CRIME ECONOMY: A CRIMINAL RATE STUDY, BASED ON BRAZILIAN STATE OF MINAS GERAIS

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Abstract

This work seeks to compile the crime rate data for the 619 municipalities of Minas Gerais, Brazil, through a published monograph review, based on socioeconomic variables, such as education, income, income inequality and public security, in each municipality in the year of 2014. The beta regression was used as the econometric model, since it is the most appropriate approach in cases where the dependent variable is in a range of (0,1) and carries a characteristic of heteroscedasticity and asymmetry in data. The results showed a positive influence of a couple of variables on the rate of aggression that was used as a proxy for crime. Others, though, were shown to be negatively related to crime, corroborating the studies pointed out in the theoretical review. The most important variable, that presented results of great magnitude, was the municipal human development index, showing an appropriate variable to explain crime.

Key Words: Crime. Regression beta. Rate of attacks. Brazil. Municipalities.
JEL: C11, C21, I38, K14

1. Introdution

Crime has become one of the most troubling issues in society as it has grown alarmingly over the past few decades and has had a negative impact on the well-being of all. The constant fear plagues Brazilian society in the smallest actions of everyday life, from practicing exercises outside the house to simply going to the bakery.

The state of Minas Gerais was registered, according to data from the National Public Security Information System[1] (SINESP, 2014) as the fourth state with the highest number of criminal occurrences in Brazil (4150 records).

The studies linked to crime and what became known as the "crime economy" were first developed by the author Becker (1968), when conducting a study on the economic side, about how the individual makes the decision whether or not to enter the illegal market. The author was able to show that the individual makes this decision through a rational analysis of costs and benefits that maximize their usefulness. The main motivation of this article is to find arguments which it explains the factors structural and regionals of each municipal responsible for high rate of criminal in Minas Gerais state.

The factors chosen for deeper thoughts in the model of this study were: urbanization rate, municipal human development index (idhm), GDP per capita, Gini index, number of

[1] *Sistema Nacional de Informações de Segurança Pública*

families headed by women, and number of inhabitants by military police and the number of blacks in the region. They were collected in the 2010 IBGE Demographic Census, in the

Index of Social Responsibility of Minas Gerais[2] (IMRS) and in the DATASUS Mortality Information System[3] (SIM). The econometric methodology used was beta regression, due to its ability to capture heteroscedasticity and asymmetry of the data used in the model, as well as being the most appropriate approach in cases in which the dependent variable is in a range of (0,1).

This work will use as a reference the study developed by Becker (1968), mentioned before, and aim to identify the main socioeconomic factors that influenced the rate of aggression in the 619 municipalities of Minas Gerais in the year 2014, and to test if these are linked to the rational cost-benefit analysis of individuals.

In addition to this introduction, this work will be divided into 5 (five) more parts, which will cover a review of the basic literature linked to the economics of crime, an explanation of the database used, the methodology discourse, an analysis of the results obtained and a general conclusion, based on the knowledge acquired.

2. Literature Review

In order to explain the determinants of crime, several theories have been developed, based on empirical and theoretical evidence. Some approaches must be taken into account in order to understand the content of this work and the choice to exalt socioeconomic variables as analysis data.

One of the first studies involving criminology as the core was conducted by Lombroso, 1968. The theory, focused on individual pathology, seeks to explain the cause of criminality through the behavior of the criminal taking into account their individual pathologies, such as their biological, psychological and psychiatric nature. The author, therefore, believes that crime is a dysfunction of the individual by itself, developed naturally in his body. Another theory of social disorganization focuses on the study of local communities because of the ease formation of formal and informal relationships that can help in the process of acculturation of the individual. The first authors to test this approach were Sampson & Groves (1989), setting aside the idea of crime as a biological dysfunction and attributing it to the social environment and interactions.

Entorf & Spengler (2000, apud CERQUEIRA & LOBÃO, 2004, pp.238-239) have stated that one of the causes of crime comes from the unwanted effects of organizations, such as a group of unsupervised adolescents. The goal of the lifestyle theory, developed by the authors Mesner and Blau in 1987, is to study how each victim's way of life can explain the causes of crime. Some aspects are used, such as a potential victim, a potential criminal, and how a potential victim protects against crime. The approach used in this theory is the study of victimization, which seeks to analyze the routine of individuals and identify the factors that lead these to be possible victims.

