Crime, Inequality and Economic Growth

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1. Introduction

The idea that the level of criminal activity in a society is strictly related to the degree of economic development, and to the distribution of wealth among individuals and classes of individuals, is certainly not new, neither it is really counterintuitive. Despite of this consideration, only very recently economists have started to study in articulated macroeconomic models the channels of interaction between crime, the incentives to commit crime and economic development and growth. Indeed, in comparison to the rich bulk of microeconomic literature studying the optimal choice of agents in presence of incentives to commit criminal offences and rent seeking behaviour (Glaeser, Sacerdote and Sheinkman, 1996; Fender, 1999; Burdet, Lagos and Randal, 2001; Huang, Laing and Wang, 1999; Lochner, 1999; Gould, Mustard and Weinberg, 2002 among others), the macroeconomic literature on the issue is very thin (Mehhulm, Moene, Torvik, 2001, 2003; Lloyd-Ellis and Marceau, 2003; Josten, 2003). Yet, it is straightforward to presume that only within a general equilibrium macroeconomic framework it is possible to fully grasp the extent at which the crime rate can affect the growth performance of an economic system.

One can guess various possible links between the diffusion of criminal activities and economic growth. On the one hand, for example, a low level of economic development implies a higher degree of poverty and, to the extent that poverty is often the major cause of crime, a high level of criminal activity. Moreover, as empirical evidence shows, economic stagnation can further increase the crime rate if it increases inequality in income distribution. On the other hand, crime can negatively affect economic growth by affecting return on investments and business profitability. The idea is that a high diffusion of criminal offences, like for example extortions, affects the riskiness of investments and the return on legal activities.

It is not difficult to understand that a key factor in driving investments decisions is the possibility to secure the return on the investment itself. If property rights are insecure, or investors run a high risk of being defrauded of their legitimate profits, the decision to invest is hindered. In this perspective, as Lloyd and Marceau (2003) argue, this insecurity can be very detrimental to growth. To these authors, among the many factors influencing the level of insecurity in the economy, the level of crime plays a crucial role. An increase in the crime rate translates in an increase in the level of insecurity and a decrease in the rate of capital accumulation and growth. Moreover, income distribution can affect the level of crime. The idea is that if individuals need to borrow, and there is uncertainty concerning the repayment (for example because the borrower might be robbed of his income before repaying the loan), the rate of interest charged by lenders – which is higher the lower is the probability of repayment – can decrease when borrowers can pay for protection against theft. As a consequence, poorer individuals who cannot afford to pay for protection might be asked a higher rate of interests on their loan and forced out of market. These individuals will ultimately turn into criminals themselves.

Following very similar arguments, Josten (2003) shows that crime can hamper growth since it can discourage investments and capital accumulation. Once more the reason is that the level of criminal activity can affect the security of property rights and, therefore, it can discourage investments. In Josten, it is inequality in income distribution the key factor which creates the incentive to crime and illegal activities.

This paper offers an alternative interpretation of the causal relationship between the degree of criminal activity, income distribution and economic growth. The key proposition is that the level of criminal activity in the economy not only can influence the return on private investment, as already argued, but also the efficiency and the return on public investments. In fact, a high level of criminality forces the government to allocate a higher proportion of public resources towards investments in security and measures to ensure public order, like the financing of police, courts and prisons. This misallocation of resources, which are diverted from investments in more productive activities like investments in education and research, has certainly a detrimental impact on growth. In addition to this, the paper investigates the effects of crime on the level of economic activity through its effects on the magnitude of labour supply. Indeed, many people who undertake criminal activities end up in prison and are unable to supply labour in the market with a negative effect on the level of production in the economy. This effect is not irrelevant if one think that the number of people ending up in jail are relatively high in many countries and that this people are mainly male of working age.

In the specific, the story goes as follows. In a two period overlapping generation economy, heterogeneous agents are born with different endowments of skills and labour productivity. In this framework, agents who are endowed with a low level of education have also a lower expected level of wage income, and since the wage forgone is the major alternative cost for being imprisoned after committing a crime, these agents have also a higher incentive to commit criminal offences. This would explain why for low level of capital accumulation, when the wage rate is low, and income inequality might be particularly severe, the economy might experience high crime rates. The role of government, in this framework, is not only to directly redistribute resources trough taxation, but also to supply the necessary infrastructure and services, like public education and schooling, in order to increase individuals' labour productivity and wage income. Such a role is hindered in presence of a large number of individuals who do not participate to the legal process of output and income production – for example because they are in jail. Indeed, in such circumstances, not only government revenues are particularly low because of a lower actual amount of taxable resources, but also because a large portion of those resource are diverted from productive investments, such as investment in education, to unproductive investments, such as investments in security. This would explain the negative impact of crime on the process of capital accumulation and growth.

