Education and Crime in India: a District Level Analysis

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IRES,PSE, PARIS 1

Abstract

Property crime imposes a cost on economies, also in developing ones. In this paper I study the optimal way of deterring crime and if necessarily implies an increase in education. I design a model of household choice where adults decide if to work in the legal or in the illegal sector, and how much of their resources to invest in the education of their children, with or without policy interventions on education accessibility, education quality or crime deterrence. As a result both education and crime are equilibrium phenomena. The model is calibrated and simulated using Indian data from different Indian districts. Education policies are effective deterrents in the short run, while in the long run general equilibrium effects make them ineffective. Moreover policy interventions on crime deterrence technology appear to be useless, both in the short and long run.

1 Introduction

Crime imposes a cost on economies as it acts like a tax on what is legally produced in the society. To prevent crime, the government can invest in crime deterrence using different tools. One of these is education. Getting more people educated increases the returns of legal activities against illegal ones. However education can also have a positive impact on crime , as it increases the amount of resources to be stolen. The relationship between education and crime is therefore ambiguous. For this reason, in this paper, I question what is the best way to deter crime and if it necessarily implies an increase in education.

To study this issue I design an overlapping generation model of household choice where adult agents have to choose in which sector to operate, legal or illegal, and how to allocate their resources between the education of their children and the savings for the retirement period. The model has three periods. In the first period of their lives, agents go to school and accumulate human capital. When they are adult, they face the occupation choice between the legal and illegal sector, and they have to decide how much to invest in the education of their children. When they retire, they enjoy their savings but they are exposed to crime. The fact that only old people are victims of crime is a strong assumption. However it is necessary to isolate the main effects of the model. The equilibrium levels of human capital and crime will therefore result from the education investment and the occupational choices. The key parameters for these two choices are the productivity of the education system(ψ), which regulates the law of accumulation of human capital of the young adults and can be seen as the quality of the school system in terms of infrastructures or teaching; the cost of education (ϵ), which represents the burden households have to take to pay for the education of their children;

and the crime deterrence technology (δ), which represents the ability of the government to prevent crime.

In the model there are three effects at work. The substitution effect between education and savings drives the education choice of the parents. If agents (adults in t) expect high crime in retirement (old in $t + 1$) they use education as substitute of savings, to be less exposed to crime. The opportunity cost of human capital and the cake size effect drive the occupation choice of the young adults. Higher is the level of human capital developed by the young adults, higher will be their loss if they decide to switch to the illegal sector(opportunity cost). However higher is the aggregate level of wealth and savings in the society, higher will be the incentive to join the illegal sector (cake size effect).

To test the implications of the theoretical model I use a numerical exercise and counterfactual experiments, using Indian data on education, crime, production and population, gathered from different sources. The main results show that in the short run education is effective as a crime deterrence policy, while it looses its power in the long run.

The reason why I use Indian data is that India is undergoing a huge change in its education system. The Right of Children to Free and Compulsory Education Act came into force in April 2010. This act concerns the implementation of new rules for free and compulsory education from class 1 to 8, that is for all children between 6 and 14 years. The efforts of the government include also data collection on schools. Since few years, India has very interesting data on education, available within the DISE project (District for Information System on Education). The number of crime acts is registered in the National Crime Records Bureau (NCRB) but suffers from bias due to under-reporting and poor registration techniques (The Hindu, South Asia

Terrorism Portal). To complete the calibration and simulation of the model I also use the resources of the National Census on India, for population data, and of the Planning Commission, for data on GDP at district level. All the data are collected at district level in order to exploit the regional variation between Indian districts.

Indian data are used to calibrate the model and exactly identify its endogenous parameters: district values of productivity (ψ), education cost (ρ) and crime deterrence (δ). After the calibration, I simulate the model under different settings, or counterfactual experiments, to study the evolution of education, savings, human capital and crime when one or more of the parameter of interest varies. A shift in the productivity of the education system can be simulated setting ψ to his lowest or highest value along the distribution of values at district level. In the same way setting ρ or δ to their lowest or highest amounts, is like simulating a shift in education accessibility costs or in crime deterrence technology across the districts. These numerical exercises are necessary to test the mechanisms at play in the model and to assess the efficacy of education. Off course they are far from being realistic proxy of government intervention against crime. However this is a necessary compromise to build a parsimonious model. One might ask how government can increase or decrease productivity according to his will, or how it can augment the efficiency of the police or justice system without introducing any tax or budget balancing measure. The answer is that the complexity of the reality is simplified to keep only the necessary elements and to focus on the mechanisms at work behind the education investment and occupation choices.

The research question of this paper is crucial and arise from the debate in the literature on the potential of education as a tool of crime deterrence. With no doubt education increases the opportunity cost of crime. Naci Mocan, Billups and Overland (2005) present a dynamic model of crime in which every individual possesses two type of human capital: legal and illegal. Changing the relative returns of these capitals in favour of the legal one, the individual should switch to the legal sector easily. A way to change these relative returns is education. There are three channels, market and non-market related, through which education can reduce crime incentives: the income effect (more education means more income and so higher return from legal activity), the time availability effect (more education means more time spent in school and less time available to commit crime) and the change in patience and risk aversion (more educated agents value more the future and avoid risky criminal present gains)(Machin, Marie and Vuijic',2011; Lochner and Moretti,2003; Buonanno and Leonida,2006; Fajnzylber et al.,2002; Usher,1997; Witte and Tauchen,1994).

