EDUCATION, RENT SEEKING AND GROWTH

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Abstract

This paper studies the role of education as a way of reducing private rent seeking activities and increasing output. In many underdeveloped economies, for most individuals, there is no private return to education. Nonetheless, according to this paper, governments are better off by investing in public education. We view education as a means to build personal character, thereby affecting macroeconomic long run equilibrium by reducing the number of individuals who are engaged in private rent-seeking activities. We show that education is more efficient than ordinary law enforcement because it has a long-run effect. The policy implication of this result is that even when education does not increase human capital, compulsory schooling will be beneficial in pulling underdeveloped economies out of poverty.

Key words: Rent Seeking, Decency, Education, Growth

1. Introduction

Macroeconomists usually view education as a means of accumulating human capital. According to this view, individuals acquire skills that enable them to use better technologies and become more productive.[1] In recent years, however, a body of empirical literature has shown that the observed differences in the factors employed in production does not explain most of the cross-country variation in income (e.g., Caselli (2005)). Other recent papers have shown that education has positive social externalities that are not necessarily related to the private accumulation of human capital.[2] One of the most important social effects of education is crime reduction. Lochner and Moretti (2004) showed that schooling significantly reduces the probability of incarceration and arrest because of its negative effect on criminal behavior. Other studies such as Puech (2005), and Buonanno Leonida (2006, 2009) have found a similar relationship between schooling and crime.[3] In this paper we examine how investing in public education might result in lower crime rates, and eventually higher output. We also examine the relative benefits of investing in education versus investing in a police force.

The paper has two theoretical contributions. First, even when there is no private return to education, public education still has a positive long run effect on output through its positive effect on moral character. Second, in many cases, underdeveloped economies are better off in public education than the police force.

[1] See Schultz (1965), Becker (1965, 1993), Nelson and Phelps (1966), Ben-Porath (1967), Mincer (1974) Lucas (1988), Galor and Zeira (1993), Galor and Moav (2004) and Galor and Moav (2006), Zeira (2009).

[2] Acemoglu and Angrist (2000) relate social externalities to education. Usher (1997) discusses the positive social effect of education, and Ehrlich (1975) its positive effect on moral character.

[3] Puech (2005) studied the influence of education on crime in Minas Gerais in Brazil showed that education significantly reduces interpersonal crime. Buonanno and Leonida (2006) examined the impact of education on criminal activity in Italy and showed that education is negatively correlated with delinquency. In a later study (2009) they demonstrated that education reduces crime more effectively than labor market opportunities.

The paper presents a simple rent seeking model similar to that of Murphy, Shleifer and Vishny (1993). Like their model, a high level of rent seeking activity diminishes the return of the legal productive activity (i.e., if the number of thieves in the economy is high, it is less profitable to become a legal producer). However, our model differs in that it assumes that the decision of whether to become producers or thieves does not depend solely on the relative return to each activity, but also on individuals' moral character (decent or indecent). The direct consequence of this assumption is that aggregate output equilibria depend not only on the relative return to each activity, but also and most importantly, on the proportion of decent and indecent individuals in the economy.

Individuals live for two periods- childhood and adulthood. In childhood, moral character develops toward either the decent or indecent type. When reaching adulthood, he chooses whether to engage in legal productive activities or to become a thief. If the adult has developed into a decent type he may only engage in legal activities.

While education does not affect an individual's abilities or skills, it does affect the probability to become decent adults. This has two results. First, public education might pull underdeveloped economies out of poverty. Second, these economies are better off investing in public education than in the police force. The second result stems from the long run effect of education versus the short run effect of policing.

In the main text we provide a basic model with a comparative static analysis that demonstrates how aggregate output in equilibrium is related to the number of decent individuals in the economy. Next, we provide two mechanisms by which education affects aggregate output through the dynamics of the level of decency.

The first mechanism is based on the assumption that in poor economies, the cost of education dominates the potential time saving value of education (babysitter effect), but when economies become wealthier, this trend is reversed and the babysitter effect dominates the cost of public education. As a result, in poor economies the number of indecent individuals is high and the economy is trapped in poverty. Compulsory schooling that educates children to decency increases the number of decent individuals in the long run and eventually pulls the economy out of its poverty trap.