When the level of capital accumulated in the economy is particularly low, the incentives for crime are higher, and in presence of unequal distribution of income, they are higher for poorer people. The high level of crime forces the government to invest more in security and less in more productive investment, such as education. This, in turn, lowers labour productivity, income and it, therefore, increases the incentive to crime. As capital accumulates this vicious circle might break and the economy might be set on a dynamic path characterised by a decreasing crime rate and increasing wealth. All the same, this might not happen under well specified parameters restrictions with the economy being trapped in a state of high crime and low growth.

The paper is structured as follows. Section 2 describe the economy. The role of each type of agent, the productive system and the role of government are all described in this section. Section 3 studies the optimal behaviour of agents and the rationale behind the crime choice. Section 4 describe the equilibrium in the economy while Section 5 studies the capital accumulation path. The last section, Section 6, contains some concluding remarks.

2. The economy

The economy is inhabited by an infinite sequence of two-period lived overlapping generations of agents divided at birth into firms and workers. Population of each generation is constant and normalised to 2, half of which are firms and half households (or workers). Workers can be born either with an initial low endowment of labour productivity: *l-type* workers (fraction μ of workers population), or with a high endowment of labour productivity: *h-type* workers (fraction 1-μ of workers population). By borrowing a commonly used terminology in this literature, we will refer to the first group of workers as *predators*, and to the latter as *prey*. These terms suggest what might be the optimal behaviour of each group of agent. As a matter of fact, in this economy, low labour productivity agents – that is agents with a relatively lower income endowment – might have the incentive to undertake a predatory activity against the other group of agents. We assume that all agents are risk neutral and strictly prefer to consume only in the second period of their life, when old. This last assumption allows us to bypass problems of consumption-saving choices without losing in generality. A single good which can be either used for consumption, or employed as capital in the production process, is manufactured by competitive firms. Time is discrete and indexed by 1, 2, …. We now turn to a more detailed description of agents' endowments in order to determine their optimal behaviour in this environment.

2.1 Households

All households are endowed with one unit of labour in each period of their life which they supply inelastically to old firms in exchange for the competitive wage rate. In spite of equal labour endowment, labour productivity is not the same for all workers. As a direct consequence of birth differences, a group of agent is more skilful than the other and, ultimately, workers will either display a high degree of labour productivity or a low degree of labour productivity. We denote with a_l the efficiency in production of low-labour productivity agents – the predators –, and with a_h the efficiency in production of high-labour productivity agents – the prey –, with $a_l < a_h$. Under the assumption of perfectly competitive markets, in which each production factor is paid its productivity, and in absence of bequests, these differences reflect differences in income for the two types of households: the low-labour productivity agents are able to obtain out of their labour services a lower income than high-labour productivity agents. Thus, in this framework, the assumption of heterogeneity among agents in the innate amount of skill level is essentially required to explain the existence of agents with differences in the initial income endowments. Birth differences in productivity and incomes can be justified in different ways. One can think of these differences in labour productivity as generated by the advantage, in the learning process, newborn in rich or more educated family might have with respect to newborn in poorer families. The idea is that children who grow up in a better family environment have more stimuli and more resources available for the learning process. It is worth stressing that this assumption of only two income classes of individuals has only the scope of simplifying the exposition and the understandings of the workings of the model. By adding a thicker distribution of income across agents wouldn't alter the main results and the implications of the model.

Besides working, each young household inhabiting the economy has the possibility to commit criminal actions. The idea is that each young agent is endowed with a given amount, $\theta > 0$, of non tradable extra time, or energy, which can be either employed as leisure time or diverted towards predatory and illegal activities[1]. In order to simplify the matter, we focus on the most simple predatory activity: theft. At a given point in time, each young household can approach another agent in the economy with the criminal intent of stealing some of her resources. The amount of resources, $\sigma(\theta)$, each agent can steal is a direct function of the amount of extra-time, θ, he is endowed with, i.e. $\sigma'(\theta) > 0$. If apprehended, the young agent is put in jail where he will spend the second period of his life. The disutility of going to jail is exogenously given and denoted by $J < 0$. Under the assumption that the effort required in stealing does not depend on the amount of resources stolen, and that the penalty for committing a crime is the same whatever is the amount stolen, each young agent who decides to commit a criminal offence will steal as much as possible for a given amount of extra-time endowment, that is $\sigma(\theta) = \bar{\sigma}$. In other words, once the agent has decided to steal, he will employ all his extra time in the criminal activity and steal as much as possible.

[1] One can think of this time as night-time. Young agents, differently from old ones, can employ this time in a criminal activity instead, for example, of resting in bed, however, they cannot employ this time by working.

When old, agents who have not committed any criminal offence in their young age, and the ones that have done so but have not been apprehended by the police, supply their labour endowment in the market for the current wage. Soon after this, they consume whatever they have saved in the first period and earned in the second and die.

