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Lethal crimes and the illegal drug market in Brazil from 2006 to 2015: an analysis from the point of view of the social disorganization theory and the economic theory of crime

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Abstract: Brazil has a high rate of homicide, whose increase in recent years seems to be closely related to the expansion of the illegal drug market. This study aims to analyze the role that socioeconomic factors (family instability, ethnic heterogeneity, unemployment rate, and average income) play in this escalation. The study uses pooled regression models and fixed and random effects, with panel data from 27 Brazilian states for the period 2006–2015. The results indicate that the illegal drug trade is positively correlated with the mortality rates in Brazil during 2006-2015. Furthermore, the results show family instability, ethnic heterogeneity, unemployment rate, and average income as crime enhancers. This research brings insights that help develop a better interpretation of Brazilian lethal violence: in the 1980s and 1990s, violence was mainly explained by economic factors. This study points to the fact that phenomena linked to social disorder are also correlated with the level of homicides in Brazilian states. Therefore, this paper contributes to the literature by incorporating other elements that suggest alternatives to mitigate violent crime in Brazil.

Keywords: illegal drug market; homicide rate; social disorganization; Brazil; panel data.

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Crimes letais e o mercado ilegal de drogas no Brasil de 2006 a 2015: uma análise sob o ponto de vista da teoria da desorganização social e da teoria econômica do crime

Resumo: O Brasil apresenta um alto índice de homicídios, cujo aumento nos últimos anos parece estar intimamente relacionado à expansão do mercado ilegal de drogas. Este estudo tem como objetivo analisar o papel que fatores socioeconômicos (instabilidade familiar, heterogeneidade étnica, taxa de desemprego e renda média) desempenham nessa escalada. O trabalho utiliza modelos de regressão pooled, efeitos fixos e aleatórios, com dados em painel de 27 estados brasileiros para o período 2006–2015. Os resultados indicam que o comércio ilegal de drogas está positivamente correlacionado com as taxas de mortalidade para o Brasil no período 2006-2015. Além disso, os resultados mostram os papéis da instabilidade familiar, heterogeneidade étnica, taxa de desemprego e renda média como potencializadores do crime. Esta pesquisa traz *insights* que ajudam a desenvolver uma melhor interpretação da violência letal brasileira: nos anos 80 e 90, a violência era explicada principalmente por fatores econômicos, este estudo aponta para o fato de fenômenos ligados à desordem social também estarem correlacionados com o nível de homicídios nos estados brasileiros. Portanto, este trabalho contribui com a literatura ao incorporar outros elementos que sugerem alternativas para mitigar a criminalidade violenta no Brasil.

Palavras-chave: mercado ilegal de drogas; taxa de homicídios; desorganização social; Brasil; dados em painel.

1. Introduction

Brazil has the ninth-largest homicide rate in the world. According to the World Health Organization (WHO), in 2016, there were 31.3 homicides for every 100,000 inhabitants in the country (WORLD HEALTH STATISTICS, 2018). The rate places the country as one of the most violent, responsible for 13% of the total number of homicides worldwide that year. Publications by Brazilian research bodies corroborate this information. In 2017, Brazil reached a rate of 31.6 deaths for every 100,000 inhabitants, which corresponds to 30 times the European mortality rate and represents the highest historical level of intentional violent lethality in the country. Between 2009 and 2019, approximately 553,000 people have died due to lethal crimes perpetrated in the national territory (Cerqueira et al., 2019).

Crime evolves in Brazil in different ways according to each region. Data from the the Brazilian Public Security Yearbook (Anuário Brasileiro de Segurança Pública, published by Fórum Brasileiro de Segurança Pública (2018), in 2018) shows that states in the North and Northeast lead the rates of intentional violent deaths: in 2017, Rio Grande do Norte, Acre, and Ceará had rates of intentional violent deaths per 100,000 inhabitants equivalent to 68.0, 63.0, and 59.1, respectively. The states of the South/Southeast, São Paulo, and Santa Catarina reached 10.7 and 16.5, respectively, in the same year.

Parallel to this, as stated by the World Drug Report (United Nations Office on Drugs and Crime, 2015), the incentives resulting from the slight decrease in cocaine production in Colombia from the 2000s onwards and the growth in participation of Peru and Bolivia led Brazil to gradually assume a strategic position as a deposit and export corridor for drugs to Africa and Europe. Studies indicate an expansion of Brazil's illegal drug market in regions previously not considered trafficking routes (Abreu, 2017; Manso and Dias, 2018; Cerqueira et al., 2019, Nsoesie et al., 2020).

In recent years, the war, which began in mid-2016, between the two largest drug trafficking groups in the country: Primeiro Comando da Capital (First Command of the Capital, PCC) and Comando Vermelho (Red Command, CV), influenced the intense increase in lethality in the North and Northeast of Brazil (Cerqueira et al., 2019). The discussion about the causes of homicides is complex and multidimensional; however, a significant amount of violence may be attributed directly or indirectly to the drug market itself (Ratton et al., 2011).

Thus, this paper hypothesizes that the expansion of the illegal drug trade is connected to variations in lethality rates in Brazilian states between 2006 and 2015. The national literature lacks empirical studies on this matter. This research aims to verify whether homicide rate in Brazil and illegal drug market are related, using information from the 26 Brazilian states and the Federal District.

Moreover, based on the social disorganization theory and the economic theory of crime, the article analyzes which socioeconomic factors are responsible for enhancing this relationship. It is essential to make it clear that this research does not aim to validate the theory of social disorganization or the economic theory of crime but uses both as a way of substantiating the variables used as controls in the statistical modeling adopted in the paper, as well as to provide a solid and robust theoretical framework that validates the results obtained.

The remainder of this paper is structured as follows. Section 2 discusses the literature review, and Section 3 describes the econometric methodology and the data. Section 4 then shows the empirical findings and discussions. Section 5 concludes the study.