In the second mechanism, decency is affected by cultural norms and values that pass from one generation to the next through social interactions between old and young individuals. In this setting, the impact of education is manifested not only in its direct affect on moral character, but also in its indirect affect on cultural legacies. This mechanism leads to a threshold effect as follows. If the number of decent individuals is below some critical point, the level of interaction between decent adults and young individuals is low, the number of decent individuals declines and the economy is trapped in poverty. If, on the other hand, the number of decent individuals is slightly above that critical point, the interaction between decent adults and young individuals is sufficiently high, the number of decent individuals rises and the economy starts to grow, up to a high level of decency and output.

When the number of indecent individuals is high, the economy is trapped in poverty because the cost of education dominates the potential time saving value of education (babysitter effect), compulsory schooling might negate the threshold effect and pull the economy out of poverty. Furthermore, unlike the first mechanism, when the number of decent individuals exceeds a critical point, education is no longer necessary.

The notion that education has a positive impact on individuals' decency is related to Lochner and Moretti (2004) who discuss possible mechanisms of the effect of education on crime, as well as to the strong empirical evidence that the effect of education on crime rates does exist. It is also related to the developmental psychological theories of Piaget (1932) and Kohlberg (1973). Kohlberg attributes a positive impact on morality to education itself, whereas Piaget attributes it to socialization with one's peer group. More recent psychologists dealing with moral development such as Gilligan (1982) and Turiel (1998) recognize the importance of formal education in understanding and clarifying moral principles and manners of behavior.

As our paper analyzes rent seeking behavior, it also relates to a large literature showing that property rights protection positively affects growth.[4] In recent years the empirical literature has used several factors for measuring property rights and its effects on growth and output; for example protection against expropriation risk (see Acemoglu, Johnson and Robinson (2005)), property registration under the law (see Rohini Pande and Christopher Udry (2005)) and government repudiation of contract and corruption (see Knack and Keefer (1995, 1997)). All of the above papers deal with legal and economic institutions. Our paper focuses on education and it effect on *interpersonal* property crimes, providing a mechanism that negatively links such crimes and public education.

While all modern economies have both public education and a police force, we show that in the context of underdeveloped economies, public education is a better economic institution. Our model predicts that the long run benefits of public

[4] See North and Thomas (1973), Mauro (1995), Barro (1997), Grossman and Kim (1995), Tornell, (1997, 1999), Hall and Jones, (1999), Chong and Calderon (2000), Acemoglu and Robinson (2000), Gradstein (2003), Acemoglu, Johnson and Robinson (2005). For survey, see also Besley and Ghatak (2009).

education will always contribute to output, whereas the introduction of a police force may not.

The paper is organized as follows. Section 2 presents the basic model. Section 3 discusses the effect of education on decency and output. Section 4 concludes.

2. The Basic Model

Consider an overlapping generations' open economy in a one-good world. In each period *t* a generation of individuals of measure one is born. Each individual has a single parent and each individual lives through two periods; childhood and adulthood. An individual consumes only in adulthood. At the end of his childhood period each individual develops either a decent personality (denoted by $\theta=d$) or an indecent personality (denoted by $\theta=nd$).

Each adult in the economy can choose one of the two following types of occupations: a decent occupation in which individuals work and produce their own income and an indecent occupation in which individuals gain their income by means of private rent-seeking activities. We denote decent and indecent occupations by *O=D,ND*, respectively. We assume that each adult has preferences over consumption and occupation that depend on his moral type. Individual preferences are presented by the following utility function:

$$U(C,O\mid\theta)=\begin{cases} C & \theta=nd \\ \begin{cases} C & O=D \\ \min\{\gamma-\upsilon,C\} & O=ND \end{cases} & \theta=d \end{cases} \tag{1}$$

where $\gamma-\upsilon$ is a subsistence level of consumption on which people can survive. This utility function implies that an indecent adult gains utility from consumption only,

whereas the utility of a decent adult depends not only on his consumption level but also on the moral aspects of his occupation.

Occupational Choice and Income

We adopt the main features of the Murphy, Shleifer and Vishny (1993) rent seeking model. There are two productive activities in the economy: a handcraft activity in which an individual can produce α units of output for the market (a technical product), and a subsistence crop in which case the individual can produce γ units of output such that $\gamma < \alpha$.[5]

