic Research; DATASUS: Database of the Ministry of Health; INFOPEN: Integrated System of Prison Information (maintained by the Ministry of Justice). STN: National Treasury Secretariat (Ministry of Finance).

In the appendix, we added Tables A and B that show the average homicide rate as well as the prisoners rate from 2004 to 2014, classifying the data by Regions and States. Besides, we display the mean by regions. The average for Brazilian homicide rate is 29.26, while the mean for Prisoners is 238.64. As regard homicide rates, only the South region show a lower rate (21.59) than the national rate, meanwhile the regions from Midwest (32.21) and southeast (32.03) present the higher rates. On the other hand, as regard prisoner's rates, just the Northeast region displays a lower rate (138.15) than the Brazilians one. In turn, the regions southeast (243.09) and Midwest (313.67) show the biggest.

Finally, we stress that considering the problem of underreporting crimes, it is expected that the dependent variable will be measured in error. This problem is not very important in the case of lethal crimes against life and in the case of theft and theft of automobiles, whose underreporting is residual. In other crimes, such as theft, intentional injuries, etc., the underreporting rate can reach 80%, as indicated by the various victimization surveys applied in Brazil (Cerqueira and Mello, 2012).

4. Econometric Results

As stated, the methodology that we propose for this end is based on an econometric exercise going through the estimation of the regressions defined by equations (1) and (2). That being so, we have estimated a set of panel data regressions by fixed effects [Hsiao, (1986), Baltagi, (1995) and Greene, (1993)], whose results are shown in table 2. Our sample is formed by Brazilian states, from 2004 to 2014. Because there were gaps in the series of some variables, we excluded three states from the sample of twenty-seven federation units. Therefore, we use 24 states based on a panel data of 11 years (2004 - 2014).

We defined the W set of variables of interest, so that $W = (\text{PRISONERS}, \text{D07*PRISONERS}, \text{D07})$, to test the effect of the drug law change. We established that variables MILITARY and EXPENDITURE would be tested as explanatory variables for possibly contributing directly to inhibit crime, which is measured here by the number of homicides. Finally, it was also defined that a set of control variables should be tested. After a battery of tests, we arrived at a group of variables capable of minimally guaranteeing reliability to the model and which accommodate all estimated regressions of Table 2.

Before describing the results, it is necessary to explain the use of the VIF statistics (Judge et ali, 1982) that appear in each column. This statistic is calculated by taking as a basis regression with stacked data (pooling) and aims at checking the degree of collinearity of regressors.

According to this statistic, there is an indication of a multicollinearity problem in regression if its value is higher than five. We may question the usefulness of these statistics insofar as our main method is the panel data model, while the VIF statistics are calculated from the OLS model for pooled data. Thus, the true value by which the variance of the estimated coefficients would be inflated is not accessible when panel data is applied. Indeed, that is true. However, the bias obtained by the VIF statistics has a propensity to be above the true value that inflates the variance of each coefficient when panel data is employed, because this technique has the advantage of decreasing collinearity between regressors (Baltagi, 1995).

By hypothesis, we assume that regressors are exogenous, that is, there is no correlation between explanatory variables and idiosyncratic error, but not that there can be a correlation between the regressors and the specific individual component of units. In order to verify this point, we applied the Hausman test, whose null hypothesis is the non-correlation between the individual component and the set of regressors. We applied this test to all models and verified this hypothesis is rejected in all of them, suggesting the choice of the fixed effects model instead of the random effect model.