2. Literature Review

According to Justus and Kassouf (2008), for decades in Brazil, the primary motivation of economists has been to control inflation, while the study of other variables that also have an impact on the economic development of countries has been neglected, inflation has been controlled but, in general, the quality of life of Brazilians can still be considered precarious. For this reason, the interest of economists in investigating problems beyond the macroeconomic environment has been significant in recent decades. Issues such as child labor, education, income inequality, poverty, health, social security, and crime have been increasingly addressed.

Different papers portray violence as a multidimensional problem. As a result, a series of theories that try to explain crime emerged: the theory of social disorganization, the theory of social learning, the economic theory of crime, the theory of social control, the theory of self-control, anomie, interactional theory, and the ecological model of crime. It is too pretentious, and we will not review here all these theories. However, two are relevant for constructing the empirical model developed to explain crime: the economic theory of crime and the social disorganization theory.

The main exponent of the economic theory of crime is Becker (1968). It seeks to explain how the individual decides his participation in criminal activities from the rational evaluation between expected gains and losses resulting from illicit activities vis-à-vis the alternative gain in the legal market. Its main variables are salaries, per capita income, income inequality, access to social welfare programs, police efficiency, population density, magnitude of punishments, education, and social learning, among others.

In turn, the social disorganization theory brings a systemic approach around communities, understood as a complex system of networks of formal and informal associations. Its main variables are ethnic heterogeneity, residential mobility, family instability, local friendship network, institutional participation, unemployment, and urbanization. The two sections below expose a brief review of the abovementioned theories.

2.1. The Economic Theory of Crime

Cerqueira and Lobão (2004), scientists interested in investigating crimes since the beginning of the 20th century, studied the subject and identified a series of criminogenic

factors aggregated in determined proportions and situations that could explain the causes of crime. As already mentioned in the introduction to this research, the curiosity of economists for the study of crime began in the late 1960s in the United States with the publication of the works of Smigel-Leibowitz (1965) and Fleisher (1966). However, the studies of Becker (1968) and Ehrlich (1973) consolidated the economic theory of crime.

Becker (1968) uses the theoretical framework of neoclassical economics to model the behavior of individuals and understand the reasons that lead them to commit an illicit act. The central hypothesis of classical economics theorists is that economic agents act from a rational perspective, with the aim of taking the best out of their relations of production and consumption. The economists created a "profile" of human beings who directs their actions based on analytical rationality: the "*homo economicus*".

Becker (1968) innovated in the way of analyzing crime by rationalizing the decision of the offender: the choice between committing a criminal act or not is part of a process of maximizing expected utility where the individual confronts, on the one hand, the possible gains resulting from the criminal action, the value of the punishment and the probabilities of detention and imprisonment involved and, on the other hand, the opportunity cost of committing the crime, which is the alternative wage to that of the labor market. The author rationalized the individual's choice when committing an illicit act, just as consumer theory rationalizes the decision of economic agents when choosing between baskets of goods.

Ehrlich (1973) extended the analysis made by Becker (1968), showing what should be the optimal allocation of time around the criminal or legal market, investigating the effects from the income distribution on crime. In particular, concerning crimes against property, the author argues that a determining element would be the opportunity offered by potential victims; to this end, he adopted as measures of this opportunity offered the median income of families in a given location and the percentage of families that receive up to the first quartile of income in the specified location, concluding that there is a significant positive relationship between the measures of inequality studied and various types of crime.

Many other choice-oriented studies have been developed in the literature. The theoretical framework created by Becker (1968) has remained practically the same over the years, so the vast majority of academic efforts have been empirical in nature.

Wolpin (1978) worked with long series of data covering six different types of crimes that occurred in England and Wales between 1894 and 1967 and used six different judicial deterrence variables: crime clearance rate, conviction rate, imprisonment rate, fine rate, recognition rate, and average sentence time. Among the deterrent variables mentioned, the most important and statistically significant were the clarification rate, followed by the imprisonment rate.

Fajnzylber et al. (1998) developed a panel based on the method of generalized moments, using data on homicides and robberies from 1970-1994 from the United Nations World Crime and inspired by the economic theory of crime. With a positive sign, the results were: the Gini index, the crime rate lagged by one period, the existence of drug production and consumption in the countries, the degree of urbanization, and the degree of polarization in income distribution. Among the statistically significant explanatory variables with a negative sign are the growth rate of the Gross Domestic Product, the probability of imprisonment and the severity of the judicial system, and the level of social capital. The GDP and the average education level of the population were insignificant.

The papers about the economic theory of crime aim to test hypotheses arising from Becker's theory (1968), as well as to promote econometric studies that reveal quantitative results regarding the relationship between crime and the labor market, income, inequality, police dissuasion, demography, and urbanization, among other variables.

2.2. Social Disorganization Theory

The Social Disorganization Theory emerged from research by Clifford Shaw and Henry MacKay in 1942. Based on a map of the city of Chicago, USA, they observed the connection between areas of crime, verifying the context of urban areas. Shaw and McKay (1942) studied the areas with the highest crime rate using a sample of young people taken to juvenile court. The authors observed that most of these young offenders lived in the most remote neighborhoods and that the lowest rates of violence were in neighborhoods with planned housing. The authors point out that crime rates show a noticeable decrease between the city center and the outskirts.

Shaw and McKay (1942) concluded that the areas with the highest crime rate had similar characteristics: deteriorated housing, dysfunctional and incomplete families, low levels of education, and socioeconomic status. The authors observed high rates of adult criminals and drug addicts in these regions, as well as prostitution centers. For the authors, there needed to be more structure from the neighborhood itself. The very nature of the breakdown of these communities would explain the variation in criminality, since the level of criminal activity in a given region is directly related to the level of social organization in that place. This situation occurs because, without social organization, a given region cannot unite or organize itself to prevent the development of such criminal activities.