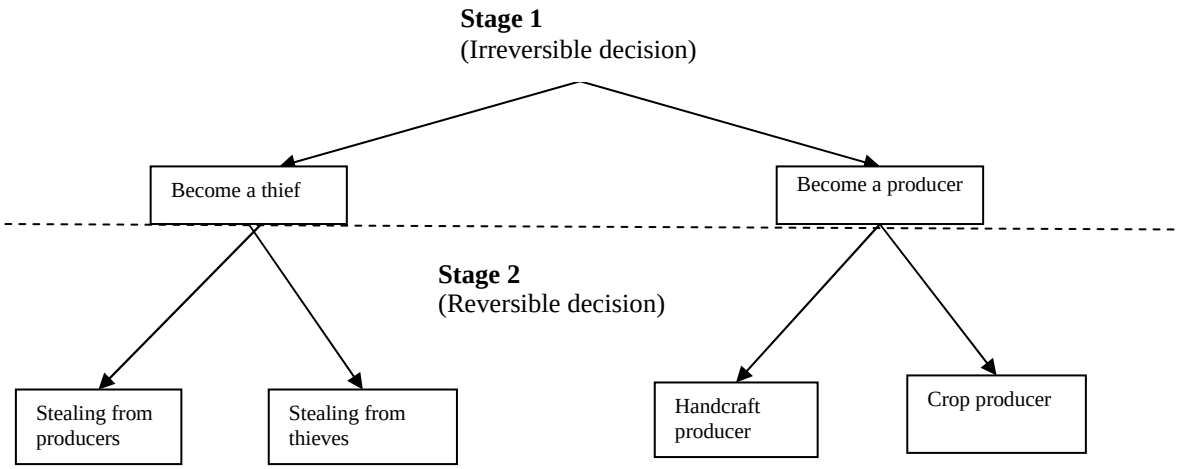
The subsistence crop is not subject to rent seeking as it cannot be stolen or expropriated. In contrast, the handcraft product is subject to theft. We assume that the rent seeking technology is subject to diminishing returns. If an adult is engaged in such an activity the maximum amount of output he can expropriate is β. Note that our assumptions on preferences and output imply that a decent adult will never steal, whereas an indecent individual may optimally choose to be engaged in either theft or productive activity, depending on the return to each activity.

At the beginning of each period *t* all adults in the economy must make decisions in two sequential stages. In the first stage, they must decide whether to be producers or thieves. In the second stage, producers must decide whether to work as handcraft producers and to produce α units for the market or to produce a subsistence crop γ. Thieves must decide whether to steal from producers or from other thieves. The first stage decision is taken simultaneously by all adults in the economy and is irreversible. The second decision, however, is reversible in that thieves can always switch from stealing from producers to stealing from thieves, and producers can always switch

[5] In Murphy, Shleifer and Vishny (1993) these products are called 'cash crop' and a 'subsistence crop', but otherwise they act the same way as our products.

from handcraft producers to subsistent crop producers and vice versa (see Figure 1 below).[6]

Figure 1



Henceforth, we denote the number of decent adults in the economy by λ (where 0≤λ≤1), and the number of indecent individuals who decide to be engaged in theft by δ (where $0 \le \delta \le 1-\lambda$). The expected income of individuals who are engaged in the handcraft activity negatively depends on δ; thus $u = \alpha - \beta\left(\frac{\delta}{1-\delta}\right)$. Furthermore, if the number of indecent individuals who are engaged in theft (δ) is sufficiently small such that $\frac{\delta}{1-\delta} < \frac{\alpha-\gamma}{\beta}$ then $\alpha - \beta\left(\frac{\delta}{1-\delta}\right) > \gamma$ and handcraft production is more lucrative than crop production. Under such conditions thieves' income is β.

If the number of indecent individuals who are engaged in theft rises such that $\frac{\delta}{1-\delta} \ge \frac{\alpha-\gamma}{\beta}$ then the net income from handcraft production falls to $\alpha - \beta\left(\frac{\delta}{1-\delta}\right) \le \gamma$. However, since individuals who are engaged in productive activity can always switch to subsistence crop γ, thieves have an incentive to start stealing from themselves.

[6] The assumption that the adults' decision in the second stage is reversible was made to simplify the model and to support an equilibrium that is consistent with that of Murphy, Shleifer and Vishny (1993). The results of the paper also carry through with the assumption that the decision in the second stage is irreversible; however each handcraft producer can ensure himself γ units of output.