Having made the first considerations, one can analyze the empirical results based on Table 2. In columns I and II, we show results of regressions (1) and (2). Firstly, we can verify that the PRISONERS variable coefficient sign is in accordance with the expected, implying that incarceration reduces the homicide rate. Based on results shown in column II, we can verify if the new drug law decreased homicides from the incarceration increase. These results illustrate the estimated parameters of equation (2). Unfortunately, the VIF statistics indicated the existence of multicollinearity among regressors and, besides, the estimated coefficient is not statistically significant. However, the estimated coefficient from Prisoners variable in regression 1, is statistically significant at 1% level with a negative sign (-0.033), as well as the dummy variable D07 that shows a positive sign of the estimated coefficient (3.853) in regression 2. As a result, there are empirical evidences that when incarceration increase, the homicide rates decrease and, besides, from 2007 to 2014 the homicide rate is higher than in the previous period.

However, as the estimated coefficient for dummy D07 is high, consequently, it affects its interaction with the PRISONERS variable, PRISONERS*D07 according to column II, table 2. In order to circumvent this problem, we estimated regression by excluding dummy D07 and the results appear in column III.

In Columns IV and V, we repeated the same exercise including variables which, by hypothesis, would act directly on crime control, such as the contingent of the military police (MILITARY) and total expenditure in safety (EXPENDITURE). Nevertheless, these variables were not significant even though they showed the expected signs. We can also verify that results as to the incarceration effect do not change in relation to the exercise implemented in columns (I) and (III).

Regarding control, variables in Table 2, only variables POVERTY, UNEMP, and SCHOOLING were significant. However, the high correlation between variables POVERTY and SCHOOLING implies distortion both sign and significance of the estimated coefficient. We chose to estimate the model by excluding the schooling variable according to Table 3. It can be observed that in all cases unemployment has a positive effect on crime while the effect arising from poverty is negative. This last result, for being less intuitive, is hard to justify. As for that, we turn to the following rationale: Even the poorest people can intuitively assess the costs and benefits of committing crimes (Becker, 1968). They know that if they are caught acting illegally, they will not be able to hire lawyers to defend them, for example, and on the other hand, sooner

or later, they will be arrested and the benefits of illegal activities will be temporary. Therefore, they prefer to work in the informal market or even beg on the streets.

In column (VI), we included D07 in regression to verify if some structural change had occurred in the homicide model because of the introduction of the new drug law. Considering that the dummy variable does not have statistical significance, then the impact on homicide rates did not occur only due to the drug law change.

Finally, in column (VII) we estimated the model of the column (IV) only with data as of 2007. The rationale behind this is to test the hypothesis that the drug law change would lead to an increase in crime if the PRISONERS variable effect were lower, and in this case, regression is estimated from data of the reduced sample comprising information only as from 2007. In this case, we can note that in both cases the coefficient of this variable is significant and presents the positive sign, with more prisoners implying less crime. However, this effect is still greater in the model of the column (IV).

TABLE 2 CLASSICAL APPROACH - Dependent variable: HOMICIDES

REGRESSORS	FE (I)	FE (II)	FE (III)	FE (IV)	FE (V)	FE (VI)	FE* (VII)
SCHOOLING	44.929 (0.000)	40.065 (0.000)	45.372 (0.000)	46.846 (0.000)	47.658 (0.000)	47.422 (0.000)	45.172 (0.000)
POVERTY	-0.597 (0.000)	-0.563 (0.000)	-0.648 (0.000)	-0.602 (0.000)	-0.655 (0.000)	-0.616 (0.000)	-0.645 (0.000)
UNEMPLOYMENT	0.963 (0.000)	0.899 (0.000)	0.917 (0.000)	0.972 (0.000)	0.924 (0.000)	0.968 (0.000)	1.255 (0.000)
MILITARY				-0.005 (0.499)	-0.007 (0.384)	-0.006 (0.494)	-0.010 (0.265)
EXPENDITURE				-0.034 (0.326)	-0.034 (0.319)	-0.033 (0.330)	-0.012 (0.596)
PRISONERS	-0.033 (0.000)	-0.008 (0.477)	-0.020 (0.000)	-0.034 (0.051)	-0.020 (0.063)	-0.034 (0.000)	-0.029 (0.000)
D07	-	3.853 (0.028)		-	-	-0.374 (0.745)	
D07*PRISONERS	-	-0.022 (0.007)	-0.010 (0.007)		-0.011 (0.019)		
VIF	1.33	6.03	2.21	1.65	2.22	1.61	1.65
R2	0.334	0.335	0.334	0.350	0.35	0.33	0.28
OBS	264	264	264	264	264	264	192

*Regression estimated with data as of 2007 only. (p-value).