The negative association between education and crime can also be observed in the data. In table 1 I regress the logarithm of the number of crime per person in 2011 (namely total crime in model 1, crime against property in model 2 and homcides in model 3) over some education indicators, using districts as units of analyis. I use the gross enrolment rate in primary and upper primary schools (GER) as a proxy of the accessibility of education, and the pupil teacher ratio in primary and upper primary schools (PUP_T_RATIO) as a proxy of the quality of education. In this way I can account for two important dimensions of education. The gross domestic product per capita and a dummy for the state, are used as controls. The coefficients show that there is a negative association between education indicators and the number of reported crimes. That is within a given state if a district invest more in education it outperforms the others in terms of crime reduction.

Table 1: Linear Regression of Crime Rate over Education in 2011

	(1)	(2)	(3)
VARIABLES	Model 1	Model 2	Model 3
TOTGER	-0.00220	-0.00499**	-0.00338*
	(0.00143)	(0.00225)	(0.00173)
PUP_T_RATIO	0.00518***	0.0110***	0.00339**
	(0.00128)	(0.00202)	(0.00155)
GDP_CA_R	2.95e-06***	4.91e-06***	1.27e-06**
	(4.22e-07)	(6.65e-07)	(5.12e-07)
Observations	504	504	502
R-squared	0.638	0.437	0.257

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Dummy for state are omitted in the table

However education may also exacerbate the inequality of income distribution and increase the size of the cake to be stolen generating the " cake size effect ". According to Ehrlich (1973,1975) criminals respond mainly to economic incentives. When income inequality is high, potential criminals have little to loose and expect high gains from crime. For this reason they choose the illegal sector. In this scenario education expansion must necessarily be coupled with education equality to avoid an increase in the polarisation of the society, which leads to frustrated aspirations and possibly to more crime and violence (Ehrlich 1973,1975; Appadurai, 2004; Ray ,2003). A society with equal education opportunity will also be a society with a more equal distribution of income. Bourguignon (1999) explains that inequality enhances crime and violence, which depress the social and economic climate, undermining economic investment and growth potential. However without a proper level of development poverty and inequality perseverate leading to more violence.

Despite this debate, there is no theoretical model addressing the contrast between the cost opportunity of human capital and the " cake size effect ", both originated and nourished by the process of human capital accumulation. However this opposition need to be investigated to better understand the elements of the education-crime dyad. As the results of this model point out, when the " cake size effect " is taken into account crime deterrence policies based on education accessibility or productivity, to boost the accumulation of human capital and exploit the cost opportunity mechanism, are not enough to reduce, in the long run, the level of crime. Any kind of deterrence policy cannot therefore be naive and should carefully take into account all the pieces of the puzzle.

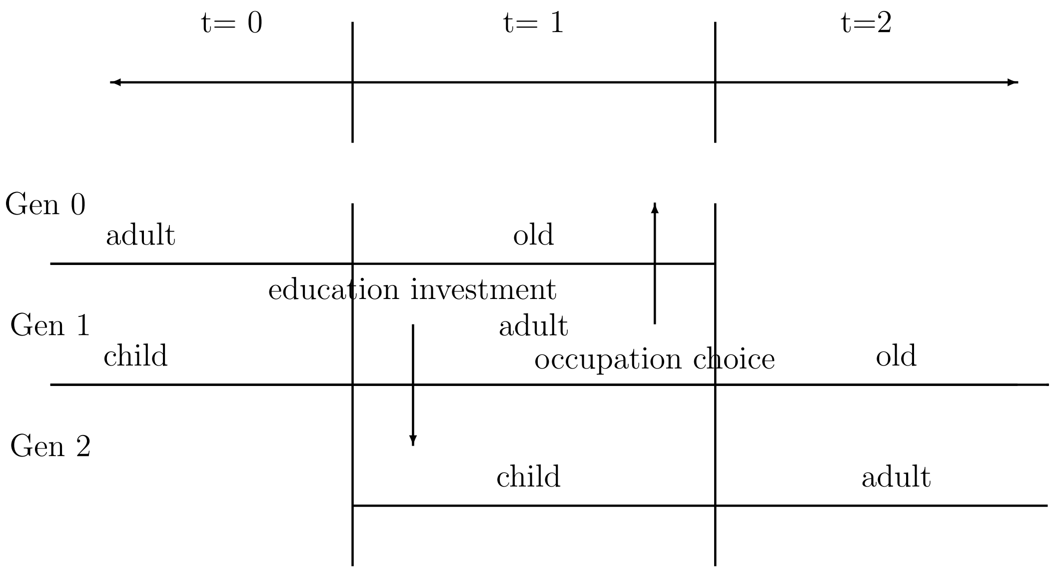
2 The Model

Consider an overlapping generation model with three periods. Agents are children in period 1, adults in period 2 and old in period 3. Their utility depends on their retirement income (d_{t+1}), or savings, and on the human capital developed by their children (h_{t+1}). Parameter γ represents the taste for the education level of the progeny.

$$U_{d,h} = d_{t+1} + \gamma \log h_{t+1} \tag{1}$$

In both periods 1 and 3 agents are not productive. When they are young they go to school, when they are old they enjoy their savings but have no other income. In period 2, when they are adults, they decide in which sector to work, legal or illegal (occupation choice), and how much of their income to invest in the education of their children (education investment choice). The occupational choice affects the old: if adults choose to be criminal they will steal from the savings of the old people and so reduce their retirement income. The investment in education choice affects the children: the more the adults invest in education and less they save for themselves, the higher will be the human capital of their children when adults. Therefore the more the adults invest in education, the higher will be the opportunity cost for the children to shift to the illegal sector once they grow up. However also the total productivity of the society and the saving capacity will increase.