2.2 Firms

In the first period of their life firms are inactive and produce output only in the second period by employing physical capital, k_t, in conjunction with either low productivity labour, x_{lt}, or high productivity labour, x_{ht}, or a combination of the two. Output production involves a Romer type technology of the following kind:

$$y_{t+1} = A(e_{t+1})(a_l x_{lt+1}{}^{\alpha} + a_h x_{ht+1}{}^{\alpha})k_{t+1}{}^{1-\alpha} K_{t+1}{}^{\alpha}, \quad 0 < \alpha < 1 \tag{1.1}$$

where K_t denotes the aggregate level of capital at time t. The technology specification implies not only a positive externality in the accumulable factor – physical capital –, but also a positive externality of government expenditure in the non accumulable factor – the labour services. Indeed, the technology factor, $A(e_t)$, is endogenously determined and, in the specific, is a positive function of the expenditure in education/output ratio, $E_t/Y_t=e_t$. As in Barro (1990), government expenditure can positively influence the process of capital accumulation and economic growth. However, we do not consider total government expenditure, and only focus on the positive effect of expenditure in education on the marginal productivity of accumulable and non accumulable factors such as labour services in production. In the specification of (1.1), government expenditure in education has a positive, $A'(e_t) > 0$, but decreasing, $A''(e_t) < 0$, impact on the marginal productivity of labour and capital. Moreover, we set $A(0)=B>0$. The idea is that public investment in education can increase the aggregate skill level in the economy and the efficiency in production of labour services. One can think, for example, of the beneficial effects on the average level of human capital in the economy streaming from a better and more accessible education system. The underlying idea is that more public funding channelled in education can both improve the efficiency of the system and increase the volume of services that this can provide. In turn, the augmentation in the aggregate skill level in the economy entails higher labour productivity with a beneficial impact on output. In particular, as for the formulation in (1.1), the efficiency in production of labour is determined by the combination of innate abilities, a_l and a_h, and the improvement in the skill level by means of public supplied services in education, $A(e_t)$. Moreover, it is reasonable to think that the effects of public expenditure in the economy depends on the size of the latter. In the specific, we assume that congestion effects lead to a lower efficiency of public services in education as the size of the economy – measured by the aggregate output, Y_t – increases.

In equilibrium each firm will employ in production the same amount of capital. Therefore, recalling that the total number of firms is 1, per firm capital stock will be equal to the aggregate level of capital, $k_t=K_t$. This result, together with the assumption of perfectly competitive markets, in which each factor of production is paid its marginal productivity, allows us to write the wage rates for low productivity workers, w_{lt}, and for high productivity workers, w_{ht}, as follows

$$w_{lt} = \alpha A(e_t) a_l x_{lt}{}^{\alpha-1} k_t, \tag{1.2}$$

$$w_{ht} = \alpha A(e_t) a_h x_{ht}{}^{\alpha-1} k_t. \tag{1.3}$$

Under the same assumptions the rate of interest is

$$r_t = (1-\alpha) A(e_t)(a_l x_{lt}{}^{\alpha} + a_h x_{ht}{}^{\alpha}). \tag{1.4}$$

Given factor prices in (1.2), (1.3) and (1.4), each firm's labour and capital demand will be determined by profit maximisation:

$$\Pi_t = y_t - w_{lt}x_{lt} - w_{ht}x_{ht} - r_t k_t.$$

2.3 Government

Government finances a balanced budget trough taxation. We assume that only income from labour services is taxed and that the government imposes different tax rates to *l*-type workers and to *h*-type workers. In the specific, a progressive tax system requires *h*-type workers to pay a higher proportion, τ^h, of their labour income than *l*-type, τ^l, that is $\tau^h > \tau^l$. In order to simplify matter, we also set $\tau^l = 0$ and assume that each agent receive the wage income already net of taxation. In other words, as it often happens in reality, employers pay taxes on behalf of employees and transfer the wage income to workers already net of taxation.

Assuming a balanced budget deficit and recalling that at each point in time only *h*-type agents (old and young) pay taxes in the economy (τ^l=0), the volume of government expenditure, G_t, that can be financed will consist of

$$G_t = \tau^h w_{ht} 2(1-\mu), \tag{1.5}$$

where 2(1- μ) is the total number of *h*-type agents (young and old both in the number of 1- μ), at time *t*, in the economy.

Government can allocate public expenditure towards two competitive alternatives: investment in education, E_t, and investment in security services and public order maintenance, S_t. Therefore, the government budget deficit reads very simply $G_t = E_t + S_t$. The possible presence in the economy of individuals who can break the law by committing theft requires the government to finance police forces to prevent crimes, and to capture the culprits, as well as to build and sustain a prison system. It is plausible to think that investments in security and public order are an increasing function of the number of individuals that commit criminal offences and, in general, of the level of criminal activity in the economy, for now generically denoted with ζ. We can, therefore, write $S_t=S(\zeta)$, where $S'(\zeta)>0$.

