Poverty Traps, Economic Inequality and Delinquent Incentives

Andrés Salazar and Edgar Villa
Pontificia Universidad Javeriana

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Abstract

This paper explores the theoretical linkages between poverty traps, economic inequality in a two sector overlapping generations model under perfect competition in which educational attainment and delinquenct incentives interact. We find that the existence of a poverty trap under high economic inequality and costly education investments generates persistent delinquency in the long run. We study comparative dynamics for technological exogenous shocks generates and find that they can generate spells of delinquent outbursts. Finally we study both law enforcement and education based policies to reduce persistent delinquency and find that they can attenuate delinquency but in some cases not eliminate it altogether. We show that contrary to common intuition education based policies that subsidize human capital investments can increase in the short run delinquency even though in the long run they can reduce it permanently.

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Introduction

Since the pioneering work of Becker (1968) and Ehrlich (1973) the economics of crime literature has argued that in order to lower crime rates it is necessary to extend and increase law enforcement policies to deter individuals from choosing delinquent activities or incapacitate them. Even so there seems to be a consensus in this literature that delinquency is not likely to be eliminated only through deterrence and incapacitation measures from law enforcement authorities since delinquency is a choice that individuals turn to when lacking other economic opportunities. It seems equally necessary to understand these other incentives that make people turn to illegal activities. In particular there is evidence that individuals are more likely to choose an illegal organization when young when they live in poverty (Blattman-Miguel (2008)) or live with high levels of economic inequality which allows high expected gains[1] from illegal activities (Bourguignon (1999), Fajnzylber et al (2001, 2002)). This suggests that we should understand the incentives for an individual to choose a delinquent life

[1] Theoretically net gains from criminal activities have been represented in different ways. For example, Bourguignon (1999) understands them as wealth differences between rich and poor, Imrohoroglu, Merlo and Rupert (2000) considers them as income differences among complex heterogeneous agents while other authors as Kelly (2000) consider income inequality as a measurement of the distance between gains from crime and its opportunity costs.

in environments where there exists both poverty and high economic inequality for given levels of law enforcement. Moreover, there is another strand of the economics of crime literature that finds evidence that human capital accumulation can weaken delinquency incentives (Lochner (2004, 2010), Lochner-Moretti (2001)). In particular Acemoglu-Angrist (2000) argue that educational attainment is causally related to higher returns in the labor market as well as positive externalities at the social level. This suggests that policies that enhance education opportunities for riskier segments of the population have a positive externality that lowers delinquency incentives.

This paper builds an overlapping generations model under perfect competition that abstracts from unemployment similar to Galor-Zeira (1993) that allows to explore the theoretical linkages between poverty traps, economic inequality and educational attainment. It builds on a dual economy in which delinquents prey on legal workers. We find that for given levels of law enforcement measures of deterrence and incapacitation delinquency is persistent in the long run if wage differentials are high enough relative to costly indivisible human capital investments and wealth inequality is large enough such that it is compatible with a poverty trap. We study both deterrence and incapacitation policies as well as education based policies to reduce long run delinquency. We find that even though in the long run these policies may not eliminate completely delinquency they can attenuate it. We show that contrary to common intuition education based policies that subsidize human capital investments can increase in the short run delinquency which shows a trade off that policy makers might not be aware of.

This paper is organized in five parts. The first part reviews a strand of literature that links both delinquency to economic inequality and poverty while also reviewing another strand of literature that links education attainment and delinquency. The second part builds up the formal model which explores the theoretical linkages between poverty traps, economic inequality and delinquent incentives. The third part explores comparative dynamics with respect to technological shocks tracing out the effect on delinquency. The fourth part examines policies that can decrease delinquent incentives such as law enforcement and education based policies. The fifth part concludes.

1 Literature review

The modern literature on the economics of law enforcement, based on Gary Becker's seminal (1968) article has focused on the effect of incentives on criminal behavior. This author argues that crime is a result of individual rational choices where benefits of crime outweigh its costs such as the probability of apprehension, conviction, and punishment, as well as their current set of opportunities. As a consequence, deterrence theory research has been predominantly concerned with the isolated effects of the severity and certainty of sanctions on illegal behavior[2], which has been an argument to extend and increase law enforcement policies in order to reduce crime rates. However, economic and social literature have also shown that delinquency is not likely to be eliminated only through deterrence policies since delinquency is an individual choice when the lack of other economic opportunities

[2] For an exhaustive bibliography review of crime deterrence theoretical and empirical literature, see Eide (1997).

exists. In this way, it seems equally necessary to understand these other incentives that make people turn to illegal activities. Specifically, several articles have shown that both poverty and high economic inequality are social conditions that induce illegal behaviors due the lack of other legal ways to acquire incomes and assets. Complementarily, the economics of education literature also has explored and found evidence that human capital accumulation can discourage illegal activities. Now we are going to review these two relations.

1.1 Economic inequality and delinquency

According to Kelly (2000) the link between inequality and crime has been studied by the three main theories of crime: the economic theory of crime, the social disorganization theory, and the strain theory.

In the economics crime literature, economic differences have been a necessary condition to keep the incentives to commit crimes, hence, property crime may partly be the consequence of excessive economic inequality (Bourguignon (1999)). Several articles have considered the effect of inequality on crime, for example, Ehrlich (1973) uses the fraction of the population in an area earning less than half the median income as a proxy for inequality, and shows that the decision to participate in criminal activities involving material gains is positively associated with income inequality. Witte and Tauchen (1994) examine the impact of earnings on criminal participation and Kelly (2000, 537) concludes that "the impact of inequality on violent crime is large, even after controlling for the effects of poverty, race, and family composition". Moreover, some other authors have found evidence of a causal link between income inequality and crime rates across countries (Krohn (1976), Fajnzylber et al (2002) and Soares (2004)).

The social disorganization theory emphasizes that the existence of several factors such as poverty, family stability, residential mobility and ethnic heterogeneity push some members of communities to commit crimes and weakens the social control of this behavior (Shaw and McKay (1942)). This theory conjectures that income inequality cause crime in an indirect way due to the fact that inequality is related with poverty and this factor induces illegal acts.

Finally, strain theory based on Merton's (1938) work developed the idea of *anomie*, as the lack of social norms or the failure of a social structure to provide mechanisms and pathways necessary for people to achieve their goals, generating deviant behaviors such as crime. In this theory individual alienation can arise from income inequality, and are also related with other measures of deprivation such as poverty and unemployment. This idea is related with the argument that criminality is based on an individual process that consists of an assessment of economic incentives and social norms (Weibull and Villa (2005)).

1.2 Education and delinquency

Complementarily, the economics of crime literature also has found evidence that human capital accumulation can discourage illegal activities. For example, Freeman (1996) shows that educational attainment is a preventive policy for crime and finds an inverse relationship between these two variables. Tauchen, et al (1994) studied a sample of men who attended school relative to those who did not and find a negative relationship between the act of studying or working with the probability of committing criminal acts. They argue that studying and working are associated with greater participation in legal activities and therefore decrease the incentives to commit illegal acts. Lochner and Moretti (2001) also show that there is an inverse relationship between school attainment and crime rates. They find that youths that finish high school are more likely no to enter in delinquent activities. Moreover, they argue that education has a positive externality in reducing crime. In consequence, it is recognized that education-based policies play an important roll in reducing crime rates (Lochner (2004, 2010)).