Fig.1 The OLG Model



Honest adults receive a legal income correspondent to their human capital net of the cost of education, plus a lump sum transfer (ω). Given the quantity of the education investment (e_t), the education costs depend on the education accessibility parameter (ρ)(Eq.2). Criminals enjoy the criminal gain (g_t), the size of which is determine by what is stolen from the old (Eq.13), and the transfer (ω). As they have decided to be criminal they loose all their human capital due to the presence of n (opportunity cost of crime parameter), and they pay a personal cost represented by η_i(Eq.3). Population is normalized to 1 and it is constant. Individual differs the one to the other according to the cost of crime η_i, which follows a uniform distribution $U(0;1)$.

$$y_i^l = h_t^i - \rho\epsilon_t^i + \omega \tag{2}$$

$$y_i^c = h_t^i(1-n) - \rho\epsilon_t^i + g_t - \eta_t^i + \omega \tag{3}$$

In the following I will consider the occupational and the education choices of the households in a private education framework, that is the burden of the education cost is entirely on the parents, with no intervention by the government in terms of provision of an education subsidy. At equilibrium I am interested in the achieved level of human capital, as a proxy of the incentive to stay in the legal sector, and in the share of criminals in the society.

2.1 The Education choice

At $t = 0$ each household is endowed with a stock of savings for the old agent (s^i_{-1}) and a stock of human capital for the adult agents ($h^i_0 > 0$). The adult agent chooses his occupation, then allocates his income between the education investment for his children and the savings for his retirement. The maximization problem of the adult agent is the following:

$$\max_{\epsilon^i_t} d^i_{t+1} + \gamma \log h^i_{t+1} \tag{4}$$

s.t.

$$h^i_{t+1} = \psi(\epsilon^i_t)^\theta h^\nu_t \tag{5}$$

$$d^i_{t+1} = Rs^i_t(1 - \delta C_{t+1}) \tag{6}$$

$$s^i_t = \begin{cases} h^i_t - \rho\epsilon^i_t + \omega, & \text{if honest} \\ h^i_t(1-n) - \rho\epsilon^i_t + g_t - \eta^i_t + \omega, & \text{if criminal} \end{cases} \tag{7}$$

Households choose the investment in education ϵ^i_t to maximize their utility. Their are better off if their retirement income is higher (Eq.6) and if the human capital of their children is higher (Eq.5). Adults see the investment in education of their children as a potential support for their retirement age. The investment in education is therefore a substitute to savings the household can use to increase her utility. We will see later that this is a key mechanism for the equilibrium results in terms of education and crime. Whatever the household is able to save is used in the following period and is exposed to crime perpetuated by the new criminals (eq.(6)). To conclude the low of accumulation of human capital (Eq.5) depends on the productivity of the education system (ψ), on the investment in education (ϵ) and on the average human capital accumulated by the generation of the parents(h_t). θ is the rate of return of the parental investment in education, while ν is the rate of return of parental human capital.

The F.O.C. of this problem is

$$\epsilon_t = \frac{\gamma\theta}{\rho R(1 - \delta C_{t+1})} \tag{8}$$

The education investment is independent on the level of human capital of the parents. If I replace the optimal value of ϵ_t in the production function of human capital (5) I obtain the equation for the optimal level of young adults human capital:

$$h_{t+1} = \psi(\frac{\gamma\theta}{\rho R(1 - \delta C_{t+1})})^{\theta} h_t^{\nu} \equiv h(C_{t+1}, \psi, \delta, \rho) \tag{9}$$

Proposition 1: *The human capital accumulation process depends positively on the taste for the education of the progeny of the parents (γ) and the productivity of the education system (ψ). However it is negatively related to the cost of education (ρ). It also depend positively on expected crime.*

This is the " substitution mechanism ", the first of the three mechanisms that regulate the relationship between education and crime. If parents expect an high crime rate in their retirement period they decide to allocate more resources to the education of the children and less to savings, to be less exposed to crime.

2.2 The Occupation Choice

The occupation choice of the adults depends on their human capital and on the cost for the criminal activity. I look at the choice from the point of view of the agent adult in t. Given the legal and illegal income:

$$y_i^l = h_t - \rho\epsilon_t + \omega \tag{10}$$

$$y_i^c = h_t(1-n) - \rho\epsilon_t + g_t - \eta_t^i + \omega \tag{11}$$

from $y_i^c = y_i^l$ I can find the threshold $\tilde{\eta}$ such that an individual is indifferent between the illegal and the legal sector.

Proposition 2: *For all individual such that $\eta^i < \tilde{\eta}$ then, for a given level of human capital, $y_i^c > y_i^l$ and they will prefer to stay in the criminal rather than in the legal sector. For all individual such that $\eta^i > \tilde{\eta}$ then $y_i^c < y_i^l$ and they will prefer to stay in the legal rather than in the criminal sector.*

From (10) = (11) I obtain an expression for $\tilde{\eta}$. However $\tilde{\eta}$ is also the share of criminals in the population at time t ($\tilde{\eta}_t = C_t$) due to the cost of crime following a uniform distribution.

$$\tilde{\eta}_t = C_t = g_t - h_t n \tag{12}$$

With

$$g_t = \frac{\delta C_t RS_{t-1}}{C_t} = \delta RS_{t-1} \tag{13}$$

The share of criminals in a given period depends therefore on the criminal gain and on the human capital accumulated when young. The criminal gain is the sum of what is stolen divided by all the criminals in the society. The ability to steal and commit crime does not increases with education as we are speaking of blue collar crime in general. Criminals in t steal from the savings of the old (s_{t-1}). Old agents are exposed to crime no matter their occupation when they were younger. At equilibrium total savings are the sum of savings of honest and criminal old people.

$$S_t = C_t(h_t(1-n) - \rho\epsilon_t + g_t + \omega) - \int_0^{\tilde{\eta}} \eta_i G(\eta_i) d\eta_i + (1-C_t)(h_t - \rho\epsilon_t + \omega) \quad (14)$$

Criminals are able to steal more if they are more productive. The productivity of crime, which can also be called the crime deterrence technology, is δ. Higher (lower) δ means that crime is more (less) productive, and deterrence measures are less (more) effective.