Under such conditions thieves' expected income becomes $(\alpha-\gamma)\cdot(\frac{1-\delta}{\delta})$ which decreases as their number grows. From the analysis above, we conclude that the utility of producers as a function of δ is given by:

$$u(O=D)=\begin{cases}\alpha-\beta\left(\frac{\delta}{1-\delta}\right) & \frac{\delta}{1-\delta}\le \min\left\{\frac{\alpha-\gamma}{\beta},\frac{1-\lambda}{\lambda}\right\}\\ \gamma & \text{Otherwise (if } \frac{\alpha-\gamma}{\beta}<\frac{\delta}{1-\delta}\le\frac{1-\lambda}{\lambda})\end{cases} \quad (2)$$

and the utility of thieves as a function of δ is given by:

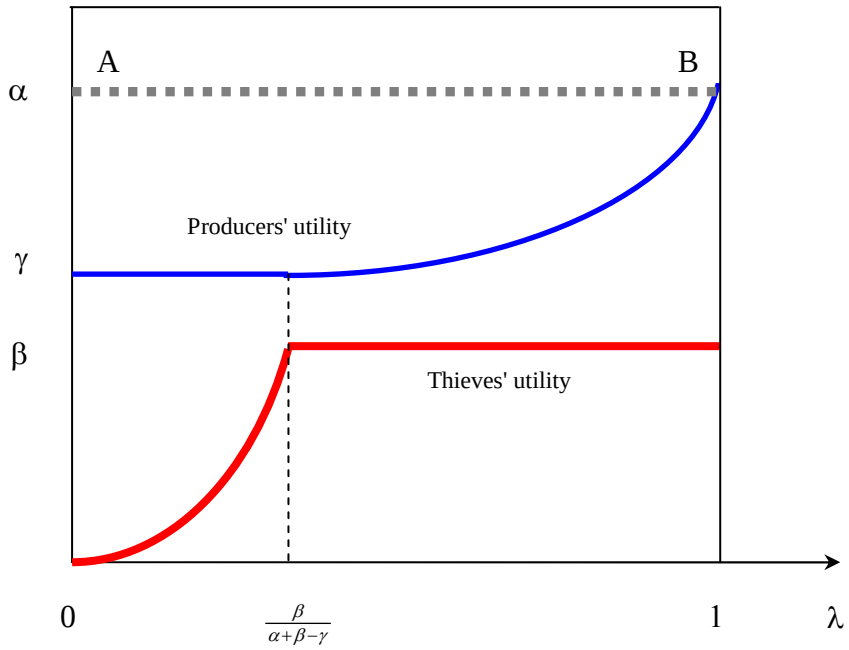
$$u(O=ND,\theta=l)=\begin{cases}\beta & \frac{\delta}{1-\delta}\le \min\left\{\frac{\alpha-\gamma}{\beta},\frac{1-\lambda}{\lambda}\right\}\\ (\alpha-\gamma)\cdot(\frac{1-\delta}{\delta}) & \text{otherwise if } \frac{\alpha-\gamma}{\beta}<\frac{\delta}{1-\delta}\le\frac{1-\lambda}{\lambda}\end{cases} \quad (3)$$

Figures 2-a, 2-b and 2-c below show the utility level of decent and indecent individuals as a function of δ in the hypothetical case where $\delta=1-\lambda$. Figure 2-a presents the case where $\beta<\gamma$, Figure 2-b presents the case where $\alpha<\beta$ and Figure 2-c presents the case where $\gamma<\beta<\alpha$. We now show how equilibrium is determined in each case as a function of λ.

Case 1: $\beta<\gamma$

In this case the return from theft is very low since the maximum amount that each thief may obtain is lower than the crop producers' output. Here the poverty trap does not exist since the strategy of becoming a thief is strictly dominated by the strategy of becoming a producer (regardless of λ). Under such conditions, all adults become handcraft producers, and the economy's output is α (see the dashed gray line $\overline{A}\overline{B}$ in Figure 1-a below).

Figure 2-a (case 1)



Case 2: $\beta > \alpha$

In this case the maximum amount that a thief can expropriate is higher than the maximum output of any productive activity and so output depends on the number of indecent adults $1-\lambda$. If $1-\lambda$ is relatively low then the economy produces high output (close to α). If, on the other hand, $1-\lambda$ is relatively high, the economy is trapped in poverty and produces low output (close to γ).

Specifically,

- If $\lambda \in (\frac{\beta}{\alpha+\beta-\gamma},1]$ then all λ decent individuals become handcraft producers and earn $\alpha-\beta\left(\frac{\delta}{1-\delta}\right)>\gamma$ while 1-λ indecent individuals become thieves and earn β (see lines CD and C'D in Figure 2-b below).
- If $\lambda \in \left[\frac{\gamma}{\alpha},\frac{\beta}{\alpha+\beta-\gamma}\right]$ then all λ decent individuals become producers and earn γ, while 1-λ indecent individuals become thieves and earn $(\alpha-\gamma)\cdot(\frac{\lambda}{1-\lambda})>\gamma$ (see lines CB and C'B in Figure 2-b below).