As a way of checking the model's robustness, we opted to estimate the models of Table 3 through the Bayesian practice [(Koop, 2003); (Lancaster, 2004); (Greenberg, 2007)], considering that our database is fragile in its size. Unlike the classical approach, the Bayesian analysis is not dependent on the central limit theorem, which eliminates the need for asymptotic properties (Gelman and Rubin, 2003, p. 696). This carries an important advantage in terms of the ability to obtain estimates that are more trustworthy in the context of small samples and high parametric dimensions. We also have that in the classical approach; critical values generated from small samples can differ substantially from asymptotic critical values. We estimated the panel data model with fixed effects based on the Bayesian methodology. Simulations for generating the

Bayesian band were made by using the Gibbs sampler. This process must be repeated a very large number of times by discarding results of the first N iterations; remaining simulation results, in turn, can be used for inference. Information on convergence can be accessed by monitoring samplings serial correlation, by the calculation of the standard deviation of estimated parameters, which are based on sampling results, and through the diagnostic of Gelman and Rubin (1992).

Thus, we carried out 50000 MCMC⁹ algorithm iterations, in which the first 20000 iterations were discarded, while the results of the next 30000 were saved. In order to reduce autocorrelation within the successive values of the simulated chain, a slight adjustment of 30 was needed. This means that, with the remaining values obtained after the 20000 iterations were discarded, we accumulated one every 30 iterations, discarding the other 29. Finally, a posteriori estimation based on a sample size of 1000 was performed. We used a confidence interval of the Bayesian band of 97.5%. The estimated parameter is non-significant when zero pertains to the Bayesian band. The empirical results are exhibited in Table 3.

As can be seen, results from the non-qualitative Bayesian approach are similar to those derived from the classical approach shown in Table 2. There is no change as regards the significance of coefficients between the two approaches, therefore results from analysis should occur the same way.

TABLE 3 BAYESIAN APPROACH - Dependent variable: HOMICIDES

REGRESSORS	FE (I)	FE (II)	FE (III)	FE (IV)	FE (V)	FE (VI)	FE* (VII)
POVERTY	-0.583	-0.541	-0.633	-0.585	-0.639	-0.592	-0.309
UNEMPLOYMENT	1.035	0.954	0.988	1.043	0.998	1.045	1.984
MILITARY	—	—	—	-0.004**	-0.006**	-0.004**	-0.007
EXPENDITURE	—	—	—	-0.032**	-0.033**	-0.032**	-0.008**
PRISONERS	-0.031	-0.005**	-0.017	-0.032	-0.016	-0.032	-0.030
D07	—	4.234	—	—	—	-0.016**	—
D07*PRISONERS	—	-0.024	-0.011	—	-0.011	—	—
OBS	264	264	264	264	264	264	192

* Regression estimated with data as of 2007 only. **Non-significant coefficient.

In summary, there is some relevant empirical evidence pointed out in the results from tables 2 and 3. First, based on column (II) of the tables 2 and 3, it is observed that the dummy D07 has statistically significant estimated coefficients and with a positive sign. This means that there was a structural break with the promulgation of the new anti-drug law. In addition, it shows that, on average, homicide rates are higher after the new law compared to the previous period.

Secondly, in columns (III) and (V) of the tables 2 and 3, the estimated coefficients of the prisoner's variable are statistically significant with a negative sign. Therefore, the results show

⁹ Markov Chain Monte Carlo.

empirical evidence that when the number of prisoners increases, a proxy for incarceration, there is, on average, reduction in homicide rates considering the entire period analyzed.

