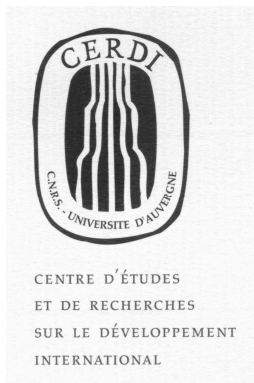CERDI, Etudes et Documents, E 2004.02

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ARE EDUCATED SOCIETIES LESS VIOLENT? EDUCATION, DEPRIVATION AND CRIME IN MINAS GERAIS.

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1

1 Introduction

In 2001, Brazil experienced homicide rate of 23 per 100,000 inhabitants (Interpol, 2002) and robbery rate of 395 per 100,000 inhabitants (Ministerio da Justiça, 2002). These rates are very high compared to neighbor countries (respectively 8 and 135 for Argentina, 8 and 279 for Uruguay in 2001), to Western Europe (respectively 4 and 229 for France, 3 and 69 for Germany) and even to United States (respectively 5.5 and 148.5). As a consequence, according to Bourguignon (2000) and Pradhan and Ravallion (2003), safety has become one of main public and private concern in Brazil and Latin America over the past 20 years.

Determinants of crime have raised interest of social scientists, and particularly of economists and sociologists. Economists rely hugely on the theoretical framework of individual behavior developed by Becker (1968) and Ehrlich (1973), considering criminals as "normal" individuals, responding to incentives and trying to maximize their expected utility following a trade-off between legal market activities and illegal sector. Sociological theory, following in Merton's wake (1968), consider for its part crime and violence as a deviant behavior coming from the inadequacy between individual and society. An extension of this theory is to consider crime as a response to relative deprivation (Kawachi, Kennedy and Wilkinson, 1999). Surprisingly, there are few recent works trying to relate education to crime, the most significant being that of Usher (1997), who studies the deterrent impact of education's "civic externality" upon crime at a theoretical level.

The intuition behind this paper is that education has a significant role to play in the reduction of crime in developing countries. In other words, the fact that universal education is not completed in developing countries could be one of the reasons of their high crime rates, by opposition to developed countries where universal education is now the norm, making education to be probably a poor determinant of crime in these countries. Moreover, this article proposes to study how education is linked to crime level, both at theoretical and empirical level and, more precisely, how education and relative deprivation interact to influence crime.

Theoretically, section 2 of this paper presents an augmented model of criminal behavior, which relies on a basic Beckerian setting, in which the concept of relative deprivation is introduced. This model allows for the possibility of crime committed without any economic motivation or, in other words, for "pure" violent crime such as homicide or assault. It is first developed at an individual level and then aggregated in order to be in adequacy with our data. Section 3 discusses the role of education in the model, distinguishing several measures of education and their expected impact upon property crime on the one hand and interpersonal violence on the other hand.

Section 4 presents the data and the econometric setting. Crime rates are issued from a newly used database, which provides quality data at the municipality level for Minas Gerais, one the 26 Brazilian states, located in the Southeastern region (municipality is the smallest administrative unit in Brazil). Our database is a cross-section of 723 municipalities of Minas Gerais for the year 2000. Though crime data are issued from police records, which are well-known to undermine

"true" crime levels, this database is, to our knowledge, the one which furnishes the best data concerning Brazil and the only one of that kind for this country. By the way, the choice of Minas Gerais has been conditioned by the existence and the availability of this database.

Section 5 presents the main results of econometric estimates of several kind of crime rates, distinguishing economic and interpersonal violence, with a special look at the impact of education variables. The main finding of this paper is that violent economic crime is not influenced by education (even indirectly), while basic education (alphabetization, primary schooling) reduces significantly interpersonal violence, not because it raises human capital (and thus reduces the incentives to commit a crime) but rather because it increases citizenship and social capital. Section 6 concludes and raises some policy implications.

2 A theoretical model of crime and deprivation

2.1 Theoretical background

2.1.1 The framework of crime economics

According to the economic theory of crime, initiated by Becker (1968) and Ehrlich (1973), criminals are like other individuals, seeking to maximize their expected utility and responding to incentives. Crime is seen as a consequence of a rational choice of time allocation between legal and illegal activities. In other words, each agent compares his expected earnings in legal and illegal sector, criminals being those for whom the former is less than the latter. This choice is expected to be hugely influenced by deterrence, more precisely, by the probability of apprehension and the size of punishment: the more the deterrence, the less the number of crimes and criminals. Following economic theory, crime is also induced by income inequality. Crime, and especially property crime, is seen by the poorest individuals as a way to reduce the income gap with richer people. However, this point of view is somewhat restrictive since it gives no explanation to crime such as homicide, assault or rape, which are committed without any economic incentive.

2.1.2 Introducing deprivation in crime models

What is relative deprivation? Relative deprivation is a sociological concept, more and more used by economists, mainly to explain migration. Stark (1991) and Yitzhaki (1979) both use the same definition of relative deprivation :

> We can roughly say that [a person] is relatively deprived of X when (i) he does not have X, (ii) he sees some other person or persons, which may include himself at some previous or expected time, as having X (whether or not this is or will be in fact the case), (iii) he wants X, and (iv) he sees it as feasible that he should have X.