The main contribution of this paper to the literature is to construct a general equilibrium model in which individuals that do not inherit enough wealth to study can have incentives to enter the illegal sector. Moreover, we show how the role of a poverty trap under economic inequality is crucial for the existence of persistent delinquency.

2 The model

2.1 Legal and Illegal Sectors

Consider an economy in a one-good world that can be used for consumption and investment. The good can be produced by two technologies, one which uses skilled labor and capital and another one that uses only unskilled labor. These define a two legal sector economy that demands workers. Nonetheless, in this economy some potential workers could choose to become delinquents and enter an illegal sector with the explicit purpose of acquiring the consumption good by targeting workers of the legal sector. We now describe these technologies.

Production in the legal skilled labor sector is described by:

$$Y_t^s = F(K_t, L_t^s) \tag{1}$$

where Y_t^s is output, K_t is capital and L_t^s is skilled labor, while F is a concave production function with constant returns to scale. It is assumed that investment in human capital and in physical capital is made one period in advance and that there are no adjustment costs to investment and no depreciation of capital. Production in the legal unskilled labor sector is described by:

$$Y_t^n = w^n \cdot L_t^n \tag{2}$$

where Y_t^n and L_t^n are output and unskilled labor respectively and $w^n > 0$ is the marginal product of labor in this sector.

The illegal sector is an abstraction of an organized sector dedicated exclusively to take away income from legal workers. It abstracts from the different types of illegal pecuniary activities that arise in the real world, like robbery in general, burglary, kidnapping, economic extortion etc, but that can be understood as having the same end in sight, namely material incentives by preying on legal workers.[3] The organization of the "firms" that operate in this sector is conceptualized in the following manner: members of the organization acquire the income from illegal activities and then share equally with all the other members. This simplifies away the hierarchy of the organization that would presumably divide in an unequal fashion the income acquired. The acquisition of the income in the illegal sector is described by the following "pseudo production function" which is assumed to be linear in the input labor where delinquents and workers are matched randomly:

$$E\left(Y_t^d\right) = (1-\pi)\rho[\theta_t W_t^n + \eta_t W_t^s] L_t^d. \tag{3}$$

The term $E\left(Y_t^d\right)$ denotes the expected income that is acquired through delinquency, θ_t and η_t are respectively the probabilities of encountering both unskilled and skilled workers in period t, L_t^d is the labor needed in the delinquency sector, $\rho \in [0,1)$ represents the fraction of the wealth that a delinquent is able to get from his victims in any given encounter, W_t^n and W_t^s are the unskilled and skilled wealth respectively. Since the model only has two kind of individuals, namely legal workers and delinquents, then it must be the case that $\theta_t + \eta_t = 1 - \lambda_t$ where λ_t is the probability in period t of encountering a delinquent in any given random match. We assume that encounters among delinquents do not generate any net gain for them. With probability $\pi \in (0,1)$ the delinquent is apprehended by law enforcement authorities in which case no wealth is maintained by the delinquent[4], while with probability $(1-\pi)$ a delinquent can obtain a net amount $\rho[\theta_t W_t^n + \eta_t W_t^s]$ of expected wealth since under random matching a delinquent "gains" $\theta_t W_t^n + \eta_t W_t^s$ from legal workers while "not gaining" anything from delinquents.

We can define an average expected "implicit wage" acquired by a delinquent in this economy as $w_t^d \equiv E\left(Y_t^d\right)/L_t^d$ given the assumption of income sharing among members of the illegal sector and therefore one can rearrange (3) to represent w_t^d as

$$\begin{aligned} w_t^d &\equiv E\left(Y_t^d\right)/L_t^d = (1-\pi)\rho\left[\theta_t W_t^n + \eta_t W_t^s\right] \\ &= (1-\pi)\rho\left[\left(1-\lambda_t-\eta_t\right)W_t^n + \eta_t W_t^s\right] \end{aligned} \tag{4}$$

by replacing $\theta_t = 1 - \eta_t - \lambda_t$. Note that w_t^d is a decreasing function in λ_t for a given value η_t which means that a higher probability of encountering a delinquent lowers the material incentives for all delinquents in this sector in expected terms. Hence, the illegal sector becomes less attractive when more delinquents enter the sector.

2.2 Overlapping Generations and Preferences

Individuals in this economy live two periods as young and old adults each in overlapping generations. In each generation there is a continuum of individuals of size L. Each individual has just one child

[3] This differs for illegal activities like illegal drugs which are goods that are considered to be illegal but are produced in the same way as legal goods.

[4] We assume that once an offense occurs with probability π law enforcement authorities are able to apprehend the delinquent and give back the wealth seized to the victim.

(there is no population growth), can work as unskilled in the first period of her life or invest in human capital when young and work as skilled worker when old, or choose a delinquency activity when young. For simplicity we shall assume that all individuals consume when old and only work one period. Unskilled workers and delinquents work when young while skilled workers do so when old. Delinquents enjoy their loot when old if they are not apprehended by law enforcement authorities when young. Moreover, we assume explicitly that decisions are irreversible which implies that a delinquent cannot go back to the legal unskilled sector when old.[5] Individuals that choose to educate themselves invest $h > 0$ when young and are able to work in the skilled labor sector when old given that we assume away unemployment in any sector.

All individuals consume when old, work in one period of their life, care in the same way about their children and can derive utility from leading a non delinquent life. This is modelled with a log utility specification in the following way

$$u = \alpha \log c + (1 - \alpha) \log b - d \log I,$$

where $0 < \alpha < 1$ captures the weight on consumption of an individual, c is consumption in the second period, b is the bequest left to his/her child, $I \geq 2$ is a psychic cost[6] of committing delinquent acts, $d = \{0, 1\}$ is a binary variable such that $d = 1$ means that an individual chooses to be a delinquent and zero otherwise. All individuals are born with the same potential abilities, same preferences and psychic cost from engaging in illegal activities. They differ only in the amounts they inherit from their parents in terms of wealth x_t where $D_t(x_t)$ is the cumulative distribution function of wealth x_t in period t. This distribution satisfies $\int_0^\infty dD_t(x_t) = L$.

We assume the existence of financial markets that allow individuals to save and earn interest on their savings at interest rate $r > 0$ given exogenously by world markets. The financial markets lend these funds to firms that pay interest rate r. Nonetheless, we assume an imperfection in the credit market for individual borrowers, namely that no access to credit is allowed to finance investment in human capital.[7] Hence, individuals born in period t that choose to invest in human capital can do so only if they have enough wealth to pay the investment h. This is a working assumption that can be relaxed with less stringent market imperfections in line with Galor-Zeira (1993) without affecting the main results that we find.

Legal firms can borrow at interest rate $r > 0$ also from world markets and as in Galor-Zeira (1993) we assume the absence of adjustment costs to investment, and given the fact that the number of skilled workers is known one period in advance, the amount of capital in the skilled labor sector is adjusted each period so that

$$F_K(K_t, L_t^s) = r.$$

[5]This assumption of irreversibility is strong but Tauchen, Witte and Griesinger (1994) found evidence of a negative relation between studying and/or working with the probability of engaging in criminal activities. They argue that this behavior comes from keeping individuals linked to legal activities through there contact with either an educational or labor institution and not necessarily due to a higher education attainment that brings higher wages.