Thirdly, the interactive variable PRISONERS*D07 presents the estimated coefficients statistically significant, with negative signs and they also are very similar, based on tables 2 and 3, considering the columns (III) and (V). In this context, note that the incarceration effect after 2007 represented by the sum of coefficients of variables PRISONERS and PRISONERS*D07, is -0.30. Based on equation (2) there will be a reduction in the efficacy of incarceration on homicide cases if, in absolute terms, the sum $\beta_1 + \beta_2$ is lower than β_1 . Thus, contrary to our hypothesis, the incarceration effect in reducing homicide rates after the introduction of the drug law of 2006 seems to have increased, because before 2007 the incarceration effect was -0.020 in table 2, given only by the PRISONERS variable.

5.1. Causality Between Homicide Rate And Incarceration Rate And Impulse-Response Function: Robustness Tests

The empirical results based on tables 1 and 2 show that there is a negative relationship between the incarceration rate and the homicide rate. In other words, the results show that increases in the number of prisoners, which equates to a higher incarceration rate, contribute to reducing the homicide rate. In this context, causality tests are carried out to verify whether the incarceration rate causes the homicide rate in order to make the empirical results more robust. In this sense, it is tested whether the null hypothesis that the rate of incarceration of the Federation States does not temporally precede the homicide rate in Brazil in the period from 2004 to 2014. If the null hypothesis is not accepted, then the incarceration rate causes the rate of homicide. Therefore, we evaluate the causality between the incarceration rate and homicide rate, based on the Granger causality test (1969).

The first step is to check the optimal number of lags for Granger's causality tests regarding the homicide rate and the incarceration rate based on the VAR Lag Order Selection Criteria. It can be observed based on table 4 that the SC and HQ criteria indicate the selection of 1 lag, while the LR, FPE and AIC criteria indicate the selection of 2 lags.

Table 4 - VAR Lag Order Selection Criteria (Endogenous variables: homicide rate and prisoner rate): 2004 – 2014.

Lag	LogL	LR		FPE	AIC	SC	HQ
0	-2165.621	NA		1784794.	20.07057	20.10182	20.08319
1	-1638.042	1040.504		14000.62	15.22261	15.31636*	15.26049*
2	-1632.726	10.38409*		13831.35*	15.21043*	15.36669	15.27356

Note 1: * indicates lag order selected by the criterion. Note 2: LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

Table 5 shows that the null hypothesis that the prisoner rate does not cause the homicide rate, with a probability less than 0.001, is not accepted. In addition, it is observed that the hypothesis that the homicide rate does not cause the prisoner rate is not rejected. In short, the results show that there is a relationship in which the incarceration rate causes the homicide rate.

Table 5 - Pairwise Granger Causality Tests (Panel causality Stacked test with 1 lag)

Null Hypothesis	Observations	F-Statistic	Prob.
Prisoner rate does not Granger Cause homicide rate	240	6.82531	0.0096
Homicide rate does not Granger Cause Prisoner rate		0.53673	0.4645

Note - Optimal number of 1 lag based on the SC and HQ criteria.

The results presented in Table 6 are similar to the results in table 5. Hence, Granger's causality tests show, based on tables 5 and 6, a causality relation from the incarceration of prisoners for the homicide rate.