- If $\lambda \in [0, \frac{\gamma}{\alpha})$ then all individuals (decent and indecent) earn $\gamma.\lambda$ decent individuals as well as $\frac{\gamma}{\alpha} - \lambda$ indecent individuals become handcraft producers and produce α units, while $1 - \frac{\gamma}{\alpha}$ indecent individuals become thieves (see point B in Figure 2-b below).

In order to understand this equilibrium note that when 1-λ is lower than $\frac{\alpha-\gamma}{\alpha+\beta-\gamma}$ (i.e., λ is higher than $\frac{\beta}{\alpha+\beta-\gamma}$), all indecent adults who become thieves gain β units of output which is higher than the return to any productive activity (see the line $\overline{CD}$ in Figure 2-b below). Thus, the dominant strategy of indecent adults' is to become thieves, while all decent individuals are better off producing α since their net income is $\alpha - \beta\left(\frac{\delta}{1-\delta}\right) > \gamma$ (see the line $\overline{C'D}$ in Figure 2-b below).

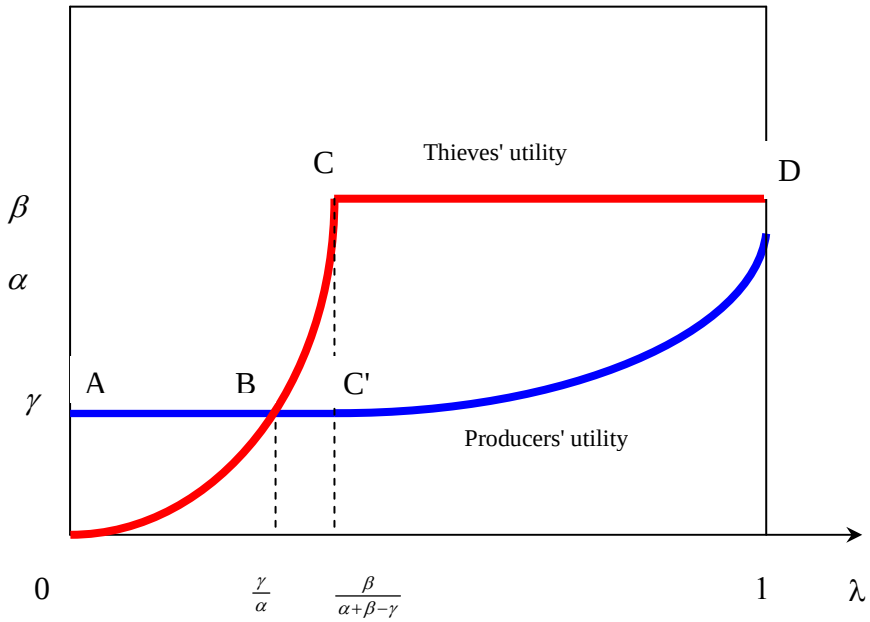
If the number of indecent adults 1-λ is equal to $\frac{\alpha-\gamma}{\alpha+\beta-\gamma}$ then $\alpha - \beta\left(\frac{\delta}{1-\delta}\right) = \gamma$, and each producer is indifferent between being a handcraft producer or crop producer (see points C' in Figure 2-b below). However, when the number of indecent adults 1-λ exceeds $\frac{\alpha-\gamma}{\alpha+\beta-\gamma}$ but is still lower than $\frac{\alpha-\gamma}{\alpha}$ (i.e., $\frac{\gamma}{\alpha} < \lambda < \frac{\beta}{\alpha+\beta-\gamma}$) then thieves cannot steal more than $(\alpha - \gamma)$ from each handcraft producers since handcraft producers can switch from handcraft to crops. Under such conditions, thieves start to steal from each other and obtain an income $(\alpha - \gamma) \cdot (\frac{\lambda}{1-\lambda}) > \gamma$.[7]

When 1-λ is higher than $\frac{\alpha-\gamma}{\alpha}$ (i.e., $0 \le \lambda < \frac{\gamma}{\alpha}$) then, as illustrated by the line BO in Figure 2-b below, $(\alpha - \gamma) \cdot (\frac{\lambda}{1-\lambda})$ must be lower than γ and therefore the economy is trapped in poverty and produces only γ. Under such conditions, only $1 - \frac{\gamma}{\alpha}$ indecent

[7] This outcome follows from two alternative (and equivalent) assumptions: one, that adults' decisions in the second stage is reversible, or two that adults' decisions in the second stage is irreversible, however, each handcraft producer can always ensure himself γ units of output.

individuals can ensure an income of γ units as thieves, while λ decent and $\frac{\gamma}{\alpha} - \lambda$ indecent individuals ensure at most an income of γ units of output as producers.