The theory of self-control, developed by Gottfredson & Hirschi (1990, apud CERQUEIRA & LOBÃO, 2004, pp. 242-244), aims to show that one of the causes of crime can be explained by the lack of efficiency in the way parents though their children, when in childhood. The considerations on social control aim to understand why some individuals do

[2] *Índice Mineiro de Responsabilidade Social*
[3] *Sistema de Informação sobre Mortalidade*

not commit crimes. This theory takes into account elements such as the probability of the individual being caught by the police and the punishment adopted for the crime committed

and was developed by Agnew & White (1992, apud CERQUEIRA & LOBÃO, 2004, pp. 242).

The theory known as “Anomia” was developed by Merton (1938, apud CERQUEIRA & LOBÃO, 2004, pp. 245), who sought to explain the cause of crime through the economic success of the individual, who can achieve his goals or not.

Finally, the economic theory of rational choice, which will be the basis for this work, had as main author Becker (1968), who sought to explain crime by a model in which the individual analyzes the benefits and costs expected of committing a crime. In this way, the individual seeks to maximize their usefulness by studying their possible gains, punishments and the costs involved in performing the illegal activity. The author adds an important variable in this analysis, risk aversion.

Thus, Becker's crime offering function is:

$$O_j = O_j\ (P_j,\ F_j\ ,\ U_j) \tag{1}$$

In which, O_j is the number of crimes that can be committed in a given period; Pj is the probability of being convicted of a crime; F_j is the punishment for crime; U_j's are other influences. For Becker (1968), society has a crime-related cost not only for suffering losses related to death, violence and stolen objects and resources; but for taking an expense to the detriment of the processes of imprisonment, conviction, punishment and imprisonment of criminals. Thus, the author has developed a function to explain the loss of each individual caused by crime:

$$L_j = H_j\ (O_j) + C_j\ (P_j, O_j, C, C_k\ ) +\ B_j P_j F_j O_j \tag{2}$$

In which, L_j is the loss function of each individual; $H_j\ (O_j)$ is the injury to the number of crimes committed; $C_j\ (P_j, O_j, C, C_k)$ is the cost of achieving a conviction probability for the number of crimes committed. The higher the number of crimes, the higher this cost. When higher c, public expenditure spent on crime, and the higher C_k, private expenditure spent on crime, lower this cost; $B_j P_j F_j O_j$ is the expected loss of society in relation to the punishment of the criminal for the crime committed, in which B_j is the coefficient of social loss.

Becker began a trend of practical studies that attribute crime to variables, econometric data and possible analysis and evaluation. Ehrlich (1973, apud CERQUEIRA & LOBÃO, 2004) was responsible, together with Becker, for the contribution of the optimal allocation of time spent in the illegal labor market, and to analyze the relationship of the variable income on crime. For him, there is a positive and significant relationship between the variable income inequality and crimes against property, in addition to identifying the significance of the "law enforcement" effect that would be the effect of the conviction, imprisonment and punishment to the crime rates, in relation to crime.

Based on international studies such as those mentioned, Andrade & Lisboa (2000) developed a model for the states of Minas Gerais, São Paulo and Rio de Janeiro from 1981 to 1997, with the objective of studying the relationship between the homicide growth and some socioeconomic variables, using a combination of cross-section with time series, because the latter presents better performance when studying economic cycles and criminal inertia. They

adopted as an estimation method the Chi-Square Minimum applied to Berkson's Logit model, since the qualitative variables were found in the frequency form.

Data on the dependent variable and the independent variables were obtained from the DATASUS Mortality Information System (SIM) and from the 1980 and 1991 Censuses and the 1996 Count. The authors concluded that "the probability of death is increasing with the age, reaching, in the great majority, the peak in the range of 20 to 25 years, when the movement is reversed and becomes decreasing".