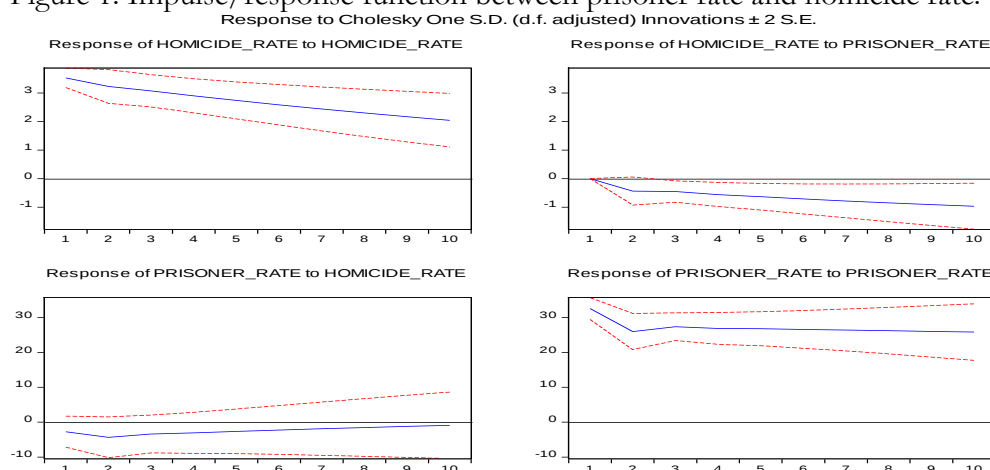
Table 6 - Pairwise Granger Causality Tests (Panel causality Stacked test with 2 lags)

Null Hypothesis	Observations	F-Statistic	Prob.
Prisoner rate does not Granger Cause homicide rate	216	4.02421	0.0193
Homicide rate does not Granger Cause Prisoner rate		0.71996	0.4880

Note - Optimal number of 2 lags based on LR, FPE and AIC criteria.

Finally, an impulse response function presented in figure 1 is performed, which shows a negative relationship between the incarceration rate and the homicide rate. The figure 1 that shows the response of the homicide rate to an impulse in the prison rate reveals a negative relationship between both rates, confirming the empirical results presented in tables 2 and 3.

Figure 1: Impulse/response function between prisoner rate and homicide rate.



6. Final Considerations

This paper evaluates the effects of the new drug Brazilian law, as well as from incarceration rate, on the homicide rate. We tested these hypotheses based on a panel data econometric models for Brazilian states between 2004 and 2014.

Empirical results show that the anti-drug law change, and the incarceration rate contribute to reduce the Brazilian homicide rate. Studies developed in Brazil and the United States, for example, point out a negative relationship between homicide rates and incarceration. We can list some of the studies developed in Brazil that point in this direction, such as Araújo

Júnior et all. (2014) and Cerqueira (2014). Based on international literature, we can list Levitt (1996,); Katz, Levitt, and Shustorovich (2003), among others.

Furthermore, the empirical results also show that incarceration rate causes homicide rate, based on the Granger causality test. Finally, the impulse response function shows a negative relationship between the incarceration rate and the homicide rate.

In this context, our contribution is to insert one more ingredient in this discussion, i.e., taking into account the incarceration rate effect, analyze the new Brazilian anti-drug law effect on the homicide rate.

From the public policy point of view, incarceration has advantages and disadvantages. The advantages translate into incapacitation and deterrence effects. The disadvantages refer to costs associated with the maintenance of prisons and with the loss of workforce since the arrested individuals could be working. In addition, losses with the investment of public resources in activities that are not directly connected to the productive sector, for example, resources used in prisons, should be used in education or public health.