[6]This phsychic cost can represent guilt or shame from commtting criminal acts.

[7]This might be rationalized by assuming that individuals that invest a certain amount (h) in their education through acquiring a credit can leave the country at zero cost without paying back the loan.

Hence there is a constant capital-labor ratio in this sector, which determines the wage of skilled labor w^s which is constant as well. This wage w^s depends on r and on technology only. We follow Galor-Zeira (1993) in assuming that both labor legal markets and the good market are perfectly competitive and expectations are fully rational.

2.3 Optimal Bequests

Recall λ_t denotes the probability in period t for a legal worker to encounter a delinquent. When the encounter occurs the delinquent steals fraction ρW_t from a worker with wealth W_t, otherwise the encounter does not occur and the worker loses nothing. Therefore an individual born in period t with wealth W_i chooses b_t^i in order to maximize expected utility

$$\max_{b_t} E\left(U_t^i\right) = \alpha[(1-\lambda_t)\log(W_t^i - b_t^i) + \lambda_t \log\left((1-\rho)W_t^i - b_t^i\right)] + (1-\alpha)\log b_t^i - d\log I \qquad (5)$$

for each occupational choice $i = \{n, s, d\}$ where n denotes unskilled sector, s denotes the skilled one and d the delinquent sector. We assume that stealing affects only directly the consumption of the individual since it is equal to $W_t^i - b_t^i$ if the individual is not matched with a delinquent and is $(1-\rho)W_t^i - b_t^i$ if matched with one. Hence, only indirectly the individual's bequest is affected through less consumption. The first order condition boils down to

$$\frac{\partial E\left(U_t^i\right)}{\partial b_t^i} = -\frac{\alpha(1-\lambda_t)}{(W_t^i - b_t^i)} - \frac{\alpha\lambda_t}{(1-\rho)W_t^i - b_t^i} + \frac{1-\alpha}{b_t^i} = 0 \qquad (6)$$

or equivalently

$$\frac{b_t^i(1-\lambda)}{W_t^i - b_t^i} + \frac{b_t^i\lambda_t}{(1-\rho)W_t^i - b_t^i} = \frac{1-\alpha}{\alpha}.$$

It turns out to be a quadratic function in b_t^i with solution

$$b_t^i = W_t^i\left\{\frac{\alpha}{2}\left[B(\lambda_t) - \sqrt{B(\lambda_t)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}}\right]\right\} \equiv W_t^i\Gamma(\lambda_t) \qquad (7)$$

where $B(\lambda_t) = 1-\rho(1-\lambda_t)+\left(\frac{1-\alpha}{\alpha}\right)(2-\rho) > 0$ since $\rho(1-\lambda_t) < 1$. Importantly the optimal bequest is a linear function of W_t^i and we take the negative root as the solution of the problem[8] showing in the appendix that $\Gamma'(\lambda) < 0$ and $0 < \Gamma(\lambda) < 1$ for all $\lambda \in [0,1]$ which guarantees that the optimal bequest is always positive. Interestingly the economic interpretation of $\Gamma'(\lambda) < 0$ is quite intuitive since it means that the more likely an individual is robbed the less likely she will be able to inherit to her child and therefore the more likely she will consume out of her wealth. This shows how the likelihood of being a delinquent victim affects negatively inheritances.

Replacing $b_t^i = W_t^i\Gamma(\lambda_t)$ in the expected utility function that is maximized in (5) yields the expected life time indirect utility function

$$EU^i = \log W_t^i - d\log I + \varepsilon(\lambda_t) \qquad (8)$$

where $\varepsilon(\lambda_t) = \alpha(1-\lambda_t)\log(1-\Gamma(\lambda_t)) + \lambda_t\log\left(1-\rho-\Gamma\left(\lambda_t\right)\right) + (1-\alpha)\log\Gamma(\lambda_t)$. Function (8) proves important to determine the different choices that individuals make.

[8] This is due to the economic intuition of the solution which shall be explained below.

2.4 Wealth Distribution and Short-Run Equilibrium

We now turn to describe individual optimal decisions. Overall wealth consists of inherited wealth denoted by x and income earned during the lifetime of an individual. Therefore the overall wealth levels of unskilled and skilled workers are respectively $W_t^n \equiv x_t + w^n$ and $W_t^s \equiv x_t + w^s$ for period t . Under the assumption of constant returns to scale wages of legal workers do not change over time hence $w_t^n = w^n$ and $w_t^s = w^s$ for all t hence the only heterogeneity in the population is inherited wealth x_t. Consider an individual that inherits $x_t \geq h$ who decides to work as skilled $(d = 0)$ and invest in human capital, her lifetime indirect utility is

$$EU^s(x_t) = \log\left[(w^s + (x_t - h)(1+r))\right] + \varepsilon(\lambda_t)$$

and leaves a bequest of

$$b^s(x_t) = [(w^s + (x - h)(1+r)]\Gamma(\lambda_t).$$

Consider now an individual who inherits an amount $0 < x_t < h$ of wealth in her first period of life and decides to work as unskilled $(d = 0)$ and not invest in human capital then her lifetime indirect utility is

$$EU^n(x_t) = \log\left[(x_t + w^n)(1+r)\right] + \varepsilon(\lambda_t),$$

and leaves a bequest of size

$$b^n(x_t) = [(x_t + w^n)(1+r)]\Gamma(\lambda_t).$$

Alternatively, an individual who inherits an amount[9] $0 \leq x_t < h$ of wealth in his first period of life and decides to become a delinquent $(d = 1)$ loses utility $\log I$ and has lifetime utility

$$EU^d(x_t) = \log\left[\left(x_t + w_t^d\right)(1+r)\right] - \log I + \varepsilon(\lambda_t)$$

and leaves a bequest of

$$b^d(x_t) = \left[\left(x_t + w_t^d\right)(1+r)\right]\Gamma(\lambda_t).$$

If the wage differential between skilled and unskilled is sufficiently wide, taking into account the investment cost h, all legal workers would prefer to work as skilled. To see this notice that $EU^s(x_t) \geq EU^n(x_t)$ is true if and only if

$$w^s - h(1+r) \geq w^n(1+r) \tag{9}$$

which is independent of wealth level x_t and is assumed through out. Without assuming (9) there would not be any incentive to invest in human capital.