Pereira et al. (2015) state that two contemporary works complement and critically test the social disorganization theory: the first is the study by Sampson and Groves (1989), and the second is the work by Lowenkamp et al. (2003). Sampson and Groves (1989) expanded Shaw and McKay's (1942) concepts by including in their analysis variables such as sparse local friendship networks, unsupervised adolescent groups, and low organizational participation. The authors relied on the theory of social disorganization and, through the British Crime Survey, were able to directly measure aspects of this theory, showing the relevance of the theory even in a more current context.

Lowenkamp et al. (2003), based on updates from the British Crime Survey, revisited the work of Sampson and Groves (1989) and confirmed the results found by the authors, revealing the relevance of this theory in a contemporary social context. The authors argue that the findings in Sampson and Groves (1989) show enduring empirical realities and that social disorganization theory is not just limited to a stylized fact of the moment in which Shaw and McKay's (1942) classic study was conducted, but this is contemporary evidence.

From 1950s to 1980s, there were strong critics of this theory. However, it has gained focus again in recent years with more complex statistical techniques and powerful computational resources (Silva, 2014).

2.3 Crime and the Illegal Drug Market

The discussion on the causes of homicides is complex and multidimensional; however, a significant amount of violence may be attributed directly or indirectly to the drug market itself (Ratton et al., 2011), although it is not an inevitable feature of this market (Pitts, 2019).

According to Reinarman and Levine (1997), questioning the almost immediate association between drug markets and violence is consistent with a significant body of evidence. The authors argue that, in the United States, most of the violence has been concentrated around crack markets in poor areas. Under a sociological framework, the analysis of the characteristics of crack consumption and trafficking shows how minor crimes committed by compulsive users of this narcotic can be endemic, with individuals stealing from their social cycle (family and friends) to guarantee consumption, producing tensions, violence and death (Anderson, 2019; Bourgois, 2003; Venkatesh, 2002; Williams, 1992).

Three mechanisms show the possible relationships between drugs and violence (Goldstein, 1985): pharmacological violence, violent acts, and systemic violence. The first is caused by the same effect of using these narcotics, creating violent behavior in the users. The second mechanism is related to the violent acts that drug users carry out in order to finance their drug consumption. The third is linked primarily, but not exclusively, to the illegality of this market. Estimates for the United States show that half of cocaine-related crimes are of the third type (Caulkins et al., 1997).

The above channels have different implications for the violence-drug relationship according to the different types of drugs (Johnson et al., 2000). The pharmacological and economic channels apply to all psychoactive substances, but systemic violence is specific to illicit drugs. Furthermore, differences in chemical composition have different impacts on the behavior of individuals.

An essential point of discussion within the systemic channel is to understand how the industrial organization of illegal drug markets differs among illicit substances in a way that make some narcotics more conducive to violence. Entry costs and market structure differ for different types of drugs. The international literature points out that different types of narcotics have different price elasticities of demand and that the demand for cocaine seems to be less elastic than the demand for other types of drugs (Dinardo, 1993; Saffer and Chaloupka, 1999)

Mello (2015) argues that when demand is inelastic, drug factions may choose to compete for territory, which necessarily generates violence. Furthermore, as drug distribution is illegal, the marginal cost of exercising violence is much lower than in the legal business. The author also argues that there are no estimates available for crack. However, due to its lower price and extreme dependence, it is to be expected that the price elasticity of demand for crack is lower than for cocaine.

Johnson et al. (2000) argue that crack sales in New York in 1988 were so lucrative that the entire workforce of the illicit drug distribution industry was drawn to this particular market and therefore, large-scale entry into the crack market retail distribution induced more competition, resulting in more violence. In the case of marijuana, because it is less addictive, profit margins were lower because marijuana has a more elastic demand, and its distribution involved access to a wholesale distributor, increasing entry costs.

We are not pioneers in drawing connections between the functioning of different drug markets and urban violence: Ratton and Daudelin (2017) have already made this connection and found, for Recife, Brazil, that open and uncovered markets, such as crack, are more prone to violence, unlike closed and covered, that is, middle-class drug markets. The authors also add other factors that contribute to more or less violence in each drug market studied, such as the availability of credit, the more or less problematic consumption of each drug, and police action in each market. Other authors follow the same approach.

Sevigny and Allen (2015) investigated the prevalence of gun ownership among individuals involved in the drug trafficking and the factors associated with this practice. The authors use data from a survey of individuals arrested for drug offenses in three USA states. They analyzed respondents' responses about gun ownership and information about their criminal history, gang involvement, and drug use. The results show that more than half of respondents reported carrying weapons regularly during drug dealing activities. In addition, the authors found significant associations between gun ownership and factors such as violent criminal history, gang involvement, and drug use. The authors conclude that carrying weapons is common among participants in the illegal drug market and that the presence of weapons may contribute to the violence associated with these businesses.

Millán-Quijano (2020) also uses the occurrence of activities related to drug use to deduce social imbalances in Colombia. By studying time variations in international cocaine prices and possible trafficking routes in Colombia, the author shows that when cocaine

prices increase in the US or Europe, homicide rates increase in municipalities strategically positioned to serve each of these international markets.

From a spatial perspective, Contreras and Hipp (2020), using data from different sources, such as prison records and information on drug-related activities in USA urban areas, and supported by a spatial model that takes into account location and time, concluded that drug-related activities and crime rates are highly correlated and that both have a spatially concentrated distribution. Furthermore, the authors note that illegal drugs activities substantially affect the crime rate more than other variables, such as poverty and inequality.

From an empirical perspective, studies using a sample of Latin American countries to investigate the development of crime find significant results in that those lucrative illegal activities, such as drug trafficking and trade, positively affect crime rates (Fajnzylber et al., 1998).

Using a difference-in-difference model, an analysis of 27 metropolitan regions in the United States investigates the relationship between crack use and crime: how the emergence of drug affects crime rates in urban areas (Grogger and Willis, 2000). The results point to a significant increase in crime rates. Indications show that an illegal drug market is among the several factors that may increase crime (Justus and Kassouf, 2007). However, Brazil has little empirical evidence to support this hypothesis, mainly because of the difficulty in obtaining reliable data to measure the size of the illegal drug market.