Another result reached by the authors was that socioeconomic variables were more significant in explaining crimes in the young male population, which showed that the age variable is very relevant to explain the crime, also. The inertia effect was quite significant in explaining properties of crime, as the individuals who enter the illegal labor market as young people tend to remain in this activity throughout their life cycle. (ANDRADE & LISBOA, 2000). The results of this model also showed that the state of Minas Gerais presents lower rates of crime than in the other two states, with a possible justification, presented by the authors, that the youth of this region seek the legal labor market in the first place.

A first analysis was developed for the region of Minas Gerais, conducted by Beato (1998) who sought to explain the relationship of socioeconomic variables with the crime rate of 756 municipalities in the region in 1991, as well as the spatial distribution of crime. The author used data from the Military Police of Minas Gerais[4] (PMMG) and estimated a model with Bayes estimators, in order to reduce data instability. Their results showed that there is no correlation of crime with the inequality indicator and that the urban centers of the region are those with the highest crime rate, such as the metropolitan region of Belo Horizonte (RMBH), showing that crimes are concentrated spatially and temporally.

Finally, authors Araujo Junior & Fajnzylber (2000) developed an analysis of the crime rate in 66 microregions of Minas Gerais, using variables representative of average educational levels, income inequality, urbanization, among others, that were collected at the Military Police of Minas Gerais. The authors believe that crime is inversely related to the opportunity cost of illegal activity, that is, for the individual to opt for the crime, the gains of this activity must be greater than it would gain in the legal market, and must compensate the costs of a conviction, imprisonment and punishment, in addition to the moral cost of breaking the law. Regions with a high income population are more likely to suffer from crime because of greater economic motivation for criminals to commit illegal activities.

The authors used the model of Ordinary Least Squares, with standard errors corrected by heteroscedasticity with the White method, in order to replace the economic variables of the model with proxies, such as the average family income *per capita* in the place of education; besides adding a dummy to the metropolitan area of Belo Horizonte. Araujo Junior & Fajnzylber (2000) concluded that variables such as: younger in the population, social disorganization factor measured by the rate of separation, more urbanized regions and greater income inequality increase crime.

3. Databases

3.1. Descriptive analysis of the variables

[4] *Polícia Militar de Minas Gerais*

This section aims to develop an analysis about socioeconomics variables used to explain the dependent variable of de model, the aggression rate. It was obtained across

DATASUS Mortality Information Systems (SIM), microdata base based on individual information like age, locality and cause of death. One of the problems faced by it is the mistaken classification of some deaths as homicides, mainly intentional ones; besides the underreporting rates of occurrences, that leaves out of the sample some deaths that were not registered.

The following variables are consider to be determinants of crime rates: urbanizations rate, municipal human development index (idhm), GDP per capita, Gini index, rate of female-headed households, Inhabitants by military police and rate of blacks per municipality. The rate of urbanization was used as a proxy for the cost plaining and execution linked to illegal activities. It has a positive relationship with crime. Data for this variable were obtained through the 2010 IBGE Demographic Census[5].

The municipal human development index is used to measure the degree of economic development of municipalities taking into account the criteria of education, income and life expectancy. This variable was collected in the 2010 IBGE Demographic Census. It has an ambiguous relationship with the crime rate, since income in education show this pattern of behavior: there is an inversely proportional relationship between these variables and crime. In which an increase in the income of the individual and his / her level of education generates an increase in the opportunity cost of them in entering the illegal market. They can also serve as a proxy for the potential gains of criminals, that is, the higher the family per capita income and the level of schooling, the more economically attractive the victim becomes.

The GDP per capita, by its turn, is used as the opportunity cost of the individual to enter the illegal labor market. Thus, one can expect a negative relationship between this variable and crime, because the larger the GDP, the more opportunities in the legal labor market arise. This variable was collected in the 2010 IBGE Demographic Census.

The Gini index serves as a proxy for the rate of inequality of income distribution, because the higher this index, the higher is a concentration of income in the region, generating a strong incentive for criminality and, showing the positive relationship that the variable has with crime. The Gini index was, also, obtained through 2010 Demographic Census.