3. Sometimes crime pays: incentives to crime

Young agents, as already stressed, have the chance, and the possibility, to commit criminal offences (here generically represented by theft). Soon after having supplied their labour in the market, young households can approach another agent and steal part of her wage. Given the extra-amount of energy they are endowed with – θ – and the fixed cost of committing crime in terms of effort and energy loss, if agents find optimal to break the law and commit theft, they will steal as much as possible, $\bar{\sigma}$, from their victim. An agent, born at time *t*, who has committed a criminal offence in his young age will remain free and supply labour in the market only if not apprehended by the police which happens with probability π.[2] If the thief is captured by the police, he is put in jail and derives a disutility of *J*. We have now enough elements to determine the payoffs attached to each possible action of the two types of agents in the economy, and the consequent optimal behaviour. Let us first consider the low skilled workers. Given the above, the expected lifetime utility of a young *l-type* agent breaking the law and committing theft can be written in the following way

$$\tilde{U}_l = w_{lt}(1+r_{t+1})(1-\tau^l) + \bar{\sigma} + w_{lt+1}(1-\tau^l)(1-\pi) + \pi J, \tag{1.6}$$

As already stressed, agents can capitalise on their savings by lending these resources to firms. The return on savings is the next period interest rate, r_{t+1}, which is the return on capital. Given that agents are risk neutral, and have a discount rate equal to 1, they strictly prefer to

[2] This probability is here taken as given in order to simplify the framework. It is possible to imagine a more complex economy in which the government, here a passive player, could actively choose the optimal level of π.

consume all income at old age. In order to simplify matter, we assume that the resources, $\bar{\sigma}$, agents have stolen in young age cannot be capitalised trough official channels. In other words, the loot from theft does not earn any interest. This assumption can be justified in different manner, the most immediate of which is the following. It is reasonable to argue that the government can very easily observe agents' savings, and therefore, it can immediately find out if an agent has committed a crime or not when extra resources, whose origin are questionable, are discovered. As a direct consequence of this assumption, agents might find optimal either to consume immediately this resources, or simply, if they can, to hide and store these resources without earning any interest. Actually, if one think of what happens in reality, the easiest way the police have to trace stolen funds is through the study of movements in bank accounts and savings. Better for thieves to keep stolen money under the bed.

If, alternatively, a young *l-type* agent decides not to commit a criminal offence, the expected lifetime utility is simply the sum of his young age capitalised wage income and his second period net wage income,

$$\hat{U}_l = w_{lt}(1-\tau^l)(1+r_{t+1}) + w_{lt+1}(1-\tau^l). \tag{1.7}$$

Clearly, if an agent does not commit any crime will have the opportunity to supply his labour services in old age with probability 1 since it does not run the risk of ending up in jail.

It is now possible to determine the optimal behaviour of an *l-type* agent. A simple comparison between the expected lifetime utility under the two options reveals that a sufficient condition for predators not to steal is

$$\hat{U}_l > \tilde{U}_l \iff w_{lt+1} > \frac{\bar{\sigma} + \pi J}{(1-\tau^l)\pi}. \tag{1.8}$$

The latter shows that the key variable in the crime-legality choice is the expected wage rate. For a given level of disutility of going to prison, a given tax rate, a given probability of being apprehended and a given utility derived from the stolen goods, the higher is the wage income at old age, the higher is the cost of theft. The forgone second period wage rate is the alternative cost agents sustain for committing a crime. If the second period wage rate, as determined by the (1.2), is low enough, they will have the incentive to commit the criminal offence. A predator will decide to steal, or not to steal, according to the following

$$\hat{U}_l \gtrless \tilde{U}_l \iff \alpha A(e_{t+1}) a_l x_{lt+1}{}^{\alpha-1} k_{t+1} \gtrless \frac{\bar{\sigma} + \pi J}{\pi} \equiv \Theta \tag{1.9}$$

It is important to stress that since agents of the same type are homogeneous, for a given wage rate, if one action rather than the other is optimal for an individual, then the same action is optimal for all other individuals of the same type. So, if it is optimal for a single predator to commit a crime, then crime is the optimal choice for all predators. A similar argument, in the opposite direction, applies when the condition is holding with a reversed sign of inequality. However, it is worth to add that since the wage rate is not exogenous, but it depends on agents' choices, then what it is optimal at individual level might not be consistent with the macroeconomic equilibrium. We will discuss in detail of this in the next section. At this stage, as a corollary to the previous conclusions, we can argue that if the crime condition is holding with strict equality, then it must be that predators must be indifferent between the two options, committing a crime or remain in the legality. This implies that in the economy there must be a fraction of predators choosing to remain legal and a fraction committing theft. We will denote with $\gamma_t \in [0,1]$ the fraction of young predators who decide to steal at time t.

It has been argued that if an individual decides to steal, she will steal the maximum amount of resources, that is $\bar{\sigma}$. Since at each point in time each predator can possibly approach only one victim, it will be sufficient to assume that $w_{ht} > \bar{\sigma} > w_{lt} \ \forall t$ to conclude that no *l-type* agent will ever steal from another predator. In different words, we can say that poor do not steal from poor. For similar but opposite argument, *h-type* agents run the risk of being robbed.