There are two components in the concept; not having X and wanting it causes deprivation, while conditions (ii) and (iv) ensure relativity. Poverty and/or low education cause absolute

deprivation, while income inequality (and maybe education inequality) involves relative deprivation. Response to relative deprivation is the willingness to improve his own position relative to other people. Stark sees rural-to-urban migration as a response to relative deprivation, higher wages in urban sector inciting rural people to migrate, in order, not to increase income *per se*, but to get a higher social position. It is possible and rather easy to adapt this setting to the crime decision.

Linking crime to relative deprivation   The sociological theory of crime, largely influenced by Merton (1968), far from considering crime as an individual choice, gives a social explanation. All individuals in a society are assumed to share common values, particularly common goals and common "legitimate" ways to reach these goals.

Crime is a way for individuals to "adapt" themselves to the society. Merton distinguishes 5 kinds of individual adaptation: (i) conformism (respect of both social goal and means), (ii) innovation (respect of goals but reject of means), (iii) ritualism (neglect of goals, respect of means), (iv) evasion (reject of both goals and means) and (v) rebellion (reject of goals and means with introduction of new social values). Crime takes part of innovation, in the sense that individuals who commit a crime follow the same goals as the hole society but differ from other individuals in their respect of rules and norms. Moreover, giving too much importance to the goals can make individuals ignoring totally the means (and their legitimacy) and lead society to a situation of *anomie* (absence of norms). In such a situation, individuals who failed to reach social goals (which, for Merton, is individual success in a competitive society) are frustrated, all the more when they face successful people, and get alienated from society. Crime, especially violent crime, is no more than a response to individual alienation. In other words, individuals are engaged in interpersonal income comparisons, generating either relative deprivation or satisfaction, depending on their own social position. According to Merton, crime is a way to improve its own income and social position.

In this paper, we stay in a Beckerian setting and just add a relative deprivation component. The traditional economic modeling of crime can be considered as incomplete in the sense that individuals do not only compare expected earnings in the legal sector and expected returns from illegal activities, they also compare their own income to that of other people, especially people around them. The setting developed in this paper makes clearer the expected effect of some key variables on crime. First, we can consider the traditional economic setting of crime (comparison between legal and illegal income) as a modeling of the effect of absolute deprivation on crime : poverty and low education incite concerned individuals to commit crimes, both because expected legal income is very small and because the psychological cost of punishment is fewer than for wealthier or more educated ones. Second, we shall add the interpersonal income comparison element. From this point of view, income inequality is a (even **the**) key variable. More generally, relative deprivation can come from other variables than income. Education inequality, or social gap between literate and illiterate people, are also probably part of the issue.

2.2 A model of crime decision and relative deprivation

Let us consider the gain from crime for individual i, g_i as the difference between benefits and costs. Benefits are equal to the loot, l_i, conditional to the probability of **not** being apprehended $(1-p)$. Costs of committing a crime are composed by direct cost of offense, c_i and the expected punishment conditional to the probability of being apprehended, $p*f$:

$$g_i = [(1-p)*l_i] - [c_i + (p*f)] \tag{1}$$

Moreover, following Fajnzylber, Lederman and Loayza (2002), we assume that crime, o_i, will be committed only if the gain, g_i, exceeds the moral cost, m_i, associated with illegal activities and the loss induced by the wage the individual could have potentially earned if he had worked instead of committing a crime. The moral cost is assumed to be measurable and to have a pecuniary value. Indirect and immaterial cost of crime will be noted e_i:

$$e_i = m_i + w_i \tag{2}$$

$$\begin{cases} o_i = 1 & when & e_i \leq g_i \\ o_i = 0 & when & e_i > g_i \end{cases} \tag{3}$$

Let us then adopt the setting of relative deprivation developed by Stark (1991). Consider a small community in which each individual compares his income w_i with the community's average income, $\bar{w}$ and assume that the income distribution in this community is uniform. Then people whose income is less than the average are relatively deprived:

$$\begin{cases} d_i = 1 & when & w_i < \widetilde{w} & , \widetilde{w} = \bar{w} - q \\ d_i \leq 0 & when & w_i \geq \widetilde{w} \end{cases} \tag{4}$$

where d_i is relative deprivation and q is a supportable lower bond, i.e. $(\overline{w} - q)$ is the upper bond of relative deprivation (individuals with such an income, though less than community's average income, do not feel relatively deprived). Notice that $d_i \leq 0$ indicates a relative *satisfaction*.

We assume that crime will be committed if and only if it enables to compensate this income gap, i.e if it contributes to reduce relative deprivation. As a consequence, the direct gain from crime, g_i must be higher than the acceptable level of income, $\widetilde{w}$:

$$\widetilde{w} \leq g_i \tag{5}$$

Crime decision depends on two elements, moral stance m_i and relative deprivation d_i, and on the relative importance of these two elements. Table 1 presents all the possible situations. There are actually 5 different cases.

- Case 1: the gain from crime is less than acceptable wage.
  This case is impossible, since crime is a response to relative deprivation and must at least enables individual to reach the level of income he considers as acceptable.