To measure the family environment, in order to classify it as organized or not, the rate of female-headed households obtained through the 2010 IBGE Demographic Census is used. It is positively correlated with the homicide rate since according to Gartner (1990 Apud Araújo Jr, Ari, 2002), a disorganized family has lower moral costs and a smaller interpersonal bond, encouraging illegal activity.

The variable inhabitants by military police will be used to measure the degree of public safety in Minas Gerais and to identify how crime behaves in relation to it. A negative relationship between the rate and aggressions is expected because the greater the security spending in a region, the greater the chance of the individual being captured, generating a demotivation for participation in illegal activities. The variable was obtained through the Minas Gerais Social Responsibility Index (IMRS) from *João Pinheiro Foundation.*

The black variable is used in the model given the culture of marginalization of the race present in Brazil, due to its historical context, which ultimately led to inequality of income and opportunities, such as education and health among whites and blacks. Thus, the purpose

[5] Censo Demográfico IBGE 2010.

of this variable is to identify whether there is a positive relation between the black race and the crime rate. This variable was taken from 2010 IBGE Demographic Census.

3.2. Descriptive Statistics of the data

Table 1 shows the statistical description of each variable.

Table 1 – Descriptive statistics of the variables dependent on the econometric model

Variablel/Description	Maximum	Minimum	Average	Medium
Aggression	0.1534807	0.000164	0.0016147	0.0004914
Urban	100.00	24.00	69.80	72.8
IDHM	0.8130000	0.529000	0.6700000	0.672000
Gdp	159387.00	4222.00	15458.00	11030.00
Gini	0.7832000	0.328800	0.4860000	0.485000
Hea_wom	233537.00	82.00	2410.800	780.00
Blacks	241155.00	67.00	2765.00	836.00
Hab_police	5323.10	0	991.10	897.90

Source: Author's Elaboration

To compile the information of table 1, it was necessary to analyse each variable of each of the 619 municipalities. By that analysis, it was pointed that the municipality with the highest rate of aggressions is Belo Horizonte while the one with the lowest rate is Abadia dos Dourados. On the other hand, São Geraldo da Piedade has the lowest rate of urbanization in the municipalities studied, and Timóteo the highest rate. Nova Lima is the municipality that has the highest human development index among those studied, while São João das Missões has the lowest. The municipality with the highest GDP per capita is Itapeva, unlike the municipality of São João das Missões, which has the lowest value for this variable. Jequitaí has the highest gini index, that is, it has a higher concentration of income in the hands of certain groups. While Córrego Fundo has the lowest index, with a lower income inequality. The municipality whit the largest number of families headed by women is Belo Horizonte, differently of the municipality of Senador José Bento, which has the lowest number. Belo Horizonte is the municipality that exhibits the highest rate of blacks in the population, differently than Senador José Bento, which has the lowest rate. Finally, Conceição da Aparecida the one that contains the least amount of inhabitants by military police, while Carmo do Rio Claro contains the largest amount.

4. Methodology

4.1. Econometric Model

The econometric model has the form of a linear regression, which uses beta regression as the estimation method. A more appropriate and practical approach when the dependent variable, which is explained by the model parameters, is in the range (0,1), as described by FERRARI & CRIBARI-NETO (2004), was also chosen for capturing heteroscedasticity and asymmetry of the data used in the model.

To model the dependent variable will be used the beta distribution, which is a continuous probability distribution. FERRARI & CRIBARI-NETO (2004) used the parameters $\mu = \frac{p}{(p+q)}$ and $\phi = p + q$, generating a new density function:

$$f(y;\mu,\phi) = \frac{\Gamma(\phi)}{\Gamma(\mu\phi)\Gamma((1-\mu)\phi)}\, y^{\mu\phi-1}(1-y)^{(1-\mu)\phi-1} \quad 0 < y < 1 \tag{3}$$

Where $0 < \mu < 1$ and > 1 . Its mean and variance are represented respectively by $E(y) = \mu$ and $VAR(y) = \frac{\mu(1-\mu)}{1+\phi} = \frac{g^{-1}(x_i{}^T\beta)[1-g^{-1}(x_i{}^T\beta)]}{1+\phi}$. It can be seen that when μ is fixed, the larger the parameter φ, the smaller the variance of y.