We now turn to the description of *h-type* agents' opportunities. Potential victims of predators are only *h*-type agents whose expected lifetime utility under the assumption they abide by the law is

$$U_h = w_{ht}(1-\tau^h)(1+r_{t+1}) + (1-p_t)w_{ht+1}(1-\tau^h) + p_t[w_{ht+1}(1-\tau^h) - \bar{\sigma})], \tag{1.10}$$

where p_t is the probability of being robbed. We implicitly assume that predators can steal only to old prey and do not rob young prey. This can be reasonably justified, for example, by arguing that young prey have the energy and the resources to defend themselves, which is not the case for old ones. While this assumption simplifies the matter, it does not substantially alter the results.

The probability of being robbed faced by each prey, depends both on the number of predators that decide, at each point in time, to opt for crime, and, of course, on the total number of prey that can be robbed in the economy. It is straightforward to argue that this probability is increasing in the number of predators committing crime and decreasing in the number of old prey. More specifically we can write $p_t = \frac{\mu\gamma_t}{1-\mu}$ where $p_t \in \left[0, \frac{\mu}{1-\mu}\right]$. For obvious reason of feasibility, we will assume that $1-\mu > \mu$, that is the number of prey in the economy is large enough to allow for an equilibrium in which all predators might decide to steal.

Similarly to what happens to *l-type* agents, *h-type* agents have the opportunity of committing crime. If they do so, they derive an expected lifetime utility of

$$\hat{U}_h = w_{ht}(1-\tau^h)(1+r_{t+1}) + \bar{\sigma} + \left\{(1-p_t)w_{ht+1}(1-\tau^h) + p_t[w_{ht+1}(1-\tau^h) - \bar{\sigma}]\right\}(1-\pi) + \pi J\,. \tag{1.11}$$

Hence, following the same arguments developed above, a sufficiently high wage rate for the *h-type* agents ensures them always abiding to the law and not committing crime. For the sake of exposition and the clarity of the results, we will hitherto assume that the expected utility in (1.10) dominates the expected utility in (1.11), that is we will assume $w_{ht+1} > \frac{(1+\pi p_t)\bar{\sigma} + \pi J}{(1-\tau^h)\pi}$, $\forall$ w_{ht+1}. Under this restriction no *h*-type agent will ever commit any crime. Of course, we do not intend to argue that in reality no rich individual ever commit crime, and this assumption shouldn't be interpreted in a strict sense. There are many motivations behind criminal actions and some rich people might be more inclined to crime than poorer ones. However, here we are focusing on a particular motive for crime, which is the loss in future earnings, and it is reasonable to think that under this specific perspective, individuals with higher expected income sustain a higher cost when committing crime. If this is the case, one can simplify by a great extent the understanding of the results by imposing a condition for which only one group of agents – the poorer – might find optimal to commit crimes.

4. The equilibrium

As one can intuitively understand, labour supply in the economy, at each point in time, is an endogenous variable and it depends on the level of criminal activity. Indeed, as already discussed, predators who have committed a criminal offence when young might be apprehended by the police when old, and put in jail. If this is the case they are unable to supply labour in the market. As a result, the higher is the level of criminal activity in the economy, the lower is *l*-type agents labour supply. In general, total labour supply at time *t* will be $2-\pi\mu\gamma_{t-1}$, given by the supply of labour from young and old agents (prey and predators) minus the labour supply of predators who have been jailed. It is worth to stress that the action chosen by predators at time *t* will only influence labour supply next period, at time *t*+1. Since labour services have distinct deployment in the production technology, we will distinguish between the high productivity and low productivity labour supply. At time t, total labour supply from old and young predators will be

$$x_{lt} = 2\mu - \pi\gamma_{t-1}\mu,$$

which, clearly, depends negatively on the fraction of old predators who have committed a criminal offence when young. On the other hand, under the restriction that no prey find ever optimal to steal, *h-type* workers labour supply at each point in time will be constant and equal to

$$x_{ht} = 2(1-\mu).$$

Given the above labour supply, the wage rates of predators and prey can be respectively written as

$$w_{lt} = \alpha A(e_t) a_l (2-\pi\gamma_{t-1})^{\alpha-1} \mu^{\alpha-1} k_t, \tag{1.12}$$

$$w_{ht} = \alpha A(e_t) a_h [2(1-\mu)]^{\alpha-1} k_t, \tag{1.13}$$

Government, as already outlined, collects taxes, and, with these resources, finances the expenditures in education, E_t, and public security and order conservation, $S_t = S(\zeta)$, which is thought to be a generic function of the level of criminal activity in the economy, ζ. In our economy, in which all crime takes the form of simple theft, and in which only predators commit criminal actions, it seems plausible to assume that the expenditure in security are a linear function of the number of predators who decide optimally to commit criminal offence. More specifically, we will assume

$$S_t = \beta\gamma_{t-1}G_t.$$

And, as a result,

$$E_t = (1-\beta\gamma_{t-1})\, G_t.$$

Substituting for the wage rate as determined by (1.12) and (1.13), and recalling that a balanced budget deficit implies $G_t = \tau^h w_{ht}\, 2(1-\mu)$, we can write the ratio of education expenditure to total output as

$$e_t(\gamma_{t-1}) = \frac{E_t}{Y_t} = (1-\gamma_{t-1}) \frac{\alpha\tau^h a_h [2(1-\mu)]^\alpha}{a_l (2-\pi\gamma_{t-1})^\alpha \mu^\alpha + a_h [2(1-\mu)]^\alpha}. \tag{1.14}$$