Mendonça et al. (2002) used the probit model to verify the empirical relationship between social interaction and crime based on data collected from interviews at the Papuda Penitentiary Complex in Brasília, Brazil. The results show that a drug user is more likely to commit homicide and less likely to be a drug dealer.

Empirical evidence supports the hypothesis that the illegal drug market, which is booming in Brazil, is one of the main causes of the high crime rates between 2001and 2003 (Justus and Kassouf, 2007). Supporting this point, the data analysis from the metropolitan region of Recife, Brazil, using spatial regression models, shows that drug dealing increases the occurrence of homicides in the neighborhoods analyzed (Cavalcanti et al., 2018). They found evidence, even when considering the influence of socioeconomic variables used as a control.

Despite the importance of the topic discussed here, empirical works are scarce in the national literature that manage to trace any relationship between the illegal drug market and the lethal violence, which makes it difficult to adopt public policies that deal with this problem. This research helps to fill this gap.

2.4 Brazil as a Drug Corridor

In the 1980s, we had a drop in macroeconomic indicators and their association with an increase in the number of homicides. The 1990s were characterized by the growth of the private security industry, an increase in demand for firearms, and increased homicides in Brazil (Cerqueira, 2014). From the 2000s onwards, the state reacted, but the homicide growth rates seemed to be diversified, meeting the growing demand for drugs in different regions. These characteristics highlight the fragility of the State in controlling the country's levels of violence.

The explanation is that, since the 1980s, two of the country´s major drug traffickers:Primeiro Comando da Capital (First Command of the Capital, PCC) and Comando Vermelho (Red Command, CV) have formed an extensive trafficking network (Millard and Hundleby, 2015; Manso and Dias, 2018). Over the next 30 years, this network divided into two large groups: the wholesalers, who work on the country´s borders to bring drugs from Bolivia, Peru, and Colombia in order to redistribute them throughout the country and send them abroad;

and the retailers, who sell the drugs in the streets of their respective states. Technological advances and the spread of cell phones have allowed the factions a better organization, which enabled them to expand to different states: the wholesaler PCC started to distribute drugs to retailers in all Brazilian states, giving rise to an interconnected national drug market (Manso and Dias, 2018; Center for Latin American and Latino Studies, 2020).

The strategic location of the state of São Paulo contributes to this aspect: it is between cocaine-producing countries (such as Bolivia) and the major drug-consuming centers (Rio de Janeiro and São Paulo). Moreover, it has the Port of Santos, which sends narcotics to Africa and Europe. This route is considered the main corridor for drug trafficking in Brazil. Furthermore, the extensive sugarcane plantations require aerial spraying in the state's north region, making makeshift airstrips in the middle of the plantations necessary. These makeshift airstrips are perfect for the transport by air of cocaine, enabling safe landings in remote areas (Abreu, 2017).

The behavior of homicide rates between 2007 and 2017 was significantly different between Brazilian regions. In recent years, while there has been a decrease in the Southeast and Midwest regions and some stability in the rate in the South, the rate of crime in the North and Northeast of the country have increased sharply. Cerqueira et al. (2019) state that the intense increase in lethality in the two regions in the last two years has been influenced by the war between criminal factions that started in mid-2016 between the two most powerful drug trafficking groups in the country: *Primeiro Comando da Capital* (PCC) and *Comando Vermelho* (CV), added to their regional allies: the factions known as *Família do Norte, Guardiões do Estado, Okaida*, *Estados Unidos* and *Sindicato do Crime.*

Therefore, Brazil is the perfect environment to promote, develop and spread these illegal markets.

2.5 Empirical Evidence

According to the literature, we present some variables related to crime.

- Family Instability

Parental characteristics affect the preferences of their descendants, and a set of initial characteristics seems capable of affecting the individuals' lives even after they become independent of their parents (Becker and Mulligan,1997). Therefore, the family structure in which the individual finds himself may affect his future decisions about whether or not to get involved in criminal activities.

Levitt and Lochner (2001), based on three different datasets for the United States, observed a positive correlation between family instability and crime. Oliveira (2005) shows that single-parent families are an increasingly common phenomenon in Brazil. According to Oliveira, this type of family has, on average, more of a risk factor than a protection factor in relation to crime, since families headed by women have problems related to income, education, and raising children, given the country's cultural context. Empirical results from 1991 to 2000 suggest that this variable has a positive relationship with homicide rates in Brazil. It seems a controversial matter, as Becker and Kassouf (2017), using panel data for Brazilian states and the sysGMM model, show that the estimated parameters of the variable "female single-parent homes" are insignificant. It is therefore impossible to draw any conclusions about the influence of this variable on the Brazilian homicide rate.

- Unemployment

The international literature points to different channels through which the unemployment rate may affect crime. Cantor and Land (1985) highlight two of them: motivation and protection. Motivation is related to the opportunity cost of crime, in which the deterioration of economic conditions and the poor capacity of the labor market to absorb the economically

active population increase the incentives for individuals to choose illegal activities. On the other hand, the protection effect is related to the fact that the unemployment rate may affect the frequency and the length of time that individuals stay in their houses, protecting property and themselves, as the reduction in the commuting decreases vulnerability and exposure to victimization.

An analysis of the USA finds significant and positive results: the estimates suggest that an essential part of the decline in property crime rates in the 1990s follows the decline in the unemployment rate; the evidence for violent crime is weaker (Raphael and Winter-Ebmer, 2001; Levitt, 2001). As for India, from 2003 to 2013, the evidence shows that the unemployment rate may be the main economic factor affecting the crime rate, thus opening ways to base crime control policies on job creation (Mittal et al., 2019). Other studies have found no significant evidence (Fox et al., 2011).