The possibility of gaining access to education depends then on inherited wealth. Therefore individuals with inherited wealth x_t strictly less than h cannot educate themselves given that it has been assumed away any possibility for financing this investment with future earnings. These

[9] Since w_t^d is lower than w^s then individuals who have wealth at least equal to h choose optimally to be skilled workers and not to become delinquents.

individuals prefer to work as legal unskilled workers relative to becoming a delinquent as long as $EU^n(x_t) \geq EU^d(x_t)$, that is as long as[10]

$$(x_t + w^n)I \geq x_t + w_t^d \tag{10}$$

Note from (4) that $w_t^d = (1-\pi)\rho\left[(1-\lambda_t-\eta_t)W_t^n + \eta_t W_t^s\right]$ and by construction $W_t^n \equiv x_t + w^n$ and $W_t^s \equiv x_t + w^s$. Replacing these in (4) yields a threshold wealth level as a function of λ_t expressed as

$$x_t \geq f(\lambda_t) = \max\left\{0, \frac{(1-\pi)\rho\left[(1-\lambda_t-\eta_t)w^n + \eta_t w^s\right] - w^n I}{I - 1 - (1-\pi)\rho(1-\lambda_t)}\right\}. \tag{11}$$

Notice that the assumption $I \geq 2$ implies that the denominator in (11) is positive while if I is large enough under a small wage gap then the numerator can be negative which explains the max operator.

The amount an individual inherits in her first period of life, therefore, fully determines her decisions whether to invest in human capital or work as unskilled or become a delinquent, and how much to consume and bequeath. Hence, the distribution D_t fully determines economic performance in period t: the amount of skilled labor $L_t^s = \int_h^\infty dD_t(x)$, delinquency $L_t^d = \int_0^f dD_t(x)$ and unskilled labor $L_t^n = \int_f^h dD_t(x) \geq 0$ if $f \leq h$. The distribution of wealth determines the REE in period t since it determines the different actions taken by the individuals.

Rational expectations requires consistency of expectations and actions chosen such that

$$\begin{aligned} \eta_t &= \frac{\int_h^\infty dD_t(x_t)}{L} \\ \theta_t &= \frac{\int_{f_t}^h dD_t(x_t)}{L} \\ \lambda_t &= (1-\pi\xi)\frac{\int_0^{f_t} dD_t(x_t)}{L} \end{aligned} \tag{12}$$

where the fraction $\pi\xi\frac{\int_0^f dD_t(x_t)}{L}$ represents in equilibrium the fraction of delinquents that are apprehended and convicted in period t under random matching[11] and rationalizes that law enforcement authorities can incapacitate at most ξ of the fraction of apprehended delinquents in a given period by putting them in jail.[12] This motivates the following definition.

Definition 1 *A rational expectations equilibrium (REE) of the economy described above consists of a distribution of fractions $\nu_t = [\lambda_t, \theta_t, \eta_t]$ for period t where $\lambda_t + \theta_t + \eta_t = 1$ such that individuals maximize expected utility, firms maximize profits, markets balance and conditions (12) are met.*

[10] We have assumed in this calculation that an individual thinks about himself if becoming a delinquent as such that he does not vary the fraction of delinquents in the economy. This implies that the term $\varepsilon(\lambda_t)$ can be eliminated on both sides of the inequality.

[11] We denote as the conditional probability of convicting an individual given that he has been apprehended as $P(c|a) = \xi$. Hence the joint probability of apprehending and convicting a delinquent is $P(a,c) = P(a)P(c|a) = \pi\xi$.

[12] Importantly individuals that are put in jail in period t do not circulate in the economy in that period therefore they are modelled here "as if" they disappeared or vanished in the distribution of wealth for (only) period t.

Theorem 1 *If the economy described above satisfies (9) then there exists a REE with fraction $\lambda_t \in [0, 1-\eta_t]$ for any given t.*

Proof. First, firms and individuals maximize profits and expected utility respectively since wages are determined under zero profit condition given the assumption of constant returns to scale in both legal sectors. Under (9) we get $\eta_t = \frac{\int_h^\infty dD_t(x)}{L} > 0$ which is constant for all t. Hence to establish the existence of a REE one has to establish the existence of $\lambda_t \in [0, 1-\eta_t]$ that satisfies (12) recognizing that the cutoff wealth level f_t is a function of λ_t for given η_t from (11). Define the following continuous function as a function of λ_t

$$g(\lambda_t) \equiv \lambda_t - (1-\pi\xi)\frac{\int_0^{f(\lambda_t)} dD_t(x_t)}{L}$$

in the support $[0, 1-\eta_t]$. Note that

$$g(0) = -(1-\pi\xi)\frac{\int_0^{f(0)} dD_t(x)}{L} \leq 0$$

where it can be zero only if $f(0, \eta_t) = 0$ and that

$$g(1-\eta_t) = 1-\eta_t - (1-\pi\xi)\frac{\int_0^{f(1-\eta_t)} dD_t(x)}{L} > 0$$

which holds since the fraction of skilled workers and delinquents that are not captured by law enforcement authorities cannot exceed one. The continuity of $g(\cdot)$ establishes that there exists a λ_t that satisfies

$$\lambda_t = (1-\pi\xi)\frac{\int_0^{f(\lambda_t)} dD_t(x)}{L}.$$

■

Notice that consistent with what has been described above the less wealthy households are the ones self-selected into delinquency which entails a link between poverty, inequality and delinquency.

2.5 The Dynamics of Wealth Distribution

The distribution of wealth not only determines equilibrium in period t, but also determines next period distribution of inheritances:

$$x_{t+1} = \begin{cases} b^d(x_t) = \left[\left(x_t + w_t^d\right)(1+r)\right]\Gamma(\lambda_t) & \text{if } 0 \leq x_t < f_t \\ b^n(x_t) = [(x_t + w^n)(1+r)]\Gamma(\lambda_t) & \text{if } f_t \leq x_t < h \\ b^s(x_t) = [((x_t - h)(1+r) + w^s]\Gamma(\lambda_t) & \text{if } x_t \geq h \end{cases} \tag{13}$$

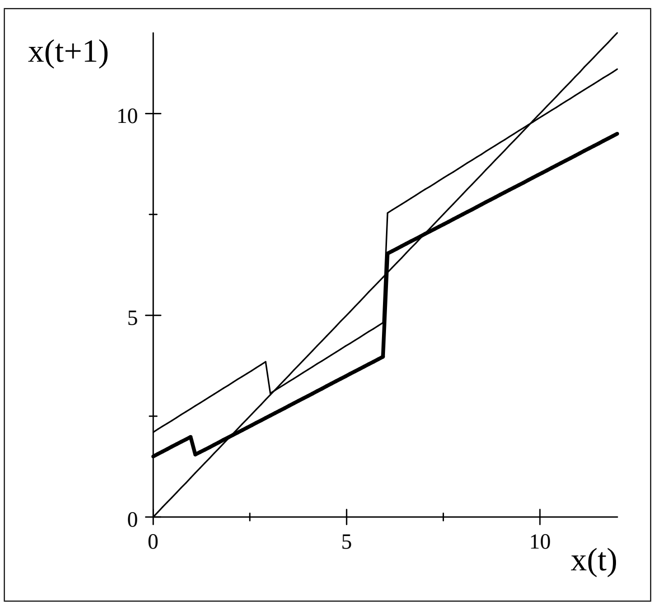
As seen above individuals who have x less than f_t choose delinquency while individuals who inherit between f_t and h work as unskilled and so are their descendants. Using $\overline{x}^n = b^n(\overline{x}^n)$ in (13), $\Gamma'(\lambda_t) < 0$ and assuming a sufficient condition $(1+r)\Gamma(0) < 1$ one has wealth level $\overline{x}_n$ given by

$$\overline{x}^n(\lambda_t) = \frac{w^n(1+r)}{\frac{1}{\Gamma(\lambda_t)} - (1+r)} \tag{14}$$

where $\lambda_t \in [0, 1-\eta_t]$ is a REE fraction of non apprehended delinquents. Individuals who inherit more than h invest in human capital hence using $\overline{x}^s = b^s(\overline{x}^s)$ in (13) and again under $\Gamma'(\lambda_t) < 0$, $(1+r)\Gamma(0) < 1$ one has wealth level $\overline{x}^s$ given by

$$\overline{x}^s(\lambda_t) = \frac{w^s - h(1+r)}{\frac{1}{\Gamma(\lambda_t)} - (1+r)}. \tag{15}$$