Therefore, as extensively argued, government expenditure in education is a function of the number of predators who find optimal to commit crime. Indeed, γ_t not only directly influences government expenditure in education by forcing the government to increase the share of public expenditure in security, but also indirectly, since it affect the aggregate labour supply of l-type agents and, therefore, aggregate output, Y_t. It is easy to show that under the specified assumptions of the model, and the restriction on the parameters, the share of government expenditure in education is a decreasing function of γ_{t-1}, i.e. $e'(\gamma_{t-1}) < 0 \ \forall \gamma_{t-1} \in [0,1]$. Appendix 1 provides a formal proof of this result. We have now all the ingredients to study the equilibrium conditions.

Essentially, the economic system can display three possible equilibria: the first is the equilibrium in which all predators find optimal to opt for crime; the second is the equilibrium in which no predator will choose to commit a criminal action; the third is the equilibrium in which only a fraction of predators decides to commit crimes. We will refer to the first equilibrium as the *crime equilibrium*, to the second as the *no crime equilibrium* and to the third as the *mixed equilibrium*. Let us analyse each of these in details.

1. Crime equilibrium

If all predators in the economy opt for crime, then it must be $\gamma_{t-1} = \gamma_t = 1$. However, this option is consistent with the macroeconomic equilibrium, if for this value of $\gamma = 1$, the condition in (1.9) is such that each predator find optimal to opt for crime, that is:

$$\alpha B a_l (2-\pi)^{\alpha-1} \mu^{\alpha-1} k_{t+1} < \Theta \tag{1.15}$$

and, consequently, $e_t = 0$.

2. No crime equilibrium

On the opposite, if all predators in the economy choose not to commit any crime, it must be $\gamma_{t-1} = \gamma_t = 0$. Again, this choice is consistent with the equilibrium, if for this value of $\gamma = 0$, the condition in (1.9) is such that no predator finds optimal to steal:

$$\alpha A(\overline{e}) a_l (2\mu)^{\alpha-1} k_{t+1} > \Theta \tag{1.16}$$

where $e_t = \overline{e} = \dfrac{\alpha \tau^h a_h [2(1-\mu)]^\alpha}{a_l (2\mu)^\alpha + a_h [2(1-\mu)]^\alpha}$.

3. Mixed equilibrium

In the mixed equilibrium case, only a fraction of predators will optimally choose to steal, while the other fraction will not commit any crime. More formally, we will have γ_{t-1}, $\gamma_t \in]0,1[$. If this is the case, the crime condition in (1.9) must hold with equality:

$$\alpha A(e_{t+1}) a_l (2 - \pi \gamma_t)^{\alpha-1} \mu^{\alpha-1} k_{t+1} = \Theta, \tag{1.17}$$

where e_{t+1} is given by (1.14). That is for the optimal choice at individual level to be consistent with the macroeconomic equilibrium, each predator must be indifferent between the two options, and the equilibrium fraction of predators choosing to steal must be such that equation (1.17) is satisfied.

A rapid analysis of the condition determining agents' optimal choices, eq. (1.9), shows that, other things being the same, the variable that determines the nature of the regime – equilibrium with crime, no crime equilibrium and mixed equilibrium – is the stock of accumulated capital. Indeed, capital accumulation can influence the wage rate and, consequently, the incentive predators have to undertake unlawful activities. However, it is also true that agents' choice can influence the rate of capital accumulation. In fact, as already seen, the level of crime activity in the economy can influence the allocation and the size of government expenditures and, by this way, the return to the accumulable factor and economic growth. We now turn to the study of the dynamics of the economic system.

5. Capital Accumulation

Capital accumulation is ultimately a function of the degree of criminal activity in the economy. Indeed, predators' choice, and the nature of the realised equilibrium, will influence, through different channels, the amount of resources channelled to investments.

Since in this economy investments depend exclusively on the amount of savings, and therefore on young agents net income wage, capital accumulation, at each point in time, will simply be governed by the following dynamics

$$\begin{aligned} k_{t+1} &= w_{lt}\mu + (1-\tau^h) w_{ht}(1-\mu) \\ &= \alpha A(e_t)[a_l (2 - \pi\gamma_{t-1})^{\alpha-1} \mu^\alpha + a_h (1-\tau^h) 2^{\alpha-1} (1-\mu)^\alpha] k_t, \end{aligned} \tag{1.18}$$

where we have substituted for the wage rates the expressions in (1.12) and (1.13), while e_t is given by (1.14). In order to ensure stability to the system we will require the variables and the parameters to satisfy the following restriction

$$\alpha A(e_t)[a_l (2 - \pi\gamma_{t-1})^{\alpha-1} \mu^\alpha + a_h (1-\tau^h) 2^{\alpha-1} (1-\mu)^\alpha] \geq 1 \quad \forall \gamma_t [0,1] \tag{1.19}$$