(Eq.12) shows that higher is the human capital of adults, higher is the opportunity cost they face to switch to the illegal sector. We can rewrite eq.(12) for young adults in period $t+1$, and express it in terms of human capital to represent the cost opportunity mechanism:

$$C_{t+1} = \delta R S_t - h_{t+1} n \quad (15)$$

$$h_{t+1} = \frac{\delta R S_t - C_{t+1}}{n} \equiv c(C_{t+1}, S_t, \delta) \quad (16)$$

Proposition 3 (Opportunity Cost of Education): *The share of criminal in the society in a given period is negatively related to the level of human capital of the adult generation of that period: higher is the human capital of adults, higher will be the income they loose if they choose to switch to the illegal sector, that is higher will be the opportunity-cost for them to become criminals.*

Proposition 4 (Cake Size Effect): *The share of criminal in the society is positively related to the level of aggregate savings of the old generation.*

Higher is the level of savings, higher is the amount of resources that can be stolen .

2.3 Temporary Equilibrium

The core results of the education choice and occupation choice are the level of human capital of young adults (h_{t+1}) and the crime share (C_{t+1}) such that:

- the education, or portfolio choice, is represented by (Eq.17)

$$h_{t+1} = \psi(\frac{\gamma\theta}{\rho R(1-\delta C_{t+1})})^{\theta} h_t^{\nu} \tag{17}$$

- the occupation choice is given by (Eq.18) and (Eq.19)

$$h_t - \rho\epsilon_t = h_t(1-n) - \rho\epsilon_t + g_t - \tilde{\eta}_t \tag{18}$$

$$C_{t+1} = \delta R S_t - h_{t+1} n \tag{15}$$

In the education choice parents maximize their utility and decide how much to invest in education according to the expected value of crime during their retirement period (maximization problem (4)). The optimal level of education investment (Eq.8) defines the level of human capital of the young adults according to (Eq.17). In the occupation choice, $\tilde{\eta}_t$ is the share of criminal in the society (C_t) and correspond the personal cost of crime of the n_{th} individual with $\eta_t^i = \tilde{\eta}_t$ which is indifferent between being in the legal or illegal sector. Changing the subscript we obtain the same expression for the choice of the young adults in the following period ($\tilde{\eta}_{t+1} = C_{t+1}$).

Equation (9) and (16) can be used to represent the portfolio and the occupation choice in the two dimensional space crime / human capital.

Fig.2

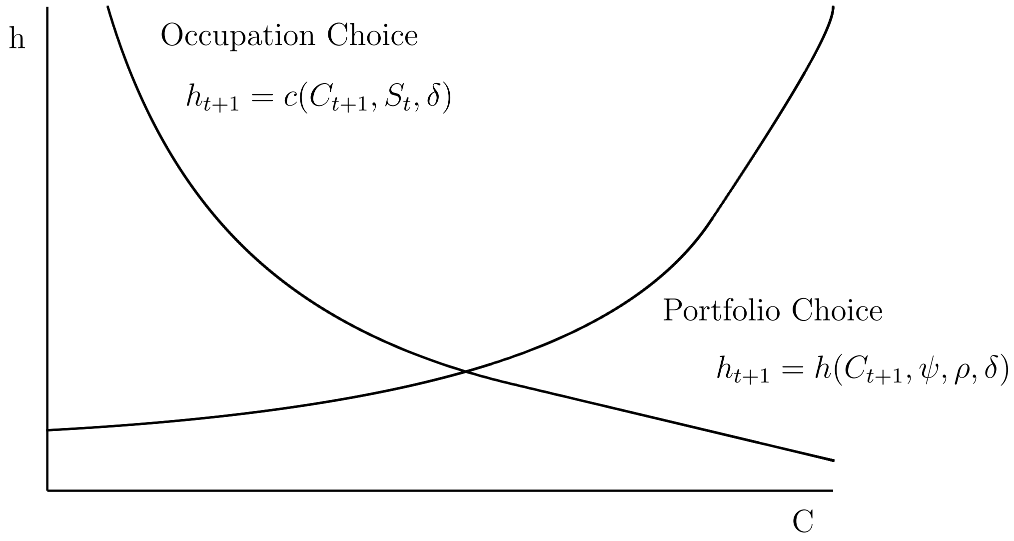


Fig.2 represents the temporary equilibrium at time $t+1$. Kids become adult following the law $h_{t+1} = h(C_{t+1}, \psi, \rho, \delta)$, and these adults decide their occupation according to $h_{t+1} = c(C_{t+1}, S_t, \delta)$. The upward sloping curve represents equation (9) or the " portfolio choice ", as expresses the substitution mechanism between education and savings that household can use if they expect high crime in their retirement period and they want to be less exposed to it. This curve depend on the parameters - δ, ψ and ρ- in addition to crime (C_{t+1}). The downward sloping curve represents equation (16) or the " occupation choice ", as stands for the fact that higher is the human capital an individual is endowed with higher is the opportunity cost he faces to switch to the illegal sector; while higher are the aggregate savings of the previous period, higher is the incentive the individual has to join the illegal sector. This curve depends on the parameter δ and on S_t and h_{t+1}.