Under assumption (9) we have that $\overline{x}^s(\lambda_t) \geq \overline{x}^n(\lambda_t)$ for all $\lambda_t \in [0, 1-\eta_t]$. Note that wealth levels (14) and (15) are decreasing in λ_t given that $\Gamma'(\lambda) < 0$. Figure 1 illustrates a typical configuration of the short run dynamics of wealth accumulation in the economy given by (13) represented as a **bold** S-curve and a 45 degree line. The points in which the S-curve intersects with the 45 degree line correspond to $\overline{x}^n(\lambda_t)$ and $\overline{x}^s(\lambda_t)$ for a REE value λ_t while the vertical bars within the S curve correspond to f_t and h thresholds. Individuals with wealth levels less than h (including unskilled and delinquents) would move towards $\overline{x}^n(\lambda_t)$ while those with wealth level greater than h move towards $\overline{x}^s(\lambda_t)$. Nonetheless, these wealth levels depend explicitly on λ_t and should not be considered the long run steady state wealth levels since one would have to determine within the dynamic system the value $\lambda_\infty \equiv \lim_{t\to\infty} \lambda_t$ to which λ_t converges in the long run.



Let us examine the long run behavior of the dynamic system. In Figure 1 the bold curve satisfies $f_t < \overline{x}_n(\lambda_t)$ in period t and one would believe that since the bequest function for delinquents does not cross the 45 degree line the long run behavior of the system should entail $\lambda_\infty = 0$. Namely, in a REE delinquent households that are just below the cutoff point f_t, who are not apprehended by law enforcement authorities in period t, can secure a reward that increases their wealth in $f_t + \epsilon$ for a certain $\epsilon > 0$. Hence, the offspring of these households in the next period would have enough wealth to choose optimally not to become a delinquent in favor of working as a legal unskilled worker and avoiding the utility loss $\log I$. In the long run, delinquent dynastic households as they accumulate wealth would cross the threshold f_t eventually given that they are only delayed some finite number of periods by some law enforcement detentions[13] implying a vanishing fraction of delinquents in the long run. Hence $\overline{x}^n(\lambda_t)$ and $\overline{x}^s(\lambda_t)$ would converge to $\overline{x}^n(0)$ and $\overline{x}^s(0)$ respectively.

This analysis misses the point that threshold f_t is not fixed since it changes with the fraction of delinquents and legal unskilled workers (note that legal skilled workers are determined independently since η_t does not change in time). From (11) one can see that the cutoff point f_t and loot w_t^d decrease with λ_t which means that migration from the illegal sector towards the legal unskilled sector increases the opportunity cost of leaving this sector. Hence in Figure 1 on the bold curve, where $f_t < \overline{x}^n(\lambda_t)$ in period t, as time passes by f increases as a non-negligible fraction of households migrate from the illegal sector towards the legal unskilled one decreasing λ while $\overline{x}^n$ and $\overline{x}^s$ increase. Figure 1 illustrates this process such that $\lambda_\infty \equiv \lim_{t\to\infty}\lambda_t$ with the *thin* line that shows how the system moves in time starting from a position in which $f_t < \overline{x}^n(\lambda_t)$. There are two cases to consider: i) a vanishing fraction of delinquents such that $\lambda_\infty = 0$ and ii) persistent delinquency $\lambda_\infty > 0$. If $\lambda_\infty = 0$ then one has a basic Galor-Zeira model abstracting from credit markets for households. Nonetheless, we argue below that in the long run it is possible to have $\lambda_\infty > 0$ under certain conditions. If so given that $\Gamma' < 0$ then in the long run the economy suffers a wealth loss since both $\overline{x}^n$ and $\overline{x}^s$ would be lower than in the absence of delinquency. This shows how persistent delinquency destroys wealth. Regardless of either case this convergence process requires us to consider a steady state in which $\lambda_\infty \equiv \lim_{t\to\infty}\lambda_t$. Consequently a steady state in the long run is one in which the migration from and to the delinquent sector ceases and should correspond to a limiting threshold value $\lim_{t\to\infty} f_t \equiv f_\infty$. This motivates the following definition.

Definition 2 *A steady state rational expectations equilibrium (SREE) consists of a REE in which $\lim_{t\to\infty}\overline{x}^i(\lambda_t) = \overline{x}^i(\lambda_\infty)$ for $i = n, s$, and the long run wealth threshold f_∞ satisfies $f_\infty = \overline{x}^n(\lambda_\infty)$ if $\lambda_\infty \in (0, 1-\eta_t)$ or $f_\infty < \overline{x}^n(0)$ if $\lambda_\infty = 0$ or $f_\infty > \overline{x}^n(\lambda_\infty)$ if $\lambda_\infty = 1-\eta_t$.*

Consider again Figure 1 and let us focus on the dynamics of the bequest function $b^d(x_t)$ as time evolves. Since the process starts off such that $f_t < \overline{x}_n(\lambda_t)$ then some fraction of the offspring of (non apprehended) delinquent households cross f (namely those with wealth level arbitrarily close to f_t) and enter the legal unskilled sector inducing a decrease in λ_{t+1}. This in turn increases the threshold f_{t+1} and loot w_{t+1}^din period $t+1$. Note that in period $t+1$ it could happen that some households that were not delinquents in period t become delinquents in period $t+1$ if f_{t+1} is greater than their wealth level in period $t+1$. Moreover, even some of the (non apprehended) delinquent households that crossed threshold f_t can still remain delinquent households in period $t+1$ since their wealth level could still be less than f_{t+1}. The net effect in any case is that λ should decrease weakly eventually since under $f_s < \overline{x}_n(\lambda_s)$ for some $s > t$ there would be a fraction of non apprehended delinquent households that inherit to their offspring wealth that would induce some to

[13]The offspring of incapacitated convicted delinquent households will again decide to become delinquents when young since their inherited wealth level is less than the initial wealth level that the parent had in the previous period given that the loot w^d would not been gained and secured for next period.

decide optimally to leave a delinquent life in some future period. This process continues up to the point in which $f_\infty = \overline{x}_n(\lambda_\infty)$ if $\lambda_\infty \in (0, 1-\eta_t)$ or it could happen that delinquency vanishes before this equality is reached i.e. $f_\infty < \overline{x}_n(0)$ if $\lambda_\infty = 0$; finally it could be the case that $\lambda_\infty = 1-\eta_t$ corresponding to $f_\infty > \overline{x}_n(\lambda_\infty)$.