The national literature is inconclusive regarding the relationship between unemployment and violent crime. Panel data for Brazilian states between 1981 and 1995 allowed us to conclude that unemployment and homicide rates in Brazil were positively related (Sachsida et al., 2010). Another study shows a positive relationship between homicide and lagged unemployment, but it is inconclusive as to a current relationship between the variables (Becker and Kassouf, 2017).

- Ethnic Heterogeneity

The indicators of lethal violence in Brazil show a continuous process of deepening racial inequality: in 2019, about 75% of homicide victims were black, and the homicide rate was 43.1 per 100,000 black individuals, in contrast with 16.0 for non-blacks. Between 2007 and 2017, the homicide rate of black people increased by 33.1, while the non-black homicide rate slightly increased by 3.3%. Considering only the variation between 2018 and 2019, the mortality rate of non-blacks is relatively stable, with a reduction of 0.3%; however, the mortality rate of black individuals increased by 7.2% (Cerqueira et al., 2019).

In the United States, people of darker color would be more likely to transition between the legal and criminal worlds (Gyimah-Brempong and Price, 2006). The reason is that Black people would have fewer opportunities in the legal labor market, thus reducing their opportunity cost to enter an illegal career.

Brazil has few empirical studies on this topic. Araujo et al. (2010), using the Conditional Auto Regressive model and census data for Salvador-BA, showed that the predicted mortality rate increases when the proportion of Black men aged between 15 and 49 increases. They defend that the relationship between race, violence, and space results from a long process of social inequality.

The discussion outlined in this section should be approached with a great deal of caution, because what the papers cited generally try to explain is more of a question of social inequality. Needless to say, it is not the fact that someone is Black that makes them more susceptible to committing a crime. However, the Black population is generally less favored than the White population regarding income, education, access to culture, and leisure. Thus, such individuals have a lower opportunity cost of crime than white individuals.

- Income Inequality

Becker and Kassouf (2017), using data from Brazilian states from 2001 and 2009 and a dynamic panel, claim that we must have measures of income inequality in the empirical specifications of economic crime models. It is because they confront the expected return associated with high-income victims and the low opportunity costs related to potential low-income criminals. Moreover, the relationship between income concentration and crime may come from the frustration of low-income individuals in relation to the prosperity of others. The authors conclude that the relationship between income inequality and the rate of lethal violent crimes shows a positive and significant result. On the other hand, with data from 225 Brazilian municipalities with a population over 100,000, Resende and Viegas (2011)

found results that suggest that income inequality has a positive and robust correlation, mainly with crimes against property and less so with crimes of passion against life.

- Public Security

People often argue that having more police officers on the streets or increasing prison rates discourages criminal activity, because the more significant public efforts are in relation to the safety of the population, the greater the efficiency of crime prevention and combat activities. The international literature has found significant results confirming this insight (Harcourt, 2011). Draca et al. (2011) used the July 2005 terrorist attack in London as an identification strategy, as the exogenous event changed the positioning of the police. Their results suggest a negative relationship between crime and police forces.

The national literature needs to be more conclusive. Sachsida and Mendonça (2013), using the number of police officers (both state and federal) per 100,000 inhabitants and the prison rate per 100,000 inhabitants as proxies for deterrence, found a negative relationship between both variables and the number of homicides in Brazilian states. In contrast, Kume (2004), Justus and Kassouf (2007), and Justus (2009) used proxies for public security and, in some cases, correcting the possible simultaneity between this variable and crime found no statistical evidence. In a more recent study carried out only for Rio de Janeiro, Montes and Lins (2018) found a deterrent effect associated with public spending on security related to levels of violence.

- Demography

It is also worth discussing how demographic aspects are related to crime indicators. For example, the degree of risk aversion may change over an individual's life: it is more likely to find young people prone to risk than older people with this behavior. The lack of opportunities for young people may also be relevant to explaining crime: because the Brazilian state has chosen to spend most of its scarce resources on older age groups, paying pensions to the detriment of age groups more prone to crime, such as young people (Oliveira, 2005). An analysis of panel data for different Brazilian regions shows that the percentage of young men in the population positively correlates with the homicide rate only for populations with less than 200,000 inhabitants. Above this value, no significant results were found (Sachsida and Mendonça, 2013).

Migration is another topic within the demographic framework that may affect crime levels. Migratory movements are concentrated on isolated population masses, which lack social control on the outskirts of urban centers under great poverty and social disorganization (Paixão, 1983). In turn, a rapid demographic change breaks the existing social networks. It makes it difficult for institutions that promote socialization and regulate life in society to act, encouraging the development of crime activity (Lee et al., 2001). However, while groups of migrants are not necessarily made of people with low qualifications it has been indicated they do have high potentials, aspirations, and low inclinations towards crime (Butcher and Piehl, 2007).

- Income

One measure of the expected return on criminal activity is per capita income: the higher the family income, the higher the return. The higher the income, the higher the cost of spending time in prison in the event of failure. However, this variable is possibly associated with the opportunity costs of crime.

Although ambiguous, national literature shows a positive and statistically significant relationship between household per capita income and lethal crime (Mendonça, 2002). It also shows that, by using GDP per capita or household income per capita, it is possible to notice that the intentional homicide rate responds positively to an increase in income (Kume, 2004; Becker and Kassouf, 2017). This possible economic effect of income on crime, associated with the greatest expected return from criminal activity, outweighs the effect of opportunity costs.

In light of the above, we can notice that the Brazilian literature still presents controversies regarding the effects of deterrence on criminal behavior and the effects of the variables used as proxies for family instability, ethnic heterogeneity, and demographics. Nonetheless, for income inequality, the literature agrees on a positive relationship with crimes against property, although there is no consensus on its relationship with crimes against life. Finally, the literature agrees that income, unemployment, and illegal drug markets positively affect homicides.