Thus, the beta regression model is given by the following function:

$$g(\mu_i) = x_i{}^T\beta = \eta_i \tag{4}$$

In which, $\beta = (\beta_1, \dots, \beta_k)^T$ is the vector of unknown parameters, $x_i = (x_{i1}, \dots, x_{ik})^T$ is the vector of k model regressors and $\eta_i = \beta_1 x_{i1} + \cdots + \beta_k x_{ik}$, being $\beta_1 x_{i1}$ the intercept of the equation, once $x_{i1} = 1$.

This model is flexible to choose the binding functions, which is responsible for relating the random distribution to the non-random distribution of the dependent variable. These connection functions can be Logit or probit. The connection function used in this model will be Logit, represented by:

$$\mu_t = \frac{e^{xt^T\beta}}{1+ e^{xt^T\beta}} \tag{5}$$

Where $xt^T = (xt_1, \dots, xt_k)$, $t = 1, \dots, n$.

To estimate the values of the different parameters of the model, the maximum likelihood estimate will be used, which will better explain the observed sample. The logarithm of its function is defined by:

$$xt^T = (xt_1, \dots, xt_k), t = 1, \dots, n \tag{6}$$

On what:

$$\ell(\mu_i,\phi) = log\Gamma(\phi) - log\Gamma(\mu_i\phi) - log\Gamma\big((1-\mu_i)\phi\big) + (\mu_i\phi - 1)logy_i + \{(1-\mu_i)\phi - 1\}\log(1-y_i) \tag{7}$$

It is important to note that the equation is a function of β, that the vector of the parameters of:

$$\mu_i = g^{-1}(xi^T\beta) \tag{8}$$

The beta regression model has different types of residues. The typical expression of residues $y_i - \hat{\mu}_i$ is not used due to heterostedasticity of the model. Thus, an alternative is the use of Pearson's Residues, determined by the following equation:

$$r_{P,i} = y_i - \hat{\mu}_i / \sqrt{\widehat{VAR(y_i)}} \quad (9)$$

Where:

$$VAR(y_i) = \widehat{\hat{\mu}_i(1-\hat{\mu}_i)/(1+\hat{\phi}_i)}, \hat{\mu}_i = {g_1}^{-1}\left(xi^T\hat{\beta}\right) \text{e} \widehat{\phi_i} = {g_2}^{-1}({z_i}^T\hat{\gamma}). \quad (10)$$

A regression of the model by the Ordinary Least Squares (OLS) method will be performed, only to compare the results with the Beta Regression model and verify which estimator would be the most appropriate.

The OLS model is defined by the following equation:

$$y_i = \beta_k X_{kn} + u_i \quad (11)$$

Beyond the he ordinary least squares are a benchmark of econometrics models, these estimators consistent and the best repressors in the class of linear unbiased estimators when variance of the model is homoscedastic. When, the hypothesis of homoscedastic is violated, the coefficients estimates aren't biased, however the variance don't configure standards of inferences to hypothesis tests and confidence interval. In these cases, a collection of random were heteroscedastic, the matrix of variance-covariance will be fixed by correction White.

4.2 Likelihood Ratio Test (LR)

It has asymptotic chi-square distribution χ^2 with q degrees of freedom and is defined as the difference between the logarithm of likelihood of the beta regression model and the logarithm of likelihood of the OLS model. Its equation is as follows:

$$LR = 2[L(\theta) - L(\theta_R) \quad (12)$$

Let L (θ) be the log of likelihood of the regression model beta and L (θ_R) the log of likelihood of the OLS model.

Under null hypothesis the coefficients of the models must be equal. If the P-value is less than zero, we reject the null hypothesis, which shows the existence of differences between the coefficients.

4.3 AIC Test

In order to define the best model, the Akaike Information Criterion (AIC) is based on the maximum of the likelihood function and is expressed by:

$$AIC = -2\log L\left(\hat{\theta}\right) + 2k \quad (13)$$

In which log L($\hat{\theta}$) is the maximum of the logarithm of likelihood function anc the parameters θ and k is the number of parameters. The model with the lowest AIC will be the most appropriate, because it has a better fit.