7. References

- ARAUJO Jr., Ari Francisco de; PEREIRA, Daniel M. P. Belo; SHIKIDA, Cláudio D. e SHIKIDA, Pery (2014). O EFEITO DO ENCARCERAMENTO SOBRE AS TAXAS DE HOMICÍDIO NO BRASIL. Revista do Instituto do Direito Brasileiro, Ano 3, nº 9
- BALTAGI, B. H. (1995) “Econometric Analysis of Panel Data”. John Wiley & Sons.
- BAUMER, E., Lauritsen, J. L., Rosenfeld, R., & Wright, R. (1998). The influence of crack cocaine on robbery, burglary, and homicide rates: A cross-city, longitudinal analysis. Journal of Research in Crime and Delinquency, 35, 316-340.
- BECKER, G. S. (1968) “Crime and Punishment: An Economic Approach”. Journal of Political Economy, v. 76, pp. 169-217.
- BLUMSTEIN, A. (1995). Youth violence, guns, and the illicit-drug industry. The Journal of Criminal Law and Criminology, 86, 10-36.
- BOITEUX, L. (Coord.) (2009). Relatório de Pesquisa “Tráfico de Drogas e Constituição”. Universidade Federal do Rio de Janeiro/Universidade de Brasília. Rio de Janeiro/Brasília: Série Pensando o Direito.
- BOTELHO, Martinho Martins e Samuel E. Braga RAMOS (2019). Criminal Law and Economics: An Approach to a possible optimal criminal penalty. Economic Analysis of Law Review, V. 10, nº 3, p.191-204, Set-Dez.
- Cerqueira, Daniel R. de Castro (2014). Causas e consequências do crime no Brasil. Rio de Janeiro: BNDES, 33º Prêmio BNDES de Economia.
- Cork, D. (1999). Examining space–time interaction in city-level homicide data: Crack markets and the diffusion of guns among youth. Journal of Quantitative Criminology, 15, 379-406.
- 325 EALR, V.11, nº 3, p.311-328, Set-Dez, 2020

- de JESUS, Maria Gorete Marques; Amanda Hildebrando Oi; Thiago Thadeu da Rocha; Pedro Lagatta; (Coordenador: Maria Gorete Marques de Jesus). (2011) "Prisão Provisória e Lei de Drogas: um estudo sobre os flagrantes de tráfico de drogas na cidade de São Paulo".
- Fagan, Abigail A. and Catalano, Richard F. (2012). What Works in Youth Violence Prevention. A Review of the Literature. *Research on Social Work Practice*, 23 (2), 141-156.
- GASTON, Shytierra ; Cunningham, Jamein P ; Gillezeau, Rob Rosenfeld, Richard (2019). A Ferguson Effect, the Drug Epidemic, Both, or Neither? Explaining the 2015 and 2016 U.S. Homicide Rises by Race and Ethnicity. *Homicide Studies*, August 2019, Vol.23(3), pp.285-313.
- GAULEZ, Maiara Patti; FERRO, Andrea Rodrigues; and MOREIRA, Gustavo Carvalho (2018). The effect of incarceration of homicides on the homicide rate in Brazil. *Economic Analysis of Law Review*, V. 9, nº 2, p. 288-307, Maio-Agosto.
- GELMAN, A.; Rubin, D.R. (1992). "Inference from iterative simulation using multiple sequences (with discussion)", *Statist. Sci.* 7: 457–511.
- GOLDSTEIN, P. J. (1985). The drugs/violence nexus: A tripartite conceptual framework. *Journal of Drug Issues*, 15, 493-506.
- GONÇALVES Jr., Carlos Alberto and SHIKIDA, Pery F. Assis (2013). Determinants of Criminal Recidivism in the State of Paraná: an empirical analysis of the economics of crime. *Economic Analysis of Law Review*, V. 4, nº 2, p. 315-336, Jul-Dez.
- GRANGER, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods, *Econometrica*, 37, pp. 424–438.
- GREENE, W. (1993) *Econometric Analysis*. Prentice Hall.
- GREENBERG, E. (2007). *Introduction to Bayesian Econometrics*. Cambridge University Press.
- HSIAO, Cheng (1986) "Analysis of Panel Data". *Econometric Society Monographs*, No. 11.
- JUDGE, George G., R. Carter Hill, William E. Griffiths, Helmut Lutkepohl, Tsoung-Chao Lee (1982). "Introduction to the Theory and Practice of Econometrics" by John Wiley & Sons, Inc.
- Meneguim, Fernando B. e Bugarin, Maurício S. (2011). Execução Provisória da Sentença: uma análise econômica do processo penal. *Economic Analysis of Law Review*, V. 2, nº 2, p. 204-229, Jul-Dez.
- KATZ, L.; Levitt, S. D.; Shustorovich, E. (2003). Prison Conditions, Capital Punishment, and Deterrence. *American Law and Economics Review* Vol. 5 No. 2.
- KOOP, G. (2003). *Bayesian Econometrics*. John Wiley-Interscience.
- LANCASTER, T. (2004), *Introduction to Modern Bayesian Econometrics*, 1 edn, New York: Wiley Blackwell.