Table 1: Crime decision as a function of relative deprivation and moral stance

	$d_i = 1$		$d_i \leq 0$		
	$e_i \leq \widetilde{w}$	$e_i > \widetilde{w}$	$e_i \leq \widetilde{w}$	$e_i > \widetilde{w}$	
			$m_i \leq 0$	$m_i \leq 0$	$m_i > 0$
$g_i \geq e_i$	$e_i \leq \widetilde{w} \leq g_i$ $o_i = 1$	$\widetilde{w} < e_i \leq g_i$ $o_i = 1$	$e_i \leq \widetilde{w} \leq g_i$ $o_i = 1$	$\widetilde{w} < e_i \leq g_i$ $o_i = 1$	$\widetilde{w} < e_i \leq g_i$ $o_i = 1$
$g_i < e_i$	Impossible	$\widetilde{w} \leq g_i < e_i$ $o_i = 0/1$	Impossible	$\widetilde{w} \leq g_i < e_i$ $o_i = 0/1$	
$g_i \leq 0$	Impossible		$o_i = 0$		

- Case 2: both gain from crime and relative deprivation are negative.
  Then $o_i = 0$ since individual has no incitation to commit a crime (no deprivation and no benefit from crime).

- Case 3: immaterial costs are less than both acceptable income and gain from crime.
  Then $o_i = 1$. There will be crime, whatever individual feels relatively deprived or satisfied. The existence of crime without deprivation can be explained by low moral stance, or even a moral satisfaction to commit a crime. This can be useful to explain crime against persons like homicide, assault or rape, which don't have economic causes. Moreover, this case suggests the existence of an important gap between expected and acceptable income: crime is a response to relative but also to absolute deprivation (poverty). In other words, the objective is to improve social position but also to raise income *per se*.

- Case 4: immaterial costs are greater than acceptable income but less than gain from crime.
  Then $o_i = 1$. There can also be crime without relative deprivation, due to low moral stance. However, in this case, the gap between expected and actual income is not too high: crime will be committed in order to improve social position but not to raise income *per se*.

- Case 5: immaterial costs are greater than both acceptable income and gain from crime
  Then $o_i = 0/1$. Crime is possible, as long as benefits from crime exceeds relative depriva-

tion. In other words, crime is limited by moral values. This case can explain occasional crime.

This setting preserves the finding of the initial model following which decision of crime depends on moral stance. But if relative deprivation is too high, individual shall commit a crime, even if benefits from crime do not compensate moral cost. Moreover, it allows "pure violence" in the sense that even without deprivation, individuals can commit a crime, provided that his moral cost is low or even negative (which means a moral benefit from crime), whatever the gain from crime. Last but not least, this model conditions the decision to commit a crime to relative deprivation. Excepted the case of low moral values, crime without deprivation is impossible, making deprivation the actual determinant of crime (instead of an eventual and subjective measure of moral values).

2.3   An aggregated model of crime

At a society's level, one needs to distinguish several kinds of crime. In this paper, we will follow the usual distinction between crime against property (or economic crime) and violent crime against persons (or interpersonal crime). Economic crime includes robbery, theft, fraud, burglary, tax evasion, *etc.*. Interpersonal violence includes homicide, assault, rape, *etc.*. Since total offenses in the society is not simply the sum of all individual offenses, and since we don't know the functional form of the relation between total offenses and its determinants, the model stays very general and explains economic crime, O_e, and interpersonal crime, O_p, as follows:

$$O_e = O_e(\bar{w},\, D,\, L,\, \bar{c},\, \bar{m},\, p,\, f)$$
$$\pm,\, +,\, +,\, -,\, -,\, -,\, -$$
$$O_p = O_p(\bar{w},\, D,\, \bar{m},\, p,\, f) \tag{6}$$
$$\pm,\, +,\, -,\, -,\, -$$

L is what can be named opportunities for criminals, or possible loots, at a social level. It should raise with urbanization and mean income level. $\bar{c}$ is the cost of crime, which would decrease in urban areas. These two variables are not simple aggregations or means of l_i and c_i but rather are social values of these variables. Following the same scheme, $\bar{m}$ is the moral stance of society, as long as it is admitted to be measurable and quantifiable, but differs from the mean (or sum) of moral stance of each individual. Since the aim of economic crime is to get a pecuniary benefit, which is not the case for interpersonal crime, L and $\bar{c}$ contribute to explain the former but not the latter. Mean income, $\bar{w}$ has an ambiguous impact upon crime for several reasons. On the first side, a higher mean income leads to biggest opportunities (a higher L) and can involve a higher relative deprivation (if income is positively correlated to inequality). But on the other side, the need of violence and of improving income is assumed to be fewer in a wealthier society.