Proposition 5 (Temporary Equilibrium): *An equilibrium with private education funding is a vector of young adults human capital and criminal share* $(h_{t+1}, C_{t+1})_{t\geq 0}$ *such that:*

- *the equilibrium exists and is unique (see Appendix A);*
- *the portfolio choice (Eq.9) is increasing in* ψ *and* δ *and decreasing in* ρ *(see Appendix B);*
- *the occupational choice (Eq.16) is increasing in* δ *(see Appendix B).*

3 The Policy Instruments

Figure 2 tells us that the key parameters that influence the temporary equilibrium are δ, ψ and ρ. These are core policy instruments the government can use to change the relative returns of legal versus illegal activities and to deter crime. As I said in the introduction these instruments are far from being realistic, due to the necessity to simplify the complexity of the reality to have a parsimonious model of education and crime. δ is the crime deterrence technology, ψ is the productivity of the education system, ρ is the price of education or accessibility of education. They affect the equilibrium values of education and crime. Figure 3 and 4 shows us some comparative statistics.

Fig.3

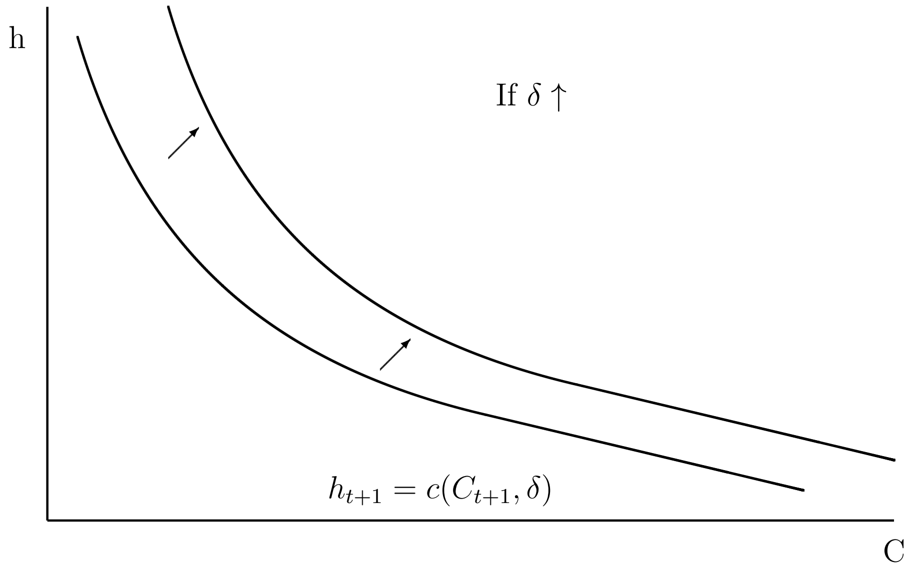
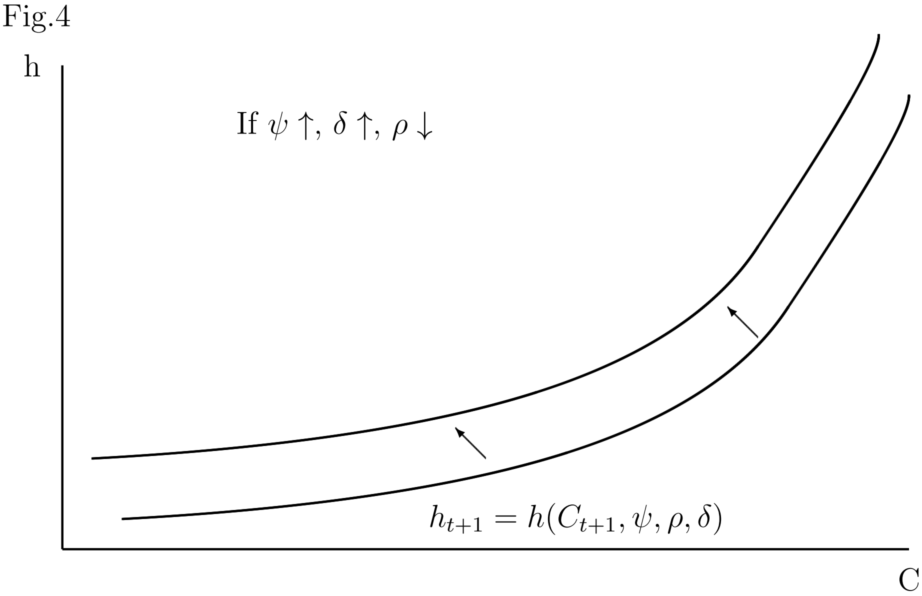


Fig.4



For the occupation choice (Fig.3), which depend on δ, an increase in crime efficiency means that crime is more productive and I expect more crime for any level of human capital. For the portfolio choice (Fig.4), if ψ or δ increase the curve moves up, for every level of crime I will have more human capital, as either the human capital accumulation process is more effective, either investment in education substitute savings when crime deterrence technology is less effective. The same is true if ρ decreases (see Appendix B).

The combined effect of the parameters on the two curves is not straightforward to predict. For example if a shift in δ make human capital increasing much more than crime incentive (the portfolio curve shifts more than the occupation choice curve), crime drops at the new equilibrium. However if crime incentives react more then the education investment to a change in δ, the opposite will happen. The final result in terms of human capital and crime depends therefore on the steepness of the two curve and on the relative response to a change in the parameters. It might be that, due to the substitution mechanism, a drop in crime deterrence technology ($\delta \uparrow$) generates a decrease instead of a increase in crime. Moreover a drop in ρ or an increase in ψ, may also have a controversial result. First they generate an increase in human capital, which increases the cost opportunity of young adults in the short run. However, in the long run, also aggregate savings increase augmenting the cake size effect and crime incentives. Government intervention on education accessibility or productivity may therefore work in the short run but not in the long run.

For this reason in section 4 of the paper I will calibrate these parameters to match the observed level of education and crime among 280 Indian districts. Therefore, once I have the calibrated parameters for the policy instruments, I will conduct counter factual experiments to evaluate the effect on crime deterrence of different types of government interventions. Some of these will affect the productivity of education system (shift in ψ), some other the accessibility of education (shift in ρ) or the crime deterrence technology (shift in δ). The aim of this quantitative check is also to see if crime reacts to policy interventions in a range of reasonable values of the parameters.