- LEVITT, S. D. (1996). The Effect of Prison Population Size on Crime Rates: Evidence from Prison Overcrowding Litigation. *Quarterly Journal of Economics*, v. 111, p. 320-351.
- MARTÍNEZ, R., Rosenfeld, R., & Mares, D. (2008). Social disorganization, drug market activity, and neighborhood violent crime. *Urban Affairs Review*, 43, 846-874.
- Nadanovsky, Paulo (2009). O aumento no encarceramento e a redução nos homicídios em São Paulo, Brasil, entre 1996 e 2005. *Caderno Saúde Pública*, Rio de Janeiro, 25(8):1859-1864, agosto.
- OUSEY, G. C., & Lee, M. R. (2002). Examining the conditional nature of the illicit drug market homicide relationship: A partial test of the theory of contingent causation. *Criminology*, 40, 73-102.
- PATEL, Deepali M. and Taylor, Rachel M. (2012). Social and Economic Costs of Violence: Workshop Summary. Forum on Global Violence Prevention; Institute of Medicine. The National Academies Press.
- RAUPP, Mariana M. (2005) "O Seleto Mundo da Justiça: análise de processos penais de tráfico de drogas". São Paulo: Dissertação (Mestrado em Sociologia), FFLCH/USP.
- ROSENFELD, R., Gaston, S., Spivak, H., & Irazola, S. (2017). Assessing and responding to the recent homicide rise in the United States (No. NCJ 251067). Retrieved from <https://www.ncjrs.gov/pdffiles1/nij/251067.pdf>.
- ROSENFELD, R., & Fox, J. A. (2019). Anatomy of the homicide rise. *Homicide Studies*, 23, 202- 224.
- SHIKIDA, Pery F. Assis (2010). Considerações sobre a Economia do Crime no Brasil: um sumário de 10 anos de pesquisa. *Economic Analysis of Law Review*, V. 1, nº 2, p. 318-336, Jul-Dez.

Appendix

Table A: Average Homicide Rate and Prisoners Rate, 2004 to 2014 - By Regions and States

Regions	States	Homicide rate	Prisoners
Northeast	Bahia	36,53	61,73
	Ceará	31,95	168,27
	Maranhão	22,15	55,36
	Paraíba	31,61	215,82
	Pernambuco	45,53	254,36
	Piauí	15,21	80,73
	Rio Grande do Norte	29,90	122,82
	Sergipe	33,84	146,09
	Mean	30,84	138,15

North	Acre	23,36	436,91
	Amapá	32,80	314,82
	Pará	37,16	117,09
	Rondônia	33,60	382,18
	Roraima	29,62	321,73
	Tocantins	21,28	134,73
	Mean	29,64	284,58

Table B: Average Homicide Rate and Prisoners Rate, 2004 to 2014 - By Regions and States

Regions	States	Homicide rate	Prisoners
Midwest	Distrito Federal	34,89	356,91
	Goiás	33,51	156,73
	Mato Grosso do Sul	28,22	427,36
	Mean	32.21	313.67
Southeast	Espírito Santo	49,83	262,45
	Minas Gerais	21,70	159,27
	Rio de Janeiro	37,80	168,64
	São Paulo	18,80	382,00
	Mean	32.03	243.09
South	Paraná	31,40	177,27
	Rio Grande do Sul	21,02	245,91
	Santa Catarina	12,35	218,00
	Mean	21.59	=13.73