3 Discussing the role of education

3.1 Education and economic crime

Let us consider the first part of the equation (6) and evaluate the impact of education on each variable, distinguishing the effect of individual education (alphabetization, level or years of schooling) from that of society's education (average years of schooling). On the one hand, individual education level is crime-enhancing, *via* higher opportunities (a bigger l_i or L) and a lower cost of crime (fewer c_i or $\bar{c}$). Like other market activities workers, "skilled" criminals shall be more efficient than "unskilled" ones. On the second hand, individual education is crime-reducing since it increases expected legal income (w_i), then reduces relative deprivation, and since it also raises moral stance (a higher m_i or $\bar{m}$). Finally, education is ambiguously related to crime decision. The effect actually depends on the relative skill-intensiveness of legal and illegal activities. If the legal sector is more skill-intensive than economic crime, then education is crime-reducing. Inversely, if it is more profitable for an individual to use his skills stealing or defrauding instead of working, then education is crime-enhancing. It depends also on the kind of crime: theft and robbery do not necessarily need a high-skill level though evading tax (for example) does.

The social education level is even more ambiguously related to economic crime. Actually, the link between social education and relative deprivation is unclear. Probably, raising the average years of schooling will increase mean income ($\bar{w}$) since the positive correlation between education and income is well-accepted. But if it is accompanied with a widening income inequality, the effect upon relative deprivation, and by the way upon crime, is positive. Moreover, consider, for example, a policy leading to an increase of income spread over society in a perfectly uniform way. This kind of policy will have no impact upon relative deprivation (since everyone keeps his social position unchanged) and upon crime. In other words, an educational policy efficient from the point of view of crime reduction is a policy that leads to decreasing income inequality and relative deprivation. In the context of a developing country, this would be alphabetization and universal basic education policy, since the income and social gap in these countries is essentially between literate and illiterate population.

3.2 Education and interpersonal violence

The link between individual education and crime against persons is clearer. Since it increases moral stance, raises legal expected income, and then reduces the gap with acceptable income, individual education is unambiguously expected to reduce interpersonal violence. Education at a social level, however, is as ambiguously related to interpersonal crime as it is to economic crime. One more time, only an educational policy leading to a reduction of inequality can ensure a crime decrease. However, crime against persons also deals with some psychological roots, some of them being influenced by education (like, for example, self-control); moreover, educating people is an efficient way to keep everyone involved in the society, whatever it induces inequality or not (what

Usher, 1997, calls education's "civic externality"). As a consequence, the level of education of a given society is expected to influence negatively its level of violence.

4 Econometric setting and the data

In this paper, we focus on crime issue in municipalities of Minas Gerais. It is one of the 26 Brazilian states, located in the Southeastern region, the wealthiest but also the most violent of Brazil. However, Minas Gerais has crime rates fewer than its neighbors states (particularly Rio de Janeiro and São Paulo) since a significant part of the state is still rural and involved in agriculture and mining activities.

4.1 Measuring crime

Crime data used in this paper are issued from a database constructed by the *Fundação João Pinheiro* and the *Universidade Federal de Minas Gerais* from police data. It contains, for the 723 municipalities of Minas Gerais[1], the number of occurrences and the gross crime rate per 100,000 inhabitants, for several violent crimes separately and for aggregated violent crimes against persons and against property. Though it contains annual data from 1986 through 2002, we use, in this paper, a cross-section of these 723 municipalities for the year 2000 only, because of the limitation of socio-economic data.

Violent economic crime is measured by an aggregated violent crime rate against property, which is the sum of robbery, armed robbery and car-stealing. By symmetry, interpersonal crime is measured by an aggregated violent crime rate against persons, which is the sum of homicide, tentative of homicide and assault. Finally, we use a violent crime rate, which corresponds to the sum of aggregated crime rates against property and against persons.

This database has the advantage to give data as disaggregated as possible, municipality being the smallest administrative unit in Brazil. Moreover, Minas Gerais is the state with the most municipality over Brazil, a sign of the willingness of decentralization of this state. Finally, it is considered, both by Brazilian government and by World Bank that "the municipal level is one of the most effective entry point for crime and violence prevention" (World Bank, 2003). As a consequence, the new *Plano Nacional da Segurança Publica* (National Plan for Public Safety) puts municipalities in charge of the public safety policy.

However, our database uses police data, which are well-known to undermine actual crime rates since it records only reported crime. As a consequence, results of this paper should be considered with caution. Moreover, this database has the advantage to be newly used in economics. To the best of our knowledge, Beato and Reis (1999) are the only authors who already used it[2].

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[1]Minas Gerais now has 853 municipalities but the database was constructed when there were only 723, thus number of offenses and population for the newly created municipalities are added to the municipality they formerly belong to.

[2]However, Beato and Reis used data for the year 1991, which was the year of the preceding census.

4.2   Explanatory variables

The sample is a cross-section of 723 municipalities of Minas Gerais for the year 2000, which was a census year in Brazil and for which the best socioeconomic data are available at the municipality level. During the census, over 25% of households are covered by a huge and detailed survey, both at household level (about 460,000 households for Minas Gerais in 2000) and individual level (about 2,000,000 people). Household questionnaire deals with conditions of living and housing while individuals are questioned about their personal characteristics, such as income, education, migration, job, *etc.* The survey contains household and individual weights, constructed in order to extend results to the hole population. All variables used here were constructed by aggregating weighted observations for each municipality, and then dividing by the municipality's population to get averages.