4 Numerical Exercise

4.1 Data

To exactly identify district values of productivity (ψ), education cost (ρ), crime deterrence (δ) and lump sum transfer (ω), I need to use given values, taken from the literature, for the exogenous parameters (R, n, γ, θ, ν) and observed human capital, crime, savings and enrolment rate for period t and $t+1$ for the core variables of the model $(h_{t/t+1}, s_{t-1}, e_t, C_{t/t+1})$. Data sources were the INDIAN CENSUS for population aged 6-14 and total population, used to calculate enrolment rates and per capita productivity measures; the National Crime Records Bureau (NCRB) for crime data at district level; the DISE for enrolment data in primary and upper primary schools; and the Planning Commission databases for total GDP at district level. Census data on population were available for two years, 2001 and 2011, therefore 2001 observed data is " Period t", while 2011 observed data is " period $t+1$". Unfortunately I had data for GDP at district level for both the census years only for 280 districts out of 686, so I had to reduce the sample available. To calibrate the endogenous parameters I used the following system of equations:

$$\epsilon_t = \frac{\gamma\theta}{\rho R(1 - \delta C_{t+1})} \tag{19}$$

$$C_{t+1} = \delta R S_t - n h_{t+1} \tag{20}$$

$$S_t = C_t \delta R S_{t-1} + \omega + h_t(1 - C_t n) - \frac{C_t^2}{2} - \rho\epsilon_t \tag{21}$$

$$h_{t+1} = \psi \epsilon_t^{\theta} h_t^{\nu} \tag{22}$$

(Eq.19) represents the optimal level of education investment. (Eq.20) is the crime share resulting from the choice of young adults. (Eq.22) represents the aggregate savings, while (Eq.22) describes the law of accumulation of human capital.

Data on education were taken from the DISE database. To obtain the gross enrolment rate (GER) for year 2001 and 2011 I sum the total enrolment, that is the number of children enrolled in school, in each district, from grade I to grade VIII and I divide this sum by the total number of children between 6 and 14 years as registered in the Census of India in 2001 and 2011. Usually children aged 6 to 10, that is in grade I to V, go to the primary school, while children aged 11 to 14, that is in grade VI to VIII , go to the upper primary school. Summary statistics for the GER across districts in 2001 and 2011 are shown in table 2. Values which are higher than 100% are possible given the fact that some children may repeat some years of school and therefore find themselves still in primary or upper primary classes even if they are older than 14.

We can observe that the average enrolment increases over the time, however there is a certain % of children still out of school. Finally the GER varies at regional level.

Table 2: Summury Statistics for Gross Enrolment Rate in 2001 and 2011

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N	mean	sd	min	max	p25	p50	p75
TOTGER	281	63.32	16.99	11.20	180.5	51.69	64.03	73.89
TOTGER_2011	281	81.14	14.88	16.19	165.5	74.04	80.96	88.61

To obtain the initial per capita value of human capital (h_0) and savings (s_{-1}) for each district I start from the GDP per capita at regional level. The GDP per capita is measured dividing the aggregate GDP in rupees by the total population of age between 15 and 60. I additionally rescale this value of per capita productivity diving by 1000. I assume that in period $t-1$ more or less 1/5 of the GDP is devoted to savings. The rest is the household human capital, taking into account that something is taken by criminals. I use this assumption as there are no data available for savings at district level in the years of interest. Human capital and savings are therefore the solution of the following system, where i is the index for the districts.

$$GDP_0^i = h_0^i(1 - C_0 n) + Rs_{t-1}^i \tag{23}$$

$$Rs_{t-1}^i = \frac{1}{5} GDP_0^i \tag{24}$$

For crime data I use the only source available in India, the National Crime Record Bureau. In the NCRB database there are many different types of crime for which I have detailed information until the district level. Usually crime is classified as crime against person, crime against property, riots, crime against children and sex crime,... My analysis focuses on property crime for two main reasons. First, property crime is usually consider a blue collar crime, that is a type of crime which does not require any particular knowledge or high skilled training and therefore is associated with more disadvantaged social groups. Second working with crime data in India is a delicate matter as the number of crime acts registered is exposed to bias due to under-reporting and poor registration techniques (The Hindu, South Asia Terrorism Portal). However property crime and homicides are usually the highest quality data among all the other criminal imputations. The district values in percentage of property crimes in 2001 and 2011 are shown in table 3. To calculate the crime rate I divide the total number of reported crimes against property in a district by the total number of individuals of age between 15 and 60 in that district, multiplying the result by 100 to obtain the percentage.

Table 3: Summury Statistics for Crime Rate in 2001 and 2011

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N	mean	sd	min	max	p25	p50	p75
Cr_2001	281	1.39	1.12	0.189	7.87	0.703	1.04	1.70
Cr_2011	281	1.36	1.43	0.0104	18.5	0.687	1.03	1.61

4.2 Calibration

Using equation (19)-(20)-(21)-(22) I calibrate the endogenous parameters of the model. In addition to the observed values for human capital, education, savings and crime against property, I have to assign a value also to the exogenous parameters. In line with the literature the saving rate (R) is 1.02^{10}; the cost opportunity parameter n is 1 (potential criminals loose all their legal human capital if they decide to switch to the illegal sector), the rate of return of parental investment in education θ is 0.5, the taste for education parameter γ is 60, and the rate of return of parental human capital is 0.1.

Summary statistics for the parameters and the observed variables used in the calibration are shown in table 4.