It is clear that capital accumulation, as determined by (1.18), is influenced by the fraction of predators in the economy and, ultimately, by predators' optimal choice. In an environment in which each and every predator find optimal to steal, the rate of growth will be given by the following expression

$$g^c \equiv k_{t+1} / k_t = \alpha B[a_l (2-\pi)^{\alpha-1} \mu^\alpha + a_h (1-\tau^h) 2^{\alpha-1} (1-\mu)^\alpha]. \tag{1.20}$$

In this case, which involves the maximum degree of criminal activity, the government does not channel any resource towards education, e_t=0, the wage rate is very low and the condition governing *l-type* agents' behaviour holds with strict inequality, as in (1.15). This regime, as one can immediately verify by analysing the choice condition, is likely to occur at low level of capital accumulation.

With similar arguments, but in the opposite direction, it is possible to argue that for very high levels of capital accumulation, the condition governing agent's choice is likely to hold with the reversed sign, as in (1.16). In this case the wage rate is particularly high and no predator has any incentive to commit a criminal action, γ_t =0. The rate of growth of the economy with no criminal activity will be given by:

$$g^n \equiv k_{t+1} / k_t = \alpha A(\overline{e})[a_l 2^{\alpha-1} \mu^\alpha + a_h (1-\tau^h) 2^{\alpha-1} (1-\mu)^\alpha] \tag{1.21}$$

It is straightforward to verify that the system in both these cases, summarised by (1.20) and (1.21), displays constant growth rates. Most importantly, one can easily prove that if the impact of government expenditure in education on the labour productivity is relatively large, the growth rate under a no crime equilibrium is higher than the growth rate in a crime equilibrium. A sufficient condition for this to happen is[3]

$$A(\overline{e}) > \left(\frac{2}{2-\pi} \right)^{1-\alpha} B. \tag{1.22}$$

In order to understand the nature of this result, one has to notice that crime displays two opposite effects on capital accumulation and growth. On the one hand, a decrease in crime can harm growth since it increase the low productivity labour supply (less people end up in prison) and by this way it reduces the wage rate, the amount of savings and, therefore, the rate of growth. On the other hand, a decrease in the crime rate can boost capital accumulation and growth since it allows the government to reallocate more resources towards education. The rise in the amount of investments in education increases the productivity of labour (both of high skilled and low skilled workers) and by this way the wage rate, savings and the rate of growth.

The dynamics of capital is much more difficult to be determined in the mixed equilibrium framework, in which $\gamma_t \in]0,1[$. In this case, the capital accumulation path is represented by eq. (1.18) and, hence, the rate of growth is simply

$$g^m \equiv k_{t+1} / k_t = \alpha A(e_t)[a_l (2-\pi\gamma_{t-1})^{\alpha-1} \mu^\alpha + a_h (1-\tau^h) 2^{\alpha-1} (1-\mu)^\alpha] \tag{1.23}$$

Even though, the dynamics of the system, in this case, is apparently similar to the dynamics governing the economy in the no crime and crime equilibrium, it is in reality more complex since it is jointly determined by two difference equations, (1.17) and (1.23). Indeed, while the level of capital in (1.23), at each point in time, depends on the values of γ, the level of γ, which keeps the system in equilibrium, and predators indifferent between the crime and the no crime option, depends, in turn, on the level of capital accumulated in the economy, eq. (1.17).

Leaving aside a full study of this dynamics, which notwithstanding its complexity might not add substantial insight to the story, the following considerations can be carried out. Under the restriction in (1.19), for every value of γ, capital is either always increasing – when this condition is holding with strict inequality – or it is stationary – if this condition is holding with equality for a value of $\gamma_t \in]0,1[$. What we can rule out by assumption, it is a decreasing capital stock.

[3] See Appendix 2.

Let us first consider the case of a continuously increasing capital stock. The economy will develop through the following stages. Initially, when the level of capital accumulation is particularly low, and so is the wage rate, the level of criminality will be at its maximum, γ=1, and the rate of growth of the economy will be given by g^c, eq. (1.20). The condition governing agent's behaviour will be given by (1.15). As capital grows, the economy will start displaying a lower level of criminality with $\gamma_t \in]0,1[$. During this stage not all *l-type* agents choose to commit crimes, and actually predators will be indifferent between the two alternatives: eq. (1.17) is in place. During this phase, very importantly, γ_t is no longer constant but it changes with k_t. It is this the stage in which the mixed equilibrium prevails and the rate of growth is given by g^m, eq. (1.23). Since capital by assumption is increasing for whatever value of γ_t, soon or later the condition behind agent's behaviour will hold with strict inequality. It is the final stage when no predator finds optimal to commit crime, eq. (1.16). The economy will certainly converge to the no crime equilibrium and the new rate of growth will be g^n as in eq. (1.21).