Moreover, to get $\lambda_\infty > 0$ in the long run one requires additionally that $b^d(f_\infty) < h$. To see why consider what would happen if we had $b^d(f_\infty) \geq h$. In this case the offspring of delinquent households with wealth level f_∞ would inherit enough wealth to educate themselves leapfrogging over the poverty trap and entering eventually the skilled sector. Hence, in the long run $\lambda_\infty = 0$. To get persistent delinquency one then requires the necessary condition $b^d(f_\infty) < h$.

It remains to show that under certain conditions there exists a SREE with a positive value $\lambda_\infty > 0$.

Theorem 2 *If $(1+r)\Gamma(0) < \frac{h}{w_n I + h}$, and $f(0) > \overline{x}^n(0)$ there exists a SREE of the economy described above such that $\lambda_\infty \in (0, 1-\eta_t]$.*

Proof. Consider a REE such that (14) and (15) are strictly positive, guaranteed by (9), $(1+r)\Gamma(0) < \frac{h}{w_n I + h} < 1$ and $\Gamma' < 0$. The condition $\overline{x}_n(0) < f(0)$ implies that $\lambda_\infty = 0$ is not consistent with a SREE. Hence it must be the case that $\lambda_\infty > 0$. To see this formally define the following function on the domain $[0, 1-\eta_t]$

$$
\begin{aligned}
m(\lambda) &= f(\lambda) - \overline{x}_n(\lambda) \\
&= \max\left\{0, \frac{(1-\pi)\rho\left[(1-\lambda-\eta_t)w^n + \eta_t w^s\right] - w^n I}{I - 1 - (1-\pi)\rho(1-\lambda)}\right\} - \frac{w^n(1+r)}{\frac{1}{\Gamma(\lambda)} - (1+r)}
\end{aligned}
$$

which is a continuous function of λ given that the *max* function is a continuous function of λ. The condition $(1+r)\Gamma(0) < 1$ coupled with $\Gamma(\lambda) \in (0,1)$ for all $\lambda \in [0, 1-\eta_t]$ implies that $\overline{x}_n(0)$ is bounded away from infinity and is positive. In this context the assumption $\overline{x}^n(0) < f(0)$ is logically possible and implies that $m(0) > 0$. Moreover evaluating m at $1-\eta_t$ yields

$$
m(1-\eta_t) = \max\left\{0, \frac{(1-\pi)\rho\eta_t w^s - w^n I}{I - 1 - (1-\pi)\rho\eta_t}\right\} - \frac{w^n(1+r)}{\frac{1}{\Gamma(1-\eta_t)} - (1+r)}
$$

which is negative if $I \geq \frac{(1-\pi)\rho\eta_t w^s}{w^n}$. Hence by continuity of $m(\cdot)$ there must exist a $\lambda_\infty \in (0, 1-\eta_t)$ such that $m(\lambda_\infty) = 0$. On the other hand if $I < \frac{(1-\pi)\rho\eta_t w^s}{w^n}$ then $m(1-\eta_t)$ could be positive or negative. If it is negative then the same argument as above follows. If positive then trivially we have $\lambda_\infty = 1-\eta_t > 0$. Hence in either case we conclude that $\lambda_\infty > 0$. We still need to check that $b^d(f_\infty) < h$ holds. Note that $(1+r)\Gamma(\lambda_\infty) < \frac{h}{w_n I + h} < 1$ since $(1+r)\Gamma(0) < \frac{h}{w_n I + h}$ and $\Gamma' < 0$.

Now let us manipulate $(1+r)\Gamma(\lambda_\infty) < \frac{h}{w_n I + h}$ conveniently

$$\begin{aligned}(1+r)\Gamma(\lambda_\infty)w_n I &< h\left[1-(1+r)\Gamma(\lambda_\infty)\right] \\ w_n\left[\frac{1}{1-(1+r)\Gamma(\lambda_\infty)}\right] &< \frac{h}{I(1+r)\Gamma(\lambda_\infty)} \\ \frac{w_n(1+r)}{\frac{1}{\Gamma(\lambda_\infty)}-(1+r)} &< \frac{h}{I(1+r)\Gamma(\lambda_\infty)} - w_n \\ f_\infty &= \overline{x}_n\left(\lambda_\infty\right) < \frac{h}{I(1+r)\Gamma(\lambda_\infty)} - w_n\end{aligned}$$

since in SREE with $\lambda_\infty \in (0, 1-\eta_t)$ we have $f_\infty = \overline{x}_n\left(\lambda_\infty\right)$ if $I \geq \frac{(1-\pi)\rho\eta_t w^s}{w^n}$. Moreover

$$\begin{aligned}\left(f_\infty + f_\infty\left(I-1\right) + w^n I\right) &< \frac{h}{(1+r)\Gamma(\lambda_\infty)} \\ f_\infty + w_\infty^d &< \frac{h}{(1+r)\Gamma(\lambda_\infty)}\end{aligned}$$

since from (10) $w_\infty^d = f_\infty\left(I-1\right) + w^n I$. Note that this last expression rearranged corresponds to $b^d(f_\infty) = \left(f_\infty + w_\infty^d\right)(1+r)\Gamma(\lambda_\infty) < h$. Hence, $b^d(f_\infty) < h$ is satisfied. Consider now the case in which $\lambda_\infty = 1-\eta_t > 0$ when $m\left(1-\eta_t\right) > 0$ which corresponds to $f_\infty > \overline{x}_n\left(\lambda_\infty\right)$ if $I < \frac{(1-\pi)\rho\eta_t w^s}{w^n}$. Note that this is the maximal value that λ can take and given that f is decreasing in λ while b^d is increasing in f we must still have that b^d is lower than h. ∎

Some remarks are in order.

i) Condition $(1+r)\Gamma(0) < \frac{h}{w_n I + h}$ is more likely to arise when the economy has a higher education investment cost h (respectively a lower unskilled wage w_n for a given level of I) ceteris paribus. This means that a society in which h is relatively higher w.r.t. $w_n I$ is more likely to have persistent delinquency.

ii) The condition $f\left(0\right) > \overline{x}^n\left(0\right)$ is more likely to arise in societies with a higher wage inequality under the existence of a poverty trap i.e. it arises in societies with a w^n low enough relative to w^s such that a poverty trap arises. To see this note that f_t is a decreasing function[14] in w^n while $\overline{x}^n$ is increasing in w^n. Hence for values of w^n low enough this condition $f\left(0\right) > \overline{x}^n\left(0\right)$ is more likely to arise. We see then a close connection between high inequality, poverty trap and persistent delinquency. High inequality per se does not lead to this result since it is possible for an economy to have a highly unequal wealth distribution but have $f_\infty < \overline{x}_n\left(0\right)$ in the long run implying $\lambda_\infty = 0$.

iii) Consider Figure 1 again and let us focus on the *thin* line that represents the steady state for $\lambda_\infty \in (0, 1-\eta_t)$ in the case $f_\infty = \overline{x}_n\left(\lambda_\infty\right)$. Note that the outflow migration from the illegal delinquent sector to the legal unskilled one is just the same as the inflow migration from the former to the latter. Hence, there is a continuous flow of households leaving for some periods the illegal sector just to come back eventually to it due to the poverty trap. So it is perfectly possible to have dynastic households that go in and out of delinquency infinitely many times. This circular flow

[14] From (11) when taking the derivative w.r.t. w^n in the positive case we get $\frac{\partial f_t}{\partial w^n} = \left(1-\pi\right)\rho\theta_t - I < 0$ since I is by definition greater than one.

is maintained because of the condition $b^d(f_\infty) < h$ that does not allow delinquent households to leapfrog over the poverty trap.