Table 4: Summury Statistics

Exogenous Parameter	**Description**	**Assigned Value**
R	Interest Rate	1.02^{10}
γ	Taste for educated progeny	60
θ	Rate of return of parental investment in education	0.5
ν	Rate of return of parental human capital	0.1
n	Cost-opportunity of Crime	1
Variables of Interest	**Description**	**Districts Average in Data**
Hc_{2001}	Individual Human Capital in Rupees in 2001	1.88
Hc_{2011}	Individual Human Capital in Rupees in 2011	3.48
S_{1990}	Individual Savings in Rupees in 1990	0.38
S_{2001}	Individual Savings in Rupees in 2001	0.70
Cr_{2001}	Crime rate for population at risk in 2001	0.014
Cr_{2011}	Crime rate for population at risk in 2011	0.014
e_{2001}	Gross Enrolment Rate	0.63

Calibrating the model I am able to exactly identify district values of productivity (ψ), education cost (ρ), crime deterrence (δ) and lump sum transfer (ω). With the calibrated regional values for the endogenous parameter I simulate the model to study the equilibrium values of education, savings, human capital and crime under different settings. Summary statistics for the parameters obtained with the calibration are given in table 5.

Table 5: Calibrated Parameters Statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N	mean	sd	min	max	p25	p50	p75
ψ_i	281	4.105	2.562	0.0706	12.76	2.744	3.666	5.419
ρ_i	281	46.92	34.44	14.47	487.8	35.16	40.60	50.23
δ_i	281	4.130	0.173	4.001	5.056	4.039	4.064	4.114
ω_i	281	26.16	20.97	22.08	375.7	24.25	24.65	25.22

Note: Subscript i stands for districts as units of analysis

4.3 Simulation and Counter-factual Experiments

The primary goal of this paper is to identify the best way to deter crime, considering that the government has three policy instrument to use to try to change the relative return of legal versus illegal activity and therefore to reduce the incentive to become criminals. In this section I will first simulate the model with district values for the core policy instruments to have a benchmark simulation at regional level. In this case each district face a different set of parameters as a result of different socio-economic frameworks. I then compare these results to counter-factual experiments where I introduce shifts in productivity, education cost and crime deterrence. Setting ψ to his lowest or highest value along the distribution of values across districts is like simulating a shift in the productivity of the education system. In the same way setting ρ or δ to their lowest or highest values, is like simulating a shift in education accessibility costs or in crime deterrence technology across the districts of India. These counterfactual experiments are used to investigate the best way to deter crime and if to do this we necessarily have to increase education. As I explained the education-crime relationship is not straightforward, therefore the outcomes of crime share and human capital, for a change in any of the policy instrument, cannot be determined a priori. The results of the counterfactual experiments are summarised in table 6. Equilibrium levels of education investment, savings, crime and human capital are shown for the first and the last period of simulation (over 20 periods of simulation).

Table 6: Numerical Exercise Results

Variable	Benchmark	$\rho\downarrow$	$\rho\uparrow$	$\delta\downarrow$	$\delta\uparrow$	$\psi\downarrow$	$\psi\uparrow$
Edu_1^i	0.63	1.85	0.057	0.62	0.64	0.65	0.61
Edu_{19}^i	0.68	2.26	0.055	0.66	0.69	0.61	0.93
Sav_1^i	0.70	$\boxed{1.18}$	$\boxed{0.21}$	$\boxed{1.35}$	$\boxed{0.57}$	$\boxed{0.02}$	$\boxed{1.64}$
Sav_{19}^i	0.81	$\boxed{1.63}$	$\boxed{0.18}$	$\boxed{1.63}$	$\boxed{0.66}$	$\boxed{0.005}$	$\boxed{3.21}$
$Crime_2^i$	0.013	0.009	0.018	0.016	0.012	0.019	0.005
$Crime_{20}^i$	0.027	0.047	0.011	0.047	0.024	0.005	0.08
HC_2^i	3.84	5.99	1.06	3.42	3.49	0.06	10.45
HC_{20}^i	4.03	8.13	0.99	3.92	4.04	0.03	16.04

Note: Apex i stands for districts as units of analisys

When education access increases ($\rho\downarrow$) crime drops in the short run. Education is less expensive, therefore the investment in education increases as well as the human capital of the young generation. At the same time the savings of the old generation increase but with less magnitude. As a result there is no much more to steal while the cost opportunity of the legal sector for the young adults is higher ($h_{t+1}\uparrow$) and crime drops with respect to the benchmark. However in the long run legal production activities increase after the shift in education accessibility of the first period and also aggregate savings increase. Set in motion by the new wealth the cake size effect wins over the cost opportunity one.

When school costs increase ($\rho\uparrow$) the opposite occurs. Education is more expensive therefore the investment in education is less. There is less cost opportunity of human capital for the young adults and crime increases with respect to the benchmark. However in the long run crime drops as there is no human capital growth and aggregate savings are too low to attract new criminals.

Interventions on crime deterrence technology trigger the substitution mechanism between savings and education investment, which makes useless the public effort. An increase in crime deterrence technology ($\delta \downarrow$) reduces the amount of resources criminals can steal, for any level of crime, therefore crime is less frightening. Agents save more and educate less their children. As a result the cake size effect wins over the opportunity cost of human capital both in the short and in the long run with respect to the benchmark. However when δ increases, as crime is more frightening, the education investment substitutes savings in the utility function of the parents: future savings are less and education investment and human capital expand. This results in crime reduction, with respect to the benchmark level, in the short run and in the long run as the opportunity cost of crime is stronger in each period.

Finally if the productivity of the education system drops (low ψ), crime increases in the short run and then decreases. A variation in ψ generate a drop the level of human capital of the young adults without affecting the savings of the starting period, therefore young adults in the first period have low cost opportunity of human capital and high incentive to be criminal. For this reason crime increases in the short run. However in the following periods there is almost nothing to steal and crime drops.