Let us now consider the possibility to have stationarity, $k_t = k_{t+1}$. Again, for a sufficiently low initial capital stock the prevailing regime will be the regime with maximum criminality. The rate of growth, at this initial stage, is g^c. As capital grows, the economy will migrate to the mixed equilibrium, and $\gamma_t \in]0,1[$. Soon or later, the economy will reach the value of $\gamma_t \in]0,1[$ such that the system of equations

$$\alpha A(e)[a_l(2-\pi\gamma)^{\alpha-1}\mu^{\alpha} + a_h(1-\tau^h)2^{\alpha-1}(1-\mu)^{\alpha}] = 1$$

$$\alpha A(e)a_l(2-\pi\gamma)^{\alpha-1}\mu^{\alpha-1}k = \Theta$$

is satisfied and $k_t = k_{t+1}=k$ and $\gamma_t = \gamma_{t+1}=\gamma$. In this case, the economy enters a growth trap with a high level of criminality and a stagnating economy.

6. Conclusions

The level of criminal activity in the economy has unarguably a strong impact on the level of production and economic activity. This idea is commonly accepted. Yet, one can think of different channels through which crime can affect real variables, investment decisions and growth. Some economists have recently focused on the negative impact crime can have on private investment profitability in order to explain the long run role played by the criminal activity in resource allocation.

Moving from a different perspective, we explore another route of research and analyse the impact of crime activity on public investments. Our main argument is that in presence of criminal activities government cannot allocated enough resources to productive activities, such as investments in education or research, and it is, instead, forced to spend resources to ensure security and public order in the economy.

The paper provides the "classical" argument for which crime mainly finds its roots in the unequal income distribution among agents. The analysis is based on the idea that if the major alternative cost of crime is the probability of going to prison, and not being able to work, then people with lower expected income will have a higher incentive to commit crimes. Of course, this is only part of the story and we do not want to deny that other factors, such as reputation issues, cultural factors or, simply, people's conscience may play a determinant role in shaping the attitude towards crime. As a matter of fact, the analysis of these elements can open very interesting avenues for further research.

The working of the model is quite simple. In presence of a severely asymmetric income distribution, poorer agents might have a higher propensity towards predatory and criminal activities. This state of affair is likely to occur at low level of capital accumulation, when the economy is relatively poor. In turn, when the level of criminal activity is high, a higher proportion of public investment are diverted towards low return investments such as investments ensuring public security and order rather than investments with higher return such as investment in research and education. This misallocation of resources lowers the rate of capital accumulation and growth with a positive impact on the level of criminal activity. This mechanism accounts for a two-way casual relationship between growth and crime, and is able to explain the co-existence of high level of criminal activity and low level of economic development observed in many economies.

Appendix 1

Differentiating (1.14), we obtain

$$\frac{\partial e_t(\gamma_{t-1})}{\partial \gamma_{t-1}} = \frac{\alpha \tau^h R}{M+R}\left\{(1-\gamma_{t-1})\frac{\alpha a_l(2\mu - \pi\gamma_{t-1}\mu)^{\alpha-1}\pi\mu}{M+R} - 1\right\}$$

where

$M = a_l(2-\pi\gamma_{t-1})^{\alpha}\mu^{\alpha}$ and $R = a_h[2(1-\mu)]^{\alpha}$. A simple analysis of the derivative shows that

$$\frac{\partial e_t(\gamma_{t-1})}{\partial \gamma_{t-1}} < 0 \text{ which implies } (1-\gamma_{t-1})\frac{\alpha a_l(2\mu - \pi\gamma_{t-1}\mu)^{\alpha-1}\pi\mu}{M+R} - 1 < 0 .$$

Rearranging the latter, we obtain

$$\left[\frac{(1-\gamma_{t-1})\alpha\pi}{2-\pi\gamma_{t-1}} - 1\right] a_l(2\mu - \pi\gamma_{t-1}\mu)^{\alpha} < a_h[2(1-\mu)]^{\alpha}$$

A sufficient condition for the latter to be satisfied is $(1-\gamma_{t-1})\alpha\pi < 2 - \pi\gamma_{t-1}$. This is always true given that

$$(1-\gamma_{t-1})\alpha\pi < 1 \text{ and } \pi\gamma_{t-1} < 1 .$$

Appendix 2

$g^n > g^c$ requires

$A(\overline{e})[a_l 2^{\alpha-1}\mu^{\alpha} + a_h(1-\tau^h)2^{\alpha-1}(1-\mu)^{\alpha}] > B[a_l(2-\pi)^{\alpha-1}\mu^{\alpha} + a_h(1-\tau^h)2^{\alpha-1}(1-\mu)^{\alpha}]$.

Rearranging the latter we obtain

$$(A(\overline{e}) - B)a_h(1-\tau^h)2^{\alpha-1}(1-\mu)^{\alpha} + a_l\mu^{\alpha}[A(\overline{e})2^{\alpha-1} - B(2-\pi)^{\alpha-1}] > 0.$$

A sufficient condition for the latter to be satisfied is

$$A(\overline{e})2^{\alpha-1} - B(2-\pi)^{\alpha-1} > 0.$$

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