Education variables

There will be 4 regressions for each crime variable used: in the first one, there will be no education variable, in order to emphasize the impact of the introduction of education variables in the following estimates; in the remaining three regressions, different measures of education are introduced alternatively: average years of schooling, alphabetization rate and, finally, shares population with primary, secondary and tertiary education introduced simultaneously. Following the theoretical model, average years of schooling is expected to have a negative impact on interpersonal crime rates and an ambiguous impact on property crime. However, this variable is well-known to measure far more than education *per se*. It is widely considered as a rather good proxy of level of development and is highly correlated to income level. As a consequence, other variables are needed to isolate effect of education *per se*. The first one is the alphabetization rate (share of people who can read and write), which is expected to be negatively correlated to either violent crimes against property or persons. Alphabetization rate differs from average years of schooling in the sense that it does not increase in a linear way along with the length of studies. In other words, a high average years of schooling can hide disparities in the access to basic education while alphabetization rate, on the opposite, is a good measure of the effort made by government to ensure equal access to school for everyone. An alternative way to differentiate the impact of the several schooling levels upon crime is to introduce simultaneously the shares of more than 10-years-old population who has respectively a primary, secondary or tertiary education.

Other explanatory variables

Following Fajnzylber *et al.* (2002) and Lederman, Loayza and Menéndez (2002), income inequality, level of development and change in economic conditions constitute what can be called the "core" model. Economic and sociological theories of crime both suggest income inequality to be crime-enhancing. The Gini coefficient of income, which measures inequality within each municipality (but not between) is introduced and expected to have a positive impact on crime

rates. Human Development Indicator (HDI) for each municipality is used as a measure of development[3]. This indicator is used in place of income level because of the endogeneity of income and official crime rates emphasized by Soares (2004). However, since Human Development Indicator, which is partially correlated with income, can also be suspected of endogeneity, we use its lagged value (actually the 1991 value). We also computed the growth rate of income between 1991 and 2000. This choice, conditioned by data availability, can also be justified from the point of view of our problematic since the 1990's were featured by a dramatic increase of crime rates in Minas Gerais.

One must finally control for several stylized facts concerning crime and demographic and social conditions. Crime rates are well-known to be higher in urban and high-population-density areas. For Glaeser and Sacerdote (1999), cities offer higher expected gains and smaller probabilities of apprehension and recognition for criminals. Population density is used in this paper. Criminals are also well-known to be often young male, especially for violent crimes. This stylized fact will be controlled for by introducing the fraction of male between 15 and 24 years in the overall population. Moreover, sociologists and criminologists have shown that crime is due to family instability and, particularly, that crime rates are highly correlated to the share of female-headed households. Since this share is higher in cities and among racial minority, it could explain why these two variables are correlated to crime. Finally, racial structure of population is generally expected to influence crime level. Esteban and Ray (1999) show that social conflict can be explained by individual characteristics and their distribution among society, and that polarization has a role to play in explaining social unrest. We follow them and construct a racial polarization index, using the methodology of Montalvo and Reynal-Querol (2003), between whites, blacks and halfcastes. Finally, we don't introduce any variable of police or deterrence because of the extreme endogeneity of that kind of variable and because we don't have any satisfying measure of deterrence. Since the data do not enable us to control for this endogeneity, it is preferable not to introduce this kind of variable.

4.3   Some descriptive statistics

Tables 5 and 6 of Appendix B give descriptive statistics and correlations between crime rates and socio-economic variables, respectively. Table 6 confirms some of the intuition of this paper and shows that violent crime against property and against persons do not follow the same scheme. Property crimes raise with development (at least reported property crime) but is weakly correlated to social and demographic conditions. More worrying is its positive linkage with most of education variables (actually all education variables excepted the share of population with a primary-schooling level are positively and significantly correlated with economic crime). In other words, economic crime rates are higher in educated municipalities, which is not really surprising if we consider education as part of development. In the same time, economic crime

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[3]This indicator has been computed by UNDP, IPEA and FJP in an Atlas of Human Development in Brazil available for download at: www.undp.org.br

is negatively linked with income growth, which means that the level of income and development is just part of the issue. It seems actually that, violent economic crime is structurally higher in richer municipalities (if we turn back to the theoretical model, it just means that loots and opportunities are higher) but is negatively influenced by a good economic conjuncture (or a higher expected legal income in the theoretical model).

On the other hand, Table 6 shows that interpersonal violence is less influenced by economic conditions than property crime but is significantly dependent from social and demographic conditions, and particularly the population structure in terms of age, sex and race. But the most important, and the main difference between interpersonal and economic crime, is the significantly negative correlation between each education variable and crime against persons. The negative impact of alphabetization and primary education is particularly significant, which suggests that municipalities with a high share of their population benefiting from basic education are the safest. Moreover, the level of development (measured by HDI) seems to be significantly violence-reducing. In other words, there is really a different behavior between economic crime and pure violence, which confirms the need of a theoretical approach that departs from the Beckerian setting in order to explain the violence phenomena. Finally, Table 6 also shows that aggregated violent crime is hugely influenced by economic crime and thus follows roughly the same scheme.