3 Comparative Dynamics under Technological Shocks

In this section we study the dynamic behavior of the economy when there are technological shocks to productivity and trace out the effect in the model.

Let us suppose the economy is in its long run SREE such that $f_\infty = \overline{x}_n(\lambda_\infty)$ consistent with $\lambda_\infty \in (0, 1-\eta_t)$. Consider first increasing w^s due to a possible *temporal* one time exogenous technological shock. Let us trace out the effect within the model. In this case initially b^s shifts outward as well as $\overline{x}^s$. Then w^d is shifted upward as well as the threshold f. Therefore f becomes greater than $\overline{x}^n$ making the illegal sector attractive in the short run for individuals with this wealth. This increases subsequently λ in a discrete manner which in turn lowers $\overline{x}^n$ while also lowering $\overline{x}^s$ from its initial upward shift. In the long run f decreases again up to the point in which it is reestablished that $f_\infty = \overline{x}^n$ at the same wealth level before the shock. Hence, a temporal increase in w^s produces an outburst of delinquency that eventually dies out later. If the shock is *permanent* the logic is the same but there is a permanent increase in λ_∞ since there is a permanent increase in the incentives to enter the illegal sector. Now the long run wealth level $\overline{x}^s$ does not go back to the initial one while $\overline{x}^n$ decreases permanently. This is due to the assumption of random matching that makes all workers possible victims of these new delinquents. This shows that a positive shock to the skilled wage sector decreases wealth level for the unskilled through the permanent increase in delinquency that the economy suffers and thus increases economic inequality i.e. wage gap increases as well as the steady state wealth levels. This result is consistent with what Fajnzylber et al (2001, 2002) have found empirically: a positive relation between income inequality and crime rates using cross country data.

Consider now a *temporal* one time exogenous negative shock on w^n. In this case b^n decreases as well as $\overline{x}^n$. Consequently there is an increase in the incentives to enter the illegal sector since $\overline{x}^n$ decreases while f increases due to the fact that $\frac{\partial f_t}{\partial w^n} = (1-\pi)\rho\theta_t - I < 0$. This induces a temporal increase in λ and produces a dynamic similar to the previous case because we have again $\overline{x}^n < f$. This overflow of delinquency reduces eventually f making delinquency decrease again to the initial level while $\overline{x}^n$ increases such that $f_\infty = \overline{x}^n$ is reestablished at the same level before the shock. Hence, a temporal increase in w^s produces an outburst of delinquency that eventually dies out later. Again if the shock is *permanent* the wealth level $\overline{x}^n$ is lower than in the temporal case since there is a net increase in delinquency. Moreover, the wealth level $\overline{x}^s$ also decreases at a lower level permanently due to this net increase in delinquency. In this case there is an increase in the wage gap but not necessarily the wealth gap between steady states increases even though most probably it will.

4 Policy Analysis

There are three policy variables in the model that can be changed in order to reduce delinquency: the probability of apprehension π, the conditional probability of convicting a delinquent given that the delinquent is captured ξ and the human capital investment h.

4.1 Law Enforcement Policies

The probability of apprehension π and the conditional probability of convicting a delinquent given that the delinquent is captured ξ represent policy variables of law enforcement that deter and incapacitate delinquents. The former is related with police force that deter and apprehend delinquents while the latter is related with the judicial system that convicts felons. Both dimensions of law enforcement are needed in order to "punish" delinquents that are found guilty in a court of justice. Naturally both complement themselves in the model since in (12) one sees that it is the product $\pi\xi$ that matters for incapacitating delinquents while only π matters to deter potential felons according to (11).

Let us suppose again the economy is in its long run SREE such that $f_\infty = \overline{x}^n(\lambda_\infty)$ consistent with persistent delinquency $\lambda_\infty \in (0, 1-\eta_t)$. Consider increasing π *temporarily* for one period. The short run effect is to decrease f and w^d. Hence the dynamic system is in the case in which $f_t < \overline{x}^n(\lambda_t)$ generating an incentive to migrate from the illegal sector in future periods. The migration in turn increases $\overline{x}^n$ inducing a higher rate of migration from the illegal sector into the legal unskilled one such that it decreases afterwards λ reestablishing again $f_\infty = \overline{x}^n(\lambda_\infty)$ at the same level than before the temporal increase. The temporal reduction in delinquency is *attenuated* by the magnitude of ξ since lower values of this parameter induces more attenuation of the initial effect of increasing π.[15] This simply says that if an increase in police enforcement is not accompanied by a previously high level of efficiency of the judicial system the effect could be quite modest. If the π increase is *permanent* there would be a permanent decrease in λ yielding a permanent increase in f , $\overline{x}^n$ and $\overline{x}^s$ such that $f_\infty = \overline{x}^n(\lambda_\infty)$ is satisfied at a higher wealth level.

A *temporal* increase in ξ reduces λ through the fixed point equation (12) inducing a temporal increase in $\overline{x}^n$ and f such that $f_\infty = \overline{x}^n(\lambda_\infty)$ is maintained as an equality but at a higher level. When ξ is reduced again to its original value then λ increases to its previous level and $f_\infty = \overline{x}^n(\lambda_\infty)$ goes down to the original wealth level. Again this temporal effect is attenuated depending on the value of π since lower this parameter is the smaller is the temporal effect of increasing ξ. Actually if π would be zero then no effect would arise of increasing ξ. Again if the increase of ξ is *permanent* then there would be a permanent reduction in λ while also increasing $f_\infty = \overline{x}^n(\lambda_\infty)$ permanently to a greater value.

To increase both π and ξ would require an increase in government spending that could only be financed by taxes. Given that there is a poverty trap this tax scheme would involve only taxing

[15] From (12) we see that if $\xi \simeq 0$ the temporal effect of increasing π works only through decreasing f and is smaller the effect relative to the case in which $\xi \simeq 1$.

skilled workers and/or capital gains of the skilled sector because otherwise poverty could be increased inducing higher crime rates. This progressive tax scheme in turn would reduce the income and wealth inequality reducing the delinquent incentives also. Nonetheless, increasing law enforcement policies through a progressive taxation is not Pareto improving since it would require redistribution of income from the skilled sector that benefits both legal sectors.