3. Methodology and Data

When investigating crime, techniques that exploit data panel characteristics are more appropriate, as they allow for the control of unobservable heterogeneity between the different states. Moreover, they also partially control the problem of measurement error resulting from the high rate of under-registration in some types of crime (Justus and Kassouf, 2007). Based on several cross-sectional units, the configuration of data that provide information for a decade (2006-2015) is consistent with this statistical procedure.

The structure of the regression model with panel data is as follows:

$$y_{it} = x_{it}'\beta + z_i'\alpha + \varepsilon_{it} \quad (1)$$

where y_{it} represents the homicide rates per 100,000 inhabitants of the i-th state, with $i = 1\ldots,27$ and $t=2006,\ldots,2015$, x_{it} represents the return matrix, which will be detailed in the next section and does not include the constant term z_i'α represents the heterogeneity of each state where z_i has a constant term and a set of state-specific variables, observable or not. We considered three types of regressions: pooled regression, fixed effects, and random effects.

3.1 Pooled Regression

Assuming that z_i is present in all states and, consequently, there are unobservable state effects, that is, that $z_i'\alpha$ has only the constant term, pooled regression provides consistent estimates based on the ordinary least squares (OLS) method. However, if z_i contains unobservable state effects, the estimates of β will be biased and inconsistent due to the omitted variable. In this case, this is not an appropriate model.

3.2 Fixed Effects

If there is unobservable heterogeneity, estimations must be carried out using models that exploit data panel characteristics and control unobservable state heterogeneity. Thus, if unobservable heterogeneity correlates with x_{it}, the strategy is to obtain estimates using the fixed effects model. The strategy assumes that $\alpha_i = z_i'\alpha$ is a specific constant term for each state, stable over time. Thus, α_i is an unknown parameter to be estimated. By letting y_i and x_i contain the T observations of the i-th state, I contain a column of ones, and ε_i contains the T values of the random error; Equation 1 is:

$$y_i = x_i\beta + I\alpha_i + \varepsilon_i \quad (2)$$

3.3 Random Effects

Finally, if the unobservable state heterogeneity exists but not correlates with the explanatory variables, then the random effect model is recommended to obtain the estimates. In this case, Equation 2 becomes:

$$y_{it} = x_{it}'\beta + E\left[z_i'\alpha\right] + z_i'\alpha - E\left[z_i'\alpha\right] + \varepsilon_{it} = x_{it}'\beta + (\alpha + \mu_i) + \varepsilon_{it} \quad (3)$$

The constant term is the expected value of unobservable heterogeneity, given by $E\left[z_i'\alpha\right]$. The component $\mu_i = z_i'\alpha - E\left[z_i'\alpha\right]$ is the unobservable random heterogeneity of the i-th state, which is constant over time.

3.4 The Empirical Model

The dependent variable is the homicide rate per 100,000 inhabitants, a proxy for crime provision. Crime data is generally subject to measurement errors. However, this problem is less intense for the dependent variable, as the number of homicides must be well measured since a corpse necessarily generates a homicide report, thus encouraging official statistics (Hartung, 2009).

States where this rate is high develop more illegal drug markets. Given the lack of data that allow us to measure the level of development of illegal drug markets, the proxy used is the hospitalization rate because of psychoactive substances (except alcohol) per 100,000 inhabitants. This hospitalization rate is an epidemiological indicator that provides data on drug use.

Based on the theoretical and empirical discussion developed so far, we decided to use the variables described as the control variables in the empirical model developed:

- Ethnic heterogeneity – the proxy is the percentage of Black people in the population;
- The opportunity cost of crime – the proxy is the unemployment rate (Sachsida et al., 2010; Scorzafave and Soares, 2009; Justus and Kassouf, 2011);
- Per capita income of population – the average household income;
- Demographics – the proxies are the percentage of young people and state migrants;
- Family instability – the proxy is the divorce rate per 100,000 inhabitants;
- Income inequality – the proxy is the Gini index;
- Public security – the proxy is the prison rate per 100,000 inhabitants. The possible reverse causality with a crime is a problem that may arise in relation to this variable. However, in Brazil, this is not a relevant problem, as public resources are generally allocated according to real needs but vary according to the political strength of each region (Justus and Kassouf, 2007).

3.5 Data Description

This research collected data from official government websites like Sistema Único de Sáude – (SUS), Instituto Brasileiro de Geografia e Estatística (IBGE), Instituto de Pesquisa Econômica Aplicada (IPEA), and Departamento Penitenciário Nacional (DEPEN). The hospitalization rate for psychoactive substance use (except alcohol) and the number of homicides come from DataSUS – SUS; the unemployment rate comes from Séries de Estatísticas Cojunturais – IPEA; the percentage of blacks, the percentage of young people, the Gini index, the per capita income and state migrants were obtained from the Pesquisa

Nacional por Amostra de Domicídios - IBGE, the divorce rate come from the Pesquisas Estatísticas do Registro Civil - IBGE, ; finally, data on the incarceration rate come from Levantamento Nacional de Informações Penitenciárias - DEPEN. The information was collected from document search, synthesizing the historical series available on the websites of each cited body. The sample consists of 270 observations from the 26 Brazilian states plus the Federal District from 2006 to 2015. Table I shows the descriptive statistics of the variables selected to build the empirical model.

The data used in the work were extracted from official administrative sources. This procedure is usual in document search: the central premise is that the data disclosed and made available by the State are valid and intend to show veracity. Even though the weaknesses inherent in this type of information are known in many situations, especially when it comes to data involving violence, a lack of further information limits the scope of the research. However, this should not be a limitation to the advancement of science.

Table I shows that the dispersion around the average is high for almost all the analyzed variables due to the extremely heterogeneous socio-economic realities in Brazilian states.