4.4 Econometric setting

The econometric model used in this paper is the one set in Puech (2004), following Anselin (2001). Simple OLS estimations are impossible since crime rates are spatially autocorrelated, which involves biased results. In order to take into account this spatial autocorrelation, the following model is estimated:

$$y = \rho W y + \beta X + \epsilon \tag{7}$$

where y is crime rate, X is the matrix of independent variables, β the associated vector of coefficients, W the spatial weights matrix, ρ the spatial autocorrelation coefficient and ϵ the error term. In this paper, W is a so-called row-standardized contiguity matrix. In other words, ρ is the coefficient associated with the effect of mean crime rate of neighbor municipalities upon the crime rate of each municipality. Estimating such a model requires a special econometric treatment. As pointed out by Anselin (2001), interdependence generates spatial autocorrelation, which bias the OLS estimator, and requires Maximum Likelihood (ML) estimations[4].

5 Results

Results are presented in separate tables for each crime rates. Tables 2, 3, and 4 present results concerning economic crime, interpersonal violence and aggregated violent crime respectively. In

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[4]see Anselin (2001) for a discussion on the OLS bias and on the spatial Maximum Likelihood estimator.

each table, column (1) is an estimate without any education variable, column (2) introduces the average years of schooling, column (3) replaces it by alphabetization rate and finally column (4) introduces simultaneously the share of adult population with a primary, secondary or tertiary education, respectively.

Table 2 confirms the intuition raised by correlation coefficients of Table 6 and shows that violent crime against property is strongly enhanced by both the level of development and income inequality. In the same time, income growth has no significant impact upon this kind of violence. In other words, economic crime are structurally higher in wealthy places, making more and more social scientists considering it as a counterpart of development. However, if we turn to Table 3, this statement appears as partially true, since development has no impact upon interpersonal violence. From tables 2 and 3 jointly, it seems that the main issue concerning violence is inequality, not development. Gini coefficient of income is strongly crime-enhancing in both tables, and for each regressions. These results are in adequacy with stylized facts concerning Brazil as a hole, i.e. one of the most unequal country in the world and for which it is really the main social issue[5].

In this context, education seems to have no significant impact upon economic crime, even through relative deprivation (Gini coefficient). The only significant change due to introduction of education variables in Table 2 is the drop of both coefficient and z-statistics of HDI while introducing average years of schooling (column (2)). However, this is not surprising since these two variables seem to suffer from multicollinearity. These results are somewhat disappointing if we consider that the theoretical model did not enable us to emphasize a clear effect of education upon crime and that we expected regressions to give more informations. It seems really that the several expected effects of education in the model, namely a criminal skill-enhancing on the one hand and a legal wage raising on the other hand, erase each other.

However, Table 3 suggests that basic education has a significant role to play in making safer streets. Both alphabetization rate (column (3)) and the share of population with primary education (column (4)) have a significantly negative impact upon interpersonal crime. These two variables, far from measuring the impact of skills and knowledge, are probably good proxies of what Usher calls the education's "civic externality". In other words, alphabetization and basic education have a social role to play in the sense that they give some linkage between persons. Another explanation would be that, *via* these two variables, we measure indirectly social capital, whose impact upon violent crime has been emphasized recently by Lederman *et al.* (2002). Anyway, universal basic education has to be part of a policy of crime reduction in Minas Gerais.

Finally, Table 4 presents results for aggregated violent crime. Like economic crime, it is significantly enhanced by both development and income inequality. Moreover, like interpersonal violence, it is significantly reduced by both alphabetization rate and primary education.

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[5]As an example, in 2000, in Minas Gerais, the richest 10% represented 44% of total income while the poorest 80% represented only 40% (*Atlas do Desevenvolvimento Humano no Brasil*, 2003).

However, the introduction of education variables has no significant impact upon coefficients of economic conditions. In other words, education has a direct role to play in the reduction of crime but has no indirect impact *via* its linkage with development or inequality. It confirms that the impact of basic education emphasized in tables 3 and 4 has probably more to do with citizenship or social capital (whose relationship with economic conditions is unclear) than with human capital.

6   Conclusion and policy implications

The aim of this paper was to study the link between education and violent crime in the context of a developing society, the state of Minas Gerais, Brazil, in 2000. With the support of a simple theoretical model of crime and deprivation and using a database of crime rates at the municipality level, we explored effects of several education variables on two kinds of violent crime, economic and interpersonal. Results suggest that these two kinds of crime follow very different schemes. On the first hand, property crime is enhanced by development (because of the increasing opportunities it induces for criminals) and income inequality. Education, whatever it is measured, has no significant impact upon that kind of crime. On the other hand, development has no significant relation with crime against persons, while income inequality increases it and basic education (alphabetization, primary schooling) appears to be crime-reducing. Finally, both economic conditions (positively) and basic education (negatively) are significantly related to violence as a hole (without distinction between the kind of violence).

These results raise several policy implications. First, it appears that the reduction of income inequality is really a crucial issue concerning the improvement of quality of life in Minas Gerais, and in Brazil as a hole. Safer streets will not exist as long as income and assets distribution is so unfair. Second, universal basic education has also a role to play in the reduction of violence in Brazil. More generally, results of this paper suggests that raising citizenship and social capital (education being only one of the several way to reach this goal) can contribute significantly to reduce violence, and particularly "pure" violence such as homicide or assault. Making basic education universal is particularly needed if we consider that Brazil suffers from an "under-education" relatively to its income and development level.