4.2 Education Based Policies

Let us consider education based policies that reduce human capital investment h like policies that subsidize education tuitions such as scholarships or even public schooling. Let us suppose again the economy is in its long run SREE such that $f_\infty = \overline{x}^n(\lambda_\infty)$ consistent with persistent delinquency $\lambda_\infty \in (0, 1-\eta_t)$. Consider that h is reduced *temporarily* (for some periods at least) but sufficiently such that it is below $f_\infty = \overline{x}^n(\lambda_\infty)$ then both delinquency and the poverty trap would be eliminated eventually with a rising delinquent fraction in the short run since as more educated individuals enter the skilled sector the loot w^d rises. Importantly, this *temporal* policy could have permanent effects in the model since it would lead to $\lambda_\infty = 0$. Of course this could be too big a subsidy for a society to handle. Therefore let us consider a *temporal* policy of reducing h somewhat but still above $f_\infty = \overline{x}^n(\lambda_\infty)$. Two cases are to be considered: i) if h is subsidized such that $b^d(f_\infty) < h'$ for $h' < h$ then no effect would arise since initially the largest bequest a delinquent could give is still lower than h' and therefore no change in delinquent incentives arises; ii) if h is subsidized such that $b^d(f_\infty) \geq h'$ then a fraction of the offspring of non apprehended delinquent households would optimally choose to enter the skilled sector. This would rise η_t reducing the support $(0, 1-\eta_t)$ while increasing in the short run the loot w^d and threshold f. Hence, λ increases due to the dynamics of the model which in turn reduces afterwards f making λ decrease again. Summarizing, in the short run the effect of subsidizing h is to reduce delinquency but then the dynamics imply that there is an increase in delinquency that eventually fades making $f_\infty = \overline{x}^n(\lambda_\infty)$ increase to a greater wealth level at the end.

In the model the indivisibility of human capital investment to enter the skilled sector abstracts from the complex education system a society has today. Nonetheless, it allows us to focus on the minimum standard of education needed to enter the skilled sector which can differ across societies. In some societies this minimum amount is higher than in others, e.g. traditional societies would require to have just primary schooling to enter the skilled sector while in more developed societies it would require to have at least a college degree. Even so, Lochner and Moretti (2001) are able to find for the United States that youths that complete secondary school are less likely to be involved in illegal acts. The model developed here goes well in line with this evidence since individuals that can invest enough to enter the skilled sector (i.e. complete the degree) end up not choosing optimally delinquency.

As Galor-Zeira (1993) argue in their model to finance the subsidy of a reduction in h for an economy would require taxing skilled wages[16] which eventually reduces the delinquent incentives

[16] In real economies it could also require taxing capital gains in the skilled sector but in the model developed above

benefiting the whole society. This policy again is not a Pareto improvement due to the fact that skilled workers would have to give up wealth and income in order to implement it.

5 Conclusions

Delinquency seems more persistent than one might think in both developed as well as under developed economies. We study an overlapping generations model under perfect competition that abstracts from unemployment similar to Galor-Zeira (1993) that allows to explore the theoretical linkages between poverty traps, economic inequality and educational attainment. It takes seriously the idea that delinquents choose rationally a criminal life when there is a lack of opportunities to enter a skilled sector that requires previously to attain a certain level of education. It builds on a dual economy in which delinquents prey on legal workers. We characterize the optimal bequest of dynastic households in the three occupational activities (delinquency, unskilled and skilled workers) that govern the wealth accumulation of the economy. ¨We show that a short run delinquency fraction always exist and define a steady state of the dynamic system compatible with the possibility of persistent delinquency in the long run. We find that for given levels of law enforcement measures of deterrence and incapacitation delinquency is persistent in the long run if wage differentials are high enough relative to costly indivisible human capital investments and wealth inequality is large enough such that it is compatible with a poverty trap. We study technological shocks that vary both unskilled and skilled wages and find conditions in which an outburst of delinquency arises in the short run and even in the long run. We study both deterrence and incapacitation policies as well as education based policies to reduce long run delinquency. We find that even though in the long run these policies may not eliminate completely delinquency they can attenuate it. We show that contrary to common intuition education based policies that subsidize human capital investments can increase in the short run delinquency even though in the long run they attenuate it permanently.

Further research would be to allow for unemployment in the model as well as endogenizing w^n in the same fashion as Galor-Zeira (1993). Another extension could be to generalize the model to consider illegal activities such as narcotics or gambling that are not necessarily seen as preying on workers but more as activities that sell workers services that are ilicit in the economy.

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we have a zero profit condition compatible with perfect competition in both legal sectors which impedes this possibility.

Appendix

Proposition 1 *Under the assumptions of the model* $\Gamma'(\lambda) < 0$ *and* $0 < \Gamma(\lambda) < 1$ *for all* $\lambda \in [0,1]$.

Proof. First we show that $\Gamma'(\lambda) < 0$ for all $\lambda \in [0,1]$. From (7) differentiating with respect to λ we get

$$\Gamma'(\lambda) = \frac{\alpha}{2}\left[\rho - \frac{1}{2}\left(B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}\right)^{-\frac{1}{2}}(2B(\lambda)\rho)\right]$$

since $B'(\lambda) = \rho$. It is sufficient to show that

$$1 < \left(B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}\right)^{-\frac{1}{2}} B(\lambda).$$

which is satisfied since

$$\begin{aligned}
\left(B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}\right)^{\frac{1}{2}} &< B(\lambda) \\
B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2} &< B(\lambda)^2 \\
\frac{4(1-\alpha)(1-\rho)}{\alpha^2} &> 0.
\end{aligned}$$

We have used the fact that $B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2} > 0$ for all $\lambda \in [0,1]$. To see why this is the case define

$$h(\lambda) \equiv B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}$$

and note that $h'(\lambda) = 2\rho B(\lambda) > 0$ and $h''(\lambda) = 2\rho^2 > 0$ for all $\lambda \in [0,1]$. Hence the function is strictly convex, increasing and does not attain a minimum in the interval $[0,1]$ since $h'(\lambda) > 0$ because $B(\lambda) > 0$ for all $\lambda \in [0,1]$.

Second we show $0 < \Gamma(\lambda) < 1$ for all $\lambda \in [0,1]$. First let us show that $\Gamma(\lambda) > 0$ for all $\lambda \in [0,1]$. From (7) it is sufficient to show that $B(\lambda) - \sqrt{B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}}$ is positive for all $\lambda \in [0,1]$. Note

$$\begin{aligned}
B(\lambda) &> \sqrt{B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}} \\
B(\lambda)^2 &> B(\lambda)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2} \\
\frac{4(1-\alpha)(1-\rho)}{\alpha^2} &> 0.
\end{aligned}$$

Finally to show that $\Gamma(\lambda) < 1$ for all $\lambda \in [0,1]$ it is sufficient to show $\Gamma(0) < 1$ since we have shown $\Gamma'(\lambda) < 0$ for all $\lambda \in [0,1]$ .Notice that for the negative root

$$\Gamma(0) = \frac{\alpha}{2}\left[B(0) - \sqrt{B(0)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}}\right] < 1$$

if the following holds

$$B(0) < \frac{2}{\alpha} + \sqrt{B(0)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}}.$$

We know that $\sqrt{B(0)^2 - \frac{4(1-\alpha)(1-\rho)}{\alpha^2}} > 0$ is adding to $\frac{2}{\alpha}$, then we just need to show that $B(0) < \frac{2}{\alpha}$ which comes down to showing that

$$1 - \rho + \left(\frac{1-\alpha}{\alpha}\right)(2-\rho) < \frac{2}{\alpha}$$

which is satisfied since this yields $(1-\alpha)(2-\rho) + \alpha(1-\rho) < 2$ or $-\alpha - \rho < 0$. ■

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