Figure 2-b (case 2)



Case 3: $\gamma<\beta<\alpha$

Since $\beta<\alpha$, indecent adults have an incentive to become producers rather than thieves. A possible Nash equilibrium is a strategy profile in which even for high levels of indecency every adult becomes an α producer (as represented by the gray dashed line AB). However, this equilibrium is unreasonable because if each indecent individual believes that there are other indecent individuals who are irrational he will choose to steal. Interestingly, this equilibrium is unstable even if indecent individuals believe that other indecent individuals might think that they are irrational or that other

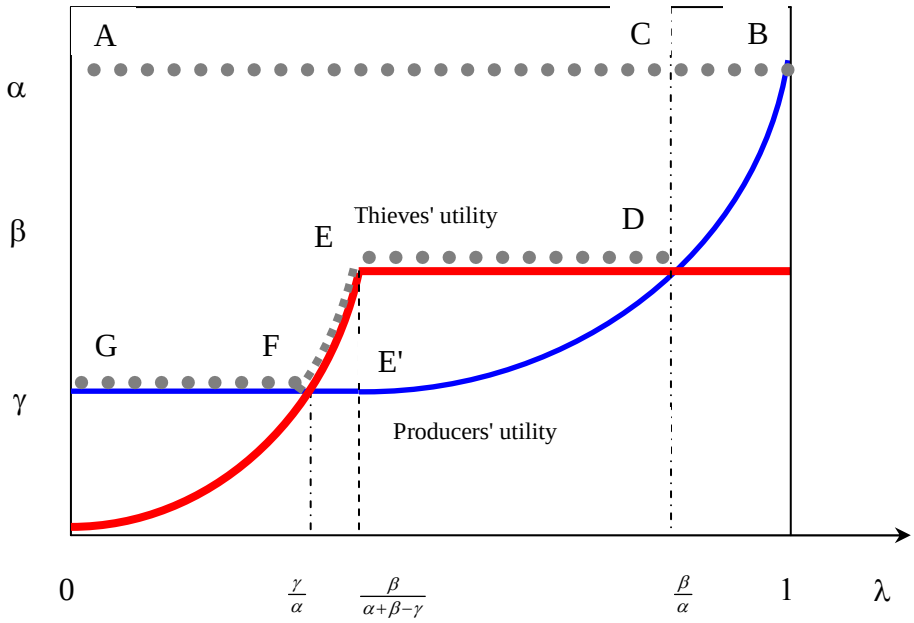
indecent individuals believe that other indecent individuals are irrational etc. Therefore, we do not analyze this equilibrium.[8]

There exists another Nash equilibrium in which all indecent adults become thieves. Such an equilibrium can arise when the number of indecent individuals is sufficiently high and the above equilibrium is unstable. In this equilibrium output depends on λ as follows:

- If $\lambda \in (\frac{\beta}{\alpha},1]$ then all individuals (decent and indecent) become handcraft producers and earn a net income α (see the gray dashed line BC in Figure 2-c below).
- If $\lambda \in [\frac{\beta}{\alpha+\beta-\gamma},\frac{\beta}{\alpha})$ then all λ decent adults become handcraft producers while 1-λ indecent adults become thieves and earn income β. Each decent adult earns a net expected income of $\alpha-\beta\left(\frac{\delta}{1-\delta}\right)>\gamma$ (see lines ED and E'D in Figure 2-c below).
- If $\lambda \in [\frac{\gamma}{\alpha},\frac{\beta}{\alpha+\beta-\gamma})$ then all indecent adults operate as thieves. They start to crowd each other and operate below their full potential such that their income becomes $(\alpha-\gamma)\cdot(\frac{\lambda}{1-\lambda})$. Decent adults earn net income γ (see lines EF and E'F in Figure 2-c below).
- If $\lambda \in [0,\frac{\gamma}{\alpha})$ then λ decent adults as well as $\frac{\gamma}{\alpha}-\lambda$ indecent adults become handcraft producers producing α units of output, while $1-\frac{\gamma}{\alpha}$ indecent individuals become thieves (see dashed gray line GF in Figure 2-c below).