4.4 Breusch-Pagan Test (BP)

The Breusch-Pagan lagrange multiplier test will be used to verify the existence of correlation of the explanatory variable with the error. Its null hypothesis is the existence of homoscedasticity, that is, the variances of the errors are equal. Thus, the alternative hypothesis is the existence of heteroscedasticity.

This is a chi-square distribution test (χ^2_{BP}) with q degrees of freedom, in which it function is defined by:

$$ui = \frac{e_i^2}{SQE/n} \ , \ i = 1, \dots, n \qquad (14)$$

Where $SQR = \sum_{i=1}^{n} e_i^2$.

This equation shows that residues are standardized by dividing each residue squared by the SQR (Sum of Squares of Residues), which, in its turn, is divided by the number of observations.

5. Analysis of Results

Seven regressions were performed changing the independent variables to confirm the net impact of each on the dependent variable. Table 2 shows the model results, having as a dependent variable the rate of aggression for 619 municipalities of Minas Gerais:

Table 2 - Results of the estimation Beta: socioeconomic variables that explain the rate aggression in the 619 municipalities of Minas Gerais.

Variables	1	2	3	4	5	6	7
Intercept	-9.74E+00	-6.75E+00	-7.12E+00	-1.03E+01	-7.91E+00	-6.60E+00	-1.14E+01
	< 2e-16 ***	< 2e-16 ***	< 2e-16 ***	< 2e-16 ***	<2e-16 ***	<2e-16***	< 2e-16 ***
Urban	1.32E-02	-	-	-	1.64E-02	-	-
	1.02e-07 ***	-	-	-	<2e-16 ***	-	-
Idhm	1.85E+00	-	-	5.34E+00	-	-	5.55E+00
	0.04530 *	-	-	5.36e-16 ***	-	-	2.84e-14 ***
GDP	2.20E-06	6.90E-06	-	-	-	-	2.32E-06
	0.25483	5.82e-05 ***	-	-	-	-	0.2767
Gini	1.56E+00	-	1.10E+00	-	-	-	1.78E+00
	0.00676 **	-	0.068260 .	-	-	-	0.00324 **
Head_wom	-9.71E-05	-1.16E-04	-1.15E-04	-1.02E-04	-1.02E-04	-1.17E-04	-
	< 2e-16 ***	< 2e-16 ***	< 2e-16 ***	< 2e-16 ***	<2e-16 ***	<2e-16 ***	-
Blacks	1.12E-04	1.33E-04	1.32E-04	1.17E-04	1.19E-04	1.34E-04	1.71E-05
	< 2e-16 ***	< 2e-16 ***	< 2e-16 ***	< 2e-16 ***	<2e-16 ***	< 2e-16 ***	< 2e-16 ***
Hab_police	-9.16E-05	-1.89E-04	-2.27E-04	-1.16E-04	-1.08E-04	-2.19E-04	-
	0.18817	0.00655 **	0.000989 ***	0.0955 .	0.124	0.00151 **	-

Source: Author's Elaboration

(*), (**) e (***) Indicates statistical significance of 10%, 5%, 1% , respectively

Table 3 – Results of the statistical tests of the econometric model: socioeconomic variables that explain the rate of aggression in the 619 municipalities of Minas Gerais.

TEST/ MODEL	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
AIC BETA	809	356	707	735	385	272	13
AIC OLS	478	860	988	976	201	847	436
LR	p-valor	p-valor	p- valor	p-valor	p-valor	p-valor	p-valor
	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	< 2.2e-16
BP OLS	p-valor	p-valor	p-valor	p-valor	p-valor	p-valor	p-valor
	2.2e-16	2.2e-16	2.2e-16	< 2.2e-16	< 2.2e-16	2.2e-16	1.491e-13

Source: Author's elaboration

Table 4 – Result of the estimation OLS Regression White Standard Errors: socioeconomic variables that explain the rate of aggression in the 619 municipalities of Minas Gerais.