Table I. Characteristics of the sample

Variables	Mean	Standard Deviation	Maximum	Minimum
Homicide rate (/100,000 inhab.)	31.35	11.69	71.39	10.45
Average Income (R$)	1257.39	405.28	2940.23	562.26
Public sec. (rate/100,000 inhab.)	222.69	122.26	559.38	35.56
Divorces (/100,000 inhab.)	105.07	47.5	261.05	12.19
Gini	0.50	0,042	0.63	0.40
Percentage of black people	7.12	3.24	19.99	1.72
Unemployment rate	8.22	2.40	16.33	3.13
Migration (%)	19.23	13.46	53.74	3.65
Percentage of young people	18.00	1.55	22.26	14.37
Drugs (rate/100,000 inhab.)	18.04	18.83	99.98	0.24
Observations	270			

Sources: SISTEMA ÚNICO DE SAÚDE (2015), INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (2015a, b), INSTITUTO DE PESQUISA ECONÔMICA E APLICADA (2015), DEPARTAMENTO PENITENCIÁRIO NACIONAL (2015).

4. Results and Discussions

Estimation of pooled models and random effects showed that they were not appropriate. Specification tests were carried out, and, as expected, the F (Chow) test indicates unobservable state effects, which, in turn, affect the crime rate in Brazilian states. Similarly, with the Breusch-Pagan Lagrange Multiplier test, we excluded the null hypothesis of the absence of personal effects. Therefore, we need more than pooled regression for the analyses developed here. The Hausman test indicates a correlation between the unobservable state effects and the model's explanatory variables; that is, it excluded the null hypothesis of the absence of correlation. In this case, we must analyze the estimates from the model with fixed effects (see Appendix A for other estimates). Thus, table II shows the parameters estimated under the fixed effects model.

A common problem with crime estimates is that the explanatory variables used in the literature have a strong correlation and therefore suffer from multicollinearity. The estimates

found here did not have this problem, as the correlation coefficients between the model variables (Appendix B) did not show high values. Moreover, no estimator presented any variance inflation factor (VIF) above 5.

Table II: Results of regression with fixed effects

Variables	Coefficient	Robust standard error
Average income	0.551***	(0.143)
Divorces	0.101**	(0.043)
Public security	-0.052	(0.112)
Gini	-0.016	(0.330)
Percentage of black people	0.126*	(0.077)
Unemployment rate	0.347***	(0.097)
Migration	0.171	(0.188)
Percentage of young people	0.483	(0.343)
Drugs	0.056*	(0.031)
Observations		270
R2		0.35
F (Chow) Test	33.577***	
Hausman Test	61.693***	
Lagrange Multiplier	22.015***	

Source: Authors (2006-2015).

Significance at 10% (*), 5% (**), or 1% (***).Functional form log-log

The variable used as a proxy for family instability (divorce) had the expected significant positive sign in the homicide crime category. This result aligns with the sociological perspective that social disorganization weakens the interpersonal bonds that hinder criminal activities. The results converge with studies that, by adopting the variable "households headed by women" as a proxy, also found a positive relationship between this variable and the homicide rate (Fajnzylber and Araújo-Junior, 2001; Oliveira, 2005). However, Becker and Kassouf (2017) did not find significant results between variables. The authors emphasize that this may be because the variable "households headed by women" is not a good measure of family instability in Brazil.

Table II shows that the proxy for ethnic heterogeneity had a positive and significant sign, from which we may infer that, in regions where the Black population prevails, the homicide rate is, on average, higher, reflecting a process of social inequality in the country. In addition, it also reinforces ethnic heterogeneity as an essential variable to explain crime, as suggested by social disorganization theory. Empirical studies for Brazil that test this relationship are scarce, which makes it difficult to compare results.

Nevertheless, Araujo et al. (2010), using a different sample and methodology from the one adopted here, suggest that the predicted mortality rate increases when the proportion of Black men aged between 15 and 49 grows. The authors argue that the relationship between race, violence, and space results from a long process of social inequality. On the other hand, Pereira et al. (2015), when investigating the determinants of homicides in the municipality of Recife-BR from the perspective of the social disorganization theory, did not find statistically significant results for the variable "percentage of Black people in the population". As there is no consensus in the literature on this matter, more studies from this perspective are needed to enlighten the debate.

For the variable "average income" (a measure of the expected return from the crime activity), we find a statistically significant elasticity of 0.551. This result coincides with the national literature, which suggests a net positive effect between income and crime.

In this sense, the higher the family income, the greater the expected return on crime, thus influencing the increase in crime in regions with a higher average income. Our result is in line with Justus (2009), who, using a fixed effects estimator, finds a parameter for average income equivalent to 0.596, an elasticity very close to the one found here for the average family income.

The Gini index must have a positive relationship between this variable and the crime rate. Table II shows the absence of a significant statistical effect between the Gini index and the homicide rate per 100,000 inhabitants. The results of this study coincide with those of Resende and Viegas (2011). They point out that the effect of inequality has a positive and robust correlation mainly with crimes against property but not so much with crimes of passion against life or against a person. Along the same line, Scorzafave and Soares (2009) observed a positive and significant relationship between the Gini index and property crime rate using information from the municipalities in São Paulo. We should be cautious with this result: this study uses the homicide rate per 100,000 inhabitants as a crime indicator. It did not investigate the relationship between income inequality and other crimes, such as crimes against property. Therefore, the results in Table II show no elements that allow us to state anything about the relationship between income inequality and crimes against life.

Finally, some studies suggest a positive relationship between homicide and the Gini index (Mendonça, 2002; Kume, 2004; Oliveira, 2005; Sachsida et al., 2010). However, international literature has since long agreed that income inequality is not related to the homicide rate but to other types of crime (Resende and Viegas, 2011). It is important to point out that, as discussed in national literature, this is one of the variables about which we have not found a consensus in terms of its relationship with homicide rate.

The incarceration rate per 100,000 inhabitants is another variable with no significant result. Thus, empirically, it is impossible to trace the relationship between this variable and the homicide rate. Justus (2009) defends that no measures used in studies carried out in Brazil are ideal. However, the lack of statistics that enable us to measure the probability of the criminal being arrested and convicted has led researchers to use different measures as proxies for the variables that deter criminal behavior. In this sense, this may have affected the expected empirical results.