Figure 2-c (case 3)

[8] Besides being unstable, this equilibrium yields no deep economic insights.



3. Education for good character

The previous equilibria considered here were without taking education into account. We now reconsider these equilibria by introducing education to the model.

3.1 A dynamic model with no social effect

Education affects the economy in two ways: First, it positively affects the probability of a child who attends school to become a decent adult. Second, education has a potential time saving value as it can free households' time otherwise used for child rearing. We henceforth label the potential time saving value of education by the 'babysitter effect'. We denote the 'lost time' (i.e., the number of hours devoted to child rearing) by z. Thus, when our production of the subsistence crop was earlier denoted by γ, we now denote *the same* level of production by $(1-z)\gamma$.

There are also expenses associated with education (such as salaries for teachers etc.). We henceforth denote these expenses by e. A poor economy has two possible levels of production: $(1-z)\cdot\gamma$ if there is no education and $\gamma-e$ if there is. If $(1-z)\cdot\gamma < \gamma-e$

then the babysitter effect dominates the costs of schooling and therefore the output gained by sending children to schools is higher than the individual cost of childcare. Under such conditions, individuals will optimally choose to send their children to schools, and an economy that starts with a low level of λ and is trapped in poverty (see cases 2 and 3 above), might escape from its poverty trap *despite the fact that the long-run effect of education on moral character is ignored by individuals*.

A more involved situation is when the babysitter effect is weak (i.e., $(1-z)\cdot\gamma > \gamma - e$) in which case individuals are better off by not sending their children to schools. In this case, if $\gamma<\beta$ then an economy that starts with a low level of λ is trapped in poverty (see cases 2 and 3 above) and cannot escape unless the government has a long run view, and compels education. The government might consider the long run effect of education on decency (and eventually on output), but this effect cannot be taken into consideration by short term utility maximizers in this economy.

If an education system were to start for some reason it would pay itself in the long run in two ways: 1) by increasing λ, thereby changing the equilibrium output from $(1-z)\gamma$ to $(1-z)\alpha$ and 2) when the output is already $(1-z)\alpha$, it might also be true that $(1-z)\alpha > \alpha - e$, since $\alpha>\gamma$.

We now explain the dynamics of education and decency.

Assumption 1: From now on we shall assume that when output is γ, the cost of education is sufficiently high to offset the babysitter effect. Namely, $e > z\gamma$ always holds. This assumption implies that in poor economies, introducing an education system is not individually incentive compatible. Thus, if, for some reason, the government is interested in starting a public education system, it must finance it either through tax or thorough a government loan. For the sake of simplicity, we limit our

discussion at present to taxes only, and assume that if a government establishes a public education system then it finances it by taxing *e* units per capita.

Assumption 2: From now on we assume that when output is α, the babysitter effect dominates the cost of education. Namely, $e < \alpha \cdot z \quad e < \alpha - \beta\left(\frac{q_2}{p_2}\right) - \gamma(1-z)$.

The dynamics of education and decency

The probability that a child becomes a decent adult depends on two variables: 1) his parent's moral type, 2) schooling (denoted by $ed \in \{0,1\}$) where $ed = 0$ denotes no public schooling and $ed = 1$ denotes public schooling.

A) The probability of a child to become a decent adult is 1-*Q(ed)* if he was born to a decent parent, where

$$Q(ed) = \begin{cases} 0 < q_1 < 1 & ed = 0 \\ 0 < q_2 < q_1 & ed = 1 \end{cases} \qquad (4)$$

B) The probability of a child to become a decent adult if he was born to an indecent parent is given by:

$$P(ed) = \begin{cases} 0 < p_1 < 1 & ed = 0 \\ p_1 < p_2 < 1 & ed = 1 \end{cases} \qquad (5)$$

Assumption 3: $q_1 - q_2 \geq p_2 - p_1$.[9]

If all children attend school then the dynamic system that describes how the population of decent individuals evolves is given by:

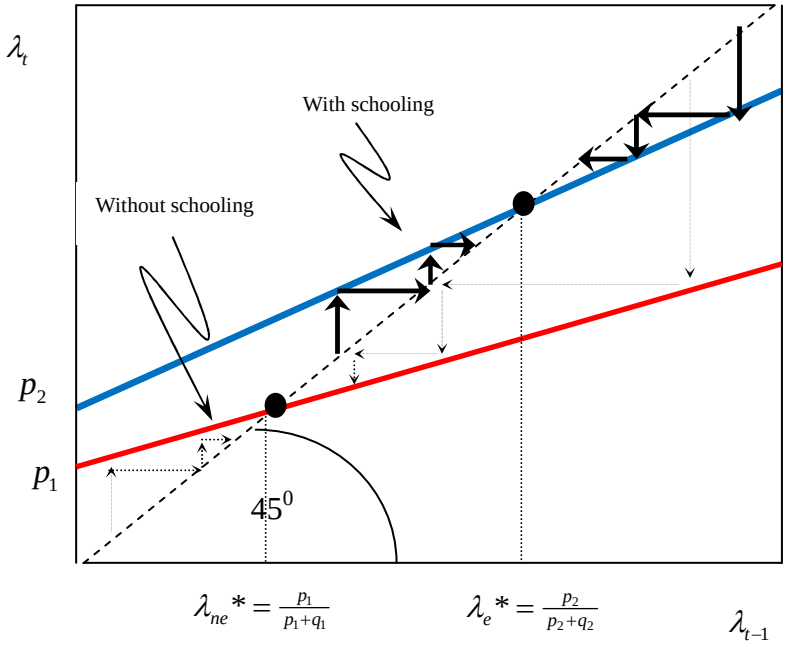
$$\lambda_t = p_2 + \lambda_{t-1}(1 - p_2 - q_2) \qquad (6)$$

If, on the other hand, there is no schooling, then the dynamic system is given by:

$$\lambda_t = p_1 + \lambda_{t-1}(1 - p_1 - q_1) \qquad (7)$$

[9] Education is at least as effective for improving the moral character of children who were born to decent parents as it is for children who were born to indecent parents.

Figure 3



Each dynamic system has a unique globally stable stationary equilibrium (see Figure 3 above):

where there is no education: $\lambda_{ne}^* = \frac{p_1}{p_1+q_1}$ and,

where there is education: $\lambda_e^* = \frac{p_2}{p_2+q_2}$.

The dynamics in Figure 3 and equations (6) and (7) illustrate how education that aims to improve moral character can affect the long run distribution of decent and indecent individuals.

Proposition 1: Suppose that e is sufficiently lower than $\alpha \cdot z$ so that $e < \alpha - \beta\left(\frac{q_2}{p_2}\right) - \gamma(1-z)$. Then the following statements hold:

(i) When $\beta<\gamma<\alpha$ there is no poverty trap and therefore public education changes the output *only due to the babysitter effect*. Output will rise from $\alpha(1-z)$ to $\alpha - e$.

(ii) When $\gamma<\beta<\alpha$, if $\lambda_{ne}^* = \frac{p_1}{p_1+q_1} \leq \frac{\gamma}{\alpha}$ then:

a) If $\frac{\beta}{\alpha+\beta-\gamma} < \lambda_e^* \leq \frac{\beta}{\alpha}$ then, in the long run, production will rise from $\gamma(1-z)$ to $\alpha - \beta\left(\frac{q_2}{p_2}\right) - e$ and eventually only $(1-\lambda_e^*) = \frac{q_2}{p_2+q_2}$ individuals will steal (see Figure 4-a below).

b) If, $\frac{\beta}{\alpha} < \lambda_e^*$, then, in the long run, production will rise from $\gamma(1-z)$ to $\alpha - e$ and no individuals will steal (see Figure 4-a below).

(iii) When $\gamma<\alpha<\beta$ if $\lambda_{ne}^* \leq \frac{\gamma}{\alpha}$ and $\lambda_e^* > \frac{\beta}{\alpha+\beta-\gamma}$ then as in case ((ii)-a), in the long run, production will rise from $\gamma(1-z)$ to $\alpha - \beta\left(\frac{q_2}{p_2}\right) - e$ and only $(1-\lambda_e^*) = \frac{q_2}{p_2+q_2}$ individuals will steal (see Figure 4-b below).

Proof: Follows immediately from equations (1)-(7) and assumptions 1, 2 and 3.

Note: Figures 4-a and 4-b explain both the levels of pre- and post-education income. To clarify these figures, we used the notations α,β and γ, and not the pre-schooling levels $\alpha(1\text{-}z)$,$\beta(1\text{-}z)$ *and* $\gamma(1-z)$ or the post schooling levels of α-*e,* β-*e and* $\gamma - e$.

Figure 4-a