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Intercept	3.2233e-03	-1.8379e-04	1.1643e-03	1.4781e-03	3.2233e-03	-1.7425e-04	3.1748e-03
	0.10099	0.30726	0.01852 *	0.27186	<2e-16 ***	0.34767	0.006551 **
Urban	-9.5375e-07	-	-	-	-9.5375e-07	-	-
	0.82416	-	-	-	0.83725	-	-
Idhm	-2.9185e-03	-	-	-2.3799e-03	-	-	-3.0461e-03
	0.23686	-	-	0.27404	-	-	0.031212 *
GDP	4.6102e-09	4.9450e-10	-	-	-	-	3.8378e-09
	0.48785	0.93600	-	-	-	-	0.585517
Gini	-2.8844e-03	-	-2.7873e-03	-	-	-	-2.8156e-03
	0.02060 *	-	0.01161 *	-	-	-	0.004476 **
Head_wom	8.3313e-08	8.1459e-08	8.3524e-08	7.8564e-08	8.3313e-08	8.1033e-08	-
	0.79452	0.77913	0.77734	0.79972	0.78231	0.78060	-
Blacks	5.7115e-07	5.6790e-07	5.6807e-07	5.7331e-07	5.7115e-07	5.6837e-07	6.4732e-07
	0.03843 *	0.03271 *	0.03353 *	0.03525 *	0.03538 *	0.03312 *	0.004476 **
Hab_police	-3.6513e-08	2.4537e-08	3.3302e-08	-4.3811e-08	-3.6513e-08	8.1033e-08	-
	0.67162	0.79469	0.74713	0.62194	0.66461	0.78060	-

Source: Author's Elaboration

(*), (**) e (***) Indicates statistical significance of 10%, 5%, 1%, respectively.

According of results the statistics test, all estimations by OLS were significant for heteroscedasticity throw Breusch-Pagan Test (BP). Therefore, in the presence of heteroscedasticity, the statistical test of significance is invalidating once the variance and covariance are underestimated. However, the variance-covariance matrix is modified to correctly for heteroskedasticity-consistent White standard errors. In general all the independent variables in the regression OLS, it was found that only GDP per capita and the number of inhabitants per military police were insignificant at the significance levels of , 1%, 5% and 10%. The variables number of families headed by women and inhabitants by military police was inversely proportional. This second confirming what was already expected, since the greater the government's expending in security (reflected in the number of police officers), the greater the costs of criminals to be captured, as studied by Araújo Jr, Ari (2002).

Meanwhile the result of the proxy used to measure the family environment was inversely because the greater the number of families headed by women more socially disorganized is the family environment, presenting lower moral costs and lower interpersonal bond, which creates an incentive to illegal activity, according to the studies carried out Gartner (1990 apud Araújo Jr, Ari, 2002).

The other variables presented a behavior according to the previously theories. The variables of the model I that presented highest magnitude were the number of families headed by women, with -9.71E-05 and, the number of inhabitants per police with -9.16E-05. Regarding the result from the test, we conclude that the OLS model shows the most appropriate, the lowest value presentation, compared to the Beta regression model. One justification for this result is the insertion of all variables in the model. In OLS, it just the variables Gini and Blacks were significant, the main results shows the important of these to explain the dependent variable. To evaluate the net effect of the GDP per capita on the aggression rate, free of other variables; urbanization variables, Gini index and municipal human development index were removed. In the model II, the results showed that all the variables present in the model are significant at significance levels of 1%, 5% and 10%. The magnitude of the GDP result was 6.90E-06, positively related to the rate of aggression, showing that higher the per capita GDP, higher the rate of aggression. This behavior is justified by the fact that the victims become more attractive economically with the increase of the GDP, generating an increase of the individual's gain whit the criminal activity, as verified in the study of Beato (1998). The result of the AIC test showed the beta regression model is the most suitable for this study because it presents a lower result than the OLS model.

The function of the fourth model was to observe the net effect of the municipal human development index on the rate of aggression. The variables urbanization, GDP per capita and Gini index were removed. Again, the results showed that the all variables are significant at all significance levels of 0,1%, 1%, 5% and 10%. The municipal human development index was positively related to the rate of aggression in the magnitude of 5.34, showing that this variable can serve as a proxy for the potential gains of criminals, as higher the per capita family income and the level of education more economically attractive the victim becomes. This behavior is also confirmed by the studies of Araujo Junior & Fajnzylber (2000). For the third consecutive time, the AIC test confirmed that beta regression is the most appropriate for this study in relation to the OLS model, and that the LR and BP tests comprised p-values smaller than zero, rejecting null hypotheses.