On the contrary when ψ increases human capital in the first period increases, while savings of the old generation are not affected. Therefore young adults have high opportunity cost of human capital and low incentive to be criminal. As a result crime drops in the short run. In the long run, due to the high level of productivity, there is high human capital growth which translates also in high aggregate savings and the cake size effect wins.

It is also important to compare results between different policies. With no doubt, in the short run, the education policies are more effective than the crime deterrence policies, thanks to the general equilibrium effects at play. Moreover the lowest level of crime rates are achieved thanks to an intervention on the productivity/quality of the school system (ψ), followed by a government intervention on the education costs (ρ). That is ensuring wider access to education is the first step to make schooling a tool for crime reduction. The next, and most important, step is ensuring education quality for all the students.

In India it seems that policy makers aknowledge this role to the quality of education. The Right for Education Act covers provisions not only on free accessibility to education for all children from 6 to 14, but also provides stricts rules on the quality of the school performance (minimun number of hours at school and minimun number of days at school during one academic year,...), on the quality of the teaching (maxmimun pupil/teacher ratio or minimum number of teachers in a school,...) and on the quality of the infrastructures (increased number of elementary schools, maximum pupil/classroom ratio, increased percentage of school with water, separate toilet facility, ramp,...)(RTE act,2009).

We cannot therefore speak of education policies without coupling education access with education quality to deter crime.

Despite the positive outcomes in the short run, in the long run crime increases in every scenario, that is the cake size effect wins. The trigger of this result might be an unequal distribution of income. If it is true that getting more people educated increases the returns of the legal activity, it is also true that this mechanism may exacerbate inequality and rise crime incentives, which generate the cake size effect (Ehrlich,1973,1975). The persistence in income inequality, even after an increase in education access and education quality, draws therefore the attention on another aspect related to education provision: the equality of opportunity of the education system. It is therefore vital to equalize education opportunity and training. A society with equal education opportunity will also be a society with a more equal distribution of income (Ehrlich,1975; Hindricks and Godin,2016).

Conclusions

The primary goal of this paper is to identify the best way to deter crime, considering that the government has three, stylized, policy instruments (the education cost - ρ -, the productivity of the education system - ψ - and the crime deterrence technology - δ -) to use to try to change the relative return of legal versus illegal activities, reducing the incentive to become criminals.

To test the implications of the theoretical model I use a numerical exercise and counterfactual experiments, using Indian data on education, crime, production and population, due to the rich amount of data available for education in this country.

The main results show that an expansion in education, lowering the cost of access to schooling, or an increase of the productivity of the education system ,more and better schools or better teaching, are effective policies to deter crime only in the short run, when the opportunity cost of human capital wins. In the long run crime increases in every scenario, that is the cake size effect is the strongest. The trigger of this result might be an unequal distribution of income. The persistence in income inequality, even after an increase in education access and education quality, draws attention to another aspect related to education provision: the equality of opportunity of the education system. A society with equal education opportunity will also be a society with a more equal distribution of income and less crime incentives.

To conclude, due to the presence of many complex dynamics at work behind the education-crime dyad, any kind of deterrence policy cannot be naive and should carefully take into account all the pieces of the puzzle. Ensuring wider access to educarion is the first step to make school a tool of crime reduction. Investing in the quality of education is the following one. Increasing also the equality of the opportunity of education should also be considered to make schooling effective also in the long run.

5 Appendix

Appendix A

Given S_{t-1}, h_t and C_t, the temporary equilibrium of period t exists and is unique. This equilibrium can be expressed as a function of h_{t+1} and C_{t+1}.

First I want to see how h_{t+1} varies with C_{t+1}. I know h_{t+1} is a function of C_{t+1}, with h_t given. Therefore I can express equation (9) in a implicit way as $g(C_{t+1}, h_{t+1}) = 0$.

$$g(C_{t+1}, h_{t+1}) = h_{t+1} - \psi(\frac{\gamma\theta}{\rho R(1 - \delta C_{t+1})})^{\theta} h_t^{\nu} = 0 \tag{25}$$

The implicit function theorem claims that I can determine how human capital varies with crime using the partial derivatives of the implicit function.

$$\frac{dh_{t+1}}{dC_{t+1}} = -\frac{\partial g/\partial C_{t+1}}{\partial g/\partial h_{t+1}} \tag{26}$$

In our case equation (26) is positive so the investment in education increase and human capital increases as crime increases.

To study how crime varies with human capital accumulation the implicit function, using equation (15), will be $\phi(h_{t+1}, C_{t+1}) = 0$:

$$\phi(h_{t+1}, C_{t+1}) = C_{t+1} - \delta RS_t - nh_{t+1} \tag{27}$$

Following the implicit function theorem I can determine how crime varies as a function of human capital accumulation.

$$\frac{dC_{t+1}}{dh_{t+1}} = -\frac{\partial\phi/\partial h_{t+1}}{\partial\phi/\partial C_{t+1}} \tag{28}$$

In our case equation (28) is negative so as human capital increases, returns from legal activities are higher, the opportunity cost of crime is higher, and there is less incentive to commit crime. Therefore the two functions go in opposite directions and will cross defying the equilibrium level for human capital and crime.

Appendix B

The portfolio choice $h(C_{t+1}, \psi, \delta, \rho)$ is increasing in δ and ψ and decreasing in ρ as: $\frac{\partial h(C_{t+1},\psi,\delta,\rho)}{\partial\psi} > 0$, $\frac{\partial h(C_{t+1},\psi,\delta,\rho)}{\partial\delta} > 0$ and $\frac{\partial h(C_{t+1},\psi,\delta,\rho)}{\partial\rho} > 0$. The occupation choice $C(h_{t+1}, \delta, \rho)$ is increasing in δ.

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