Finally, it would be particularly useful to extend this study following several ways. First, it needs to be applied to several other developing countries, in order to test the strength of the hypothesis. Second, it would be particularly interesting to distinguish the characteristics of criminals from those of the rest of the population, in order to deepen the link between education and crime and to get more precise policy implications. Third, we have to remember that data used in this paper are official statistics of police, well-known to be downward-biased; a nation-wide or state-wide victimization survey would be welcome in order to compare results presented using official crime rates to those obtained with "true" crime rates.

Table 2: Education and violent crime against property

	(1)	(2)	(3)	(4)
HDI 1991	11.736	8.884	12.708	11.354
	(9.25)	(3.92)	(5.15)	(5.41)
Gini coefficient	4.598	4.415	4.520	4.230
	(6.79)	(6.43)	(6.47)	(5.80)
Income growth	-0.044	-0.142	-0.015	-0.037
	(0.21)	(0.65)	(0.07)	(0.17)
Average years of schooling		1.103		
		(1.52)		
Alphabetization rate			-0.410	
			(0.46)	
Primary education				-0.780
				(0.79)
Secondary education				0.270
				(0.98)
Tertiary education				-0.039
				(0.47)
Population density	0.000	0.000	0.000	0.000
	(1.38)	(1.22)	(1.37)	(1.20)
Female-headed households	0.020	0.016	0.020	0.009
	(0.55)	(0.46)	(0.56)	(0.24)
Male 15-24 years-old	32.487	33.300	32.132	32.282
	(4.64)	(4.75)	(4.56)	(4.58)
Racial polarization	0.764	0.682	0.789	0.665
	(2.07)	(1.83)	(2.11)	(1.76)
Intercept	-12.622	-12.161	-11.425	-11.909
	(10.21)	(9.57)	(3.97)	(4.97)
rho (spatial correlation)	0.263	0.265	0.262	0.261
	(5.62)	(5.67)	(5.60)	(5.57)
Observations	723	723	723	723
Log likelihood	-1297.052	-1295.900	-1296.946	-1295.751
Wald test of $rho = 0$	31.549	32.202	31.318	31.068
$(p - values)$	(0.000)	(0.000)	(0.000)	(0.000)
LR test of $rho = 0$	29.716	30.301	29.508	29.287
$(p - values)$	(0.000)	(0.000)	(0.000)	(0.000)
LM test of $rho = 0$	33.225	33.868	33.071	32.830
$(p - values)$	(0.000)	(0.000)	(0.000)	(0.000)

Absolute value of z statistics in parentheses.

Crime rate and education variables are expressed in logarithms.

Table 3: Education and violent crime against persons

	(1)	(2)	(3)	(4)
HDI 1991	-2.139	-1.830	3.015	2.102
	(1.83)	(0.87)	(1.32)	(1.09)
Gini coefficient	3.668	3.689	3.263	2.464
	(5.71)	(5.64)	(4.95)	(3.63)
Income growth	-0.052	-0.041	0.102	0.203
	(0.26)	(0.20)	(0.50)	(1.00)
Population density	0.000	0.000	0.000	0.000
	(1.19)	(1.20)	(1.16)	(0.49)
Average years of schooling		-0.121		
		(0.18)		
Alphabetization rate			-2.212	
			(2.62)	
Primary education				-4.879
				(5.26)
Secondary education				-0.306
				(1.19)
Tertiary education				-0.090
				(1.16)
Female-headed households	0.042	0.042	0.044	0.014
	(1.24)	(1.25)	(1.30)	(0.41)
Male 15-24 years-old	24.856	24.775	23.154	22.398
	(3.73)	(3.71)	(3.47)	(3.40)
Racial polarization	1.302	1.312	1.460	1.342
	(3.66)	(3.64)	(4.06)	(3.76)
Intercept	-2.399	-2.447	4.115	-7.531
	(2.05)	(2.04)	(1.50)	(3.39)
rho (spatial correlation)	0.204	0.203	0.188	0.170
	(3.81)	(3.78)	(3.48)	(3.16)
Observations	723	723	723	723
Log likelihood	-1255.378	-1255.363	-1251.960	-1241.3647
Wald test of $rho = 0$	14.499	14.318	12.117	9.987
$(p - values)$	(0.000)	(0.000)	(0.000)	(0.002)
LR test of $rho = 0$	13.924	13.752	11.694	9.690
$(p - values)$	(0.000)	(0.000)	(0.001)	(0.002)
LM test of $rho = 0$	14.556	14.301	12.097	10.034
$(p - values)$	(0.000)	(0.000)	(0.001)	(0.002)

Absolute value of z statistics in parentheses.

Crime rate and education variables are expressed in logarithms.