Aiming to estimate the net effect of the rate of urbanization on the rate of aggression in the 619 municipalities of Minas Gerais studied, GDP per capita and Gini Index were used. Only the variable inhabitants by police did not show significant for all levels of significance of , 1% 5% and 10%. The magnitude of the impact of urbanization on the dependent variable was 1.64E-02, positively correlated. This result confirmed the theory that the higher this rate, the closer the offenders are to potential offenders, leading to a transfer of information, tips and techniques linked to crime, what consequently decreases the cost of entering the illegal market. However, the AIC test result showed that the OLS model is presented as the most adequate and this model only the variable Black was significant. There are evidences which GDP is not a significant choice, although it was impact in regression Beta.

To observe the net effect of the number of inhabitants per police on the rate of aggression, the variables municipal human development, GDP per capita, Gini index, and urbanization were removed. All the results were significant for significance levels of 5% and 10%. The observed effect of the variable number of inhabitants per police on the variable

aggression rate of the 619 municipalities studied in Minas Gerais was consistent with the theory presented previously. Its impact has a magnitude of -2.19E-04. Their behavior is inversely proportional, because the greater the security spending in a region, the greater the chance of the individual being captured, generating a demotivation of participation in illegal activities. To verify the net effect of the number of blacks on the rate of aggression, the

variables urbanization, number of families headed by women and number of inhabitants by police were withdrawn. The results showed that all variables were significant at significance levels of 1%, 5% and 10%. All signs of the variables were proportional to the aggression rate for the 619 municipalities of Minas Gerais studied. The magnitude of the impact of the black variable in relation to the dependent variable was 1.71E-05, positively related, which was due to the culture of marginalization of the black race that Brazil carries. There is, therefore, a relationship between the black race and the crime rate. In this model, the magnitude of the municipal human development index variable was large, with 5.55E+00. As expected, given the study of the other 6 models, the AIC test showed that the beta regression is the well-adjusted for this work, compared to the OLS model.

6. Conclusion

Crime is one of the subjects that most afflicts society in the past few decades. Many studies have already been realized aiming to identify the factors that most influence crime, the criminal's and the victim's characteristics. The first author to develop deep studies about crime, using as reference the economic theory of rational choice, was Gary Becker (1968), who sought, in his article Crime and Punishment: An Economic Approach, to explain crime through a model in which the individual analyses the expected benefits and costs of committing an illegal activity.

This work sought to explain the aggression rate in 619 municipalities of Minas Gerais in 2014, through a couple of socioeconomic variables, such as GDP *per capita*, gini index, human development index, number of population per police, among others. For that, the econometric model used was the beta regression, for being the most suitable in cases in which the dependent variable is between (0,1), as shown by Ferrari & Cribari-Neto (2004) and for being able to capture the heteroscedasticity and the asymmetry of the data used in the model.

The results showed that the aggression rate is positively impacted by urbanization variables, municipal human development rates, gini index, blacks and GDP *per capta*. The last variable showed a significant result only in the second model, when it was analyzed isolated from other variables. As expected, the variable population number per police showed itself negatively related with the aggression rate, because once higher the government investments in public security, higher the chance of the individual being caught and, therefore, higher the cost of acting in the illegal market. The variable number of families headed by woman showed a different behavior then the one expected, as the variable is linked with a disorganized family environment, that represents a less moral cost and interpersonal bond, as showed by Gatner (1990 apud Araújo Jr., Ari Fajnzylber, 2002).

It is important to emphasize that studies like this have a fundamental role in the decision-making about implementation of public politics in society, especially because they present the real causes of problems and suggest measures that can improve the well-being of population. Therefore, this work expects to allow its readers to better understand the causes of crime and suggest proper measures for the Brazilian government to try and solve the problems linked with it.

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