Some studies, using proxies for public security and, in some cases, correcting the possible simultaneity between this variable and crime, found no statistical evidence to conclude that, in Brazil, public security has a deterrent power on lethal homicides (Kume, 2004; Justus and Kassouf, 2007; Justus, 2009). On the other hand, studies using public security expenses as a proxy found significant results (Mendonça, 2002; Loureiro and Carvalho Júnior, 2007; Sachsida et al., 2010). Due to the lack of consensus, further discussion is needed.

In turn, the unemployment rate has a positive and significant elasticity of 0.34, showing a positive relationship between unemployment and the homicide rate. This result implies that the deterioration of economic conditions and the poor capacity of the labor market to absorb the economically active population increase the incentives for individuals to carry out illegal activities, converging with the results of other studies (Sachsida et al., 2010; Justus and Kassouf, 2011; Scorzafave and Soares, 2009). Nonetheless, this relationship is a process that takes time. Research conducted by Scorzafave and Soares (2009) shows a positive relationship between unemployment and the property crime rate. However, Becker and Kassouf (2017) do not find a positive relationship between the current unemployment rate and the homicide rate; they do find a positive relationship with the unemployment rate lagged by one period, corroborating the hypothesis that unemployment affects the opportunity costs of crime.

The proxies used for demography did not yield significant results, partly due to the low variability of the "percentage of young people" variable in the period covered here. Regarding the "migration" variable, it was also not possible to associate it with the number of homicides. These results are in line with the study by Sachsida and Mendonça (2013). They only found significant results for the variable "percentage of young men in the population" in populations with less than 50,000 inhabitants. With regard to migration, there is a lack of national empirical studies measuring the association between these two variables, which makes it difficult to compare results.

Finally, the proxy used to measure illegal drug markets showed a positive and significant elasticity of 0.056. According to the literature, this market, which has been expanding in Brazil since the 2000s, contributes to the variation in homicide rates per 100,000 inhabitants in the various Brazilian states. In the news, it is common to see that many homicides are the result of hits and misses between drug dealers and drug users. In this sense, the econometric evidence found here converges with common sense. Although there is little empirical evidence available for Brazil, this study is in line with results previously found by Mendonça et al. (2002), Justus and Kassouf (2007), and Cavalcanti et al. (2018). They also suggest a positive relationship between the illegal drug market and the homicide rate. This result is also in line with the theoretical perspectives discussed by Reinarman and Levine (1997) and Ratton et al. (2011). They suggested that part of the violence in societies could be attributed directly or indirectly to illegal drug markets.

5. Conclusion

This article makes contributions towards a better interpretation of lethal violence in Brazil today by showcasing some significant results. In the 1980s and 1990s, violence was explained by economic factors. Our research finds results that points to phenomena related to social disturbances present in Brazilian states that also correlate with their homicide levels. Additionally, we found evidence of more than one element that overloads the current levels of lethal violence in the country: the development of the illegal drug market.

Ethnic heterogeneity and family instability, proxies for social disorganization, unemployment and income, are factors that positively affect crime. However, the results found for the variables that portray income inequality, public security, and demographic aspects were not statistically significant enough to allow a relationship to be drawn between these variables and homicide rate.

Given the results, we make recommendation in the sense that the Brazilian State should invest public resources to deter illegal drug markets, promoting actions that put individuals off these illegal activities. Fostering a sustainable long-term economic policy that allows macroeconomic aggregates, such as the unemployment rate, to be well maintained is also an efficient way of reducing the homicide rate in Brazilian states. Moreover, investing in public policies that seek equality between White and Black populations in terms of access to culture, education, and leisure can also reduce the rate of lethal violence. Finally, encouraging families to promote a peaceful and tranquil environment in which to raise their children may lead to lower indicators of violence.

The main methodological difficulties of this research are related to the fragility of public databases available to measure crime in Brazil. For future research, we suggest analyzing the behavior between the variables discussed here and other types of crime beyond the homicide rate, such as crimes against property, and also expanding the study and analysis of the relationship between the socioeconomic variables studied here and the illegal drug market.

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Appendix A: Results of the pooled regression with random effects.

Variables	Pooled		Random effects	
	Coefficient	Robust standard error	Coefficient	Robust standard error
Constant	2.681	(2.747)	0.184	(1.669)
Average income	-0.279	(0.179)	0.445***	(0.132)
Divorces	0.227***	(0.074)	0.107**	(0.046)
Public security	-0.059	(0.099)	-0.066	(0.100)
Gini	-1.202**	(0.467)	-0.189	(0.313)
Percentage of black people	0.133	(0.106)	0.145**	(0.069)
Unemployment rate	0.671***	(0.198)	0.369***	(0.091)
Migration	0.032	(0.086)	-0.025	(0.097)
Percentage of young people	-0.234	(0.722)	-0.451	(0.370)
Drugs	0.032	(0.040)	0.042	(0.028)
Observations	270			
R2	0.33		0.31	

Source: Authors (2006-2015).

Significance at 10% (*), 5% (**), or 1% (***)

Functional form log-log

Appendix B: Pearson's correlation between the model's variables.

	Hom.	Sec.	Div.	% Black	Income	UNEP	Gini	Drugs	% Young	Mig.
Homicide	1	-0.12	0.04	0.2	-0.15	-0.4	-0.09	-0.17	0.04	-0.05
Security		1	0.63	-0.1	0.55	-0.15	-0.31	0.11	-0.19	0.53
Divorces			1	0.03	0.58	-0.25	-0.18	0.00	-0.33	0.49
Black P.				1	0.02	0.2	0.12	-0.32	-0.17	0.03
Income					1	-0.22	-0.21	0.19	-0.49	0.55
UnemP						1	0.14	-0.44	0.42	-0.05
Gini							1	-0.18	0.29	-0.12
Drugs								1	-0.41	-0.21
Young P.									1	0.06
Mig.										1

Source: authors (2006-2015).