Table 4: Education and violent crime

	(1)	(2)	(3)	(4)
HDI 1991	3.346	3.133	7.393	6.710
	(3.25)	(1.65)	(3.59)	(3.88)
Gini coefficient	3.414	3.400	3.092	2.394
	(5.95)	(5.83)	(5.24)	(3.93)
Income growth	-0.130	-0.137	-0.013	0.065
	(0.73)	(0.74)	(0.07)	(0.36)
Population density	0.000	0.000	0.000	0.000
	(1.98)	(1.96)	(1.97)	(1.36)
Average years of schooling		0.082		
		(0.13)		
Alphabetization rate			-1.711	
			(2.27)	
Primary education				-3.930
				(4.73)
Secondary education				-0.183
				(0.80)
Tertiary education				-0.081
				(1.16)
Female-headed households	0.050	0.050	0.051	0.026
	(1.66)	(1.65)	(1.71)	(0.85)
Male 15-24 years-old	25.538	25.592	24.183	23.503
	(4.28)	(4.28)	(4.05)	(3.98)
Racial polarization	1.062	1.055	1.180	1.066
	(3.34)	(3.28)	(3.67)	(3.33)
Intercept	-5.280	-5.247	-0.261	-9.186
	(5.08)	(4.91)	(0.11)	(4.60)
rho (spatial correlation)	0.281	0.281	0.270	0.257
	(5.70)	(5.69)	(5.45)	(5.20)
Observations	723	723	723	723
Log likelihood	-1177.759	-1177.750	-1175.198	-1166.093
Wald test of $rho = 0$	32.517	32.423	29.737	27.052
$(p-values)$	(0.000)	(0.000)	(0.000)	(0.000)
LR test of $rho = 0$	30.368	30.271	27.899	25.516
$(p-values)$	(0.000)	(0.000)	(0.000)	(0.000)
LM test of $rho = 0$	33.929	33.566	30.837	28.068
$(p-values)$	(0.000)	(0.000)	(0.000)	(0.000)

Absolute value of z statistics in parentheses.

Crime rate and education variables are expressed in logarithms.

Appendix A: Aggregating relative deprivation

If we consider a general case in which individuals compare their own income not only with their community's average but with all others communities' average, we get [6]:

$$D(w) = \int_w^{w_h} [1 - F(x)]dx \tag{8}$$

where w_h is the highest income known and $F(.)$ is the cumulative distribution of income among society.

Symmetrically, we can define satisfaction as :

$$S(w) = \int_0^w [1 - F(x)]dx \tag{9}$$

This induces:

$$D(w) + S(w) = \mu \tag{10}$$

where μ is mean income. As a consequence, according to Yitzhaki (1979), it is equivalent to work on $S(w)$ or on $D(w)$, as they are complements to μ . Yitzhaki also shows that, by integrating, we get:

$$S(w) = w[1 - F(w)] + \mu\phi(w) \tag{11}$$

where $\phi(w)$ is the value of the Lorenz curve at w, i.e. the proportion of total income received by those whose income is less than or equal to w.

By aggregating at the society level, we get :

$$S = \mu(1 - G) \tag{12}$$

where G is the Gini coefficient. Total relative deprivation can then be written as follows:

$$D = \mu.G \tag{13}$$

In other words, the theory of relative deprivation can be related to a "tangible" variable, the Gini coefficient. This result shall be useful when running econometric estimates of the model because, by using the Gini coefficient, the "true" measure of the theoretical concept of relative deprivation will be used.

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[6]This appendix is inspired from Yitzhaki (1979).

Appendix B: Descriptive statistics and correlations

Table 5: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Crime against property (/100,000)	723	49.207	94.920	0.000	1118.805
Crime against persons (/100,000)	723	41.152	36.657	0.000	349.284
Violent crime (/100,000)	723	90.282	108.961	0.000	1244.501
HDI 1991	723	0.644	0.058	0.483	0.791
Gini coefficient	723	0.688	0.090	0.500	0.841
Income growth	723	0.512	0.266	-0.330	1.972
Average years of schooling	723	4.118	0.696	2.417	6.731
Alphabetization rate	723	75.672	10.037	40.126	92.879
Primary education	723	0.599	0.043	0.438	0.705
Secondary education	723	0.108	0.035	0.027	0.235
Tertiary education	723	0.023	0.016	0.000	0.123
Population density	723	57.319	289.88	1.430	6744.580
Female-headed households	723	5.298	1.701	1.980	15.440
Male 15-24 years old	723	0.099	0.009	0.068	0.135
Racial polarization	723	0.779	0.166	0.053	0.980

Table 6: Correlation between crime rates and socio-economic variables

	Violent crime against property	Violent crime against persons	Violent crime
Violent crime against property			
Violent crime against persons	0.2177		
Violent crime	0.9435	0.5248	
HDI 1991	0.3687	-0.2300	0.2463
Gini coefficient	0.3480	0.1206	0.3438
Income growth	-0.1075	-0.0503	-0.1158
Average years of schooling	0.4056	-0.1634	0.2997
Alphabetization rate	0.3157	-0.2573	0.1902
Primary education	-0.1304	-0.3639	-0.2366
Secondary education	0.4180	-0.0377	0.3540
Tertiary education	0.3588	-0.1441	0.2644
Population density	0.6405	0.1286	0.6012
Female-headed households	0.0366	0.2528	0.1175
Male 15-24 years-old	0.0541	0.2557	0.1316
Racial polarization	0.1086	0.2923	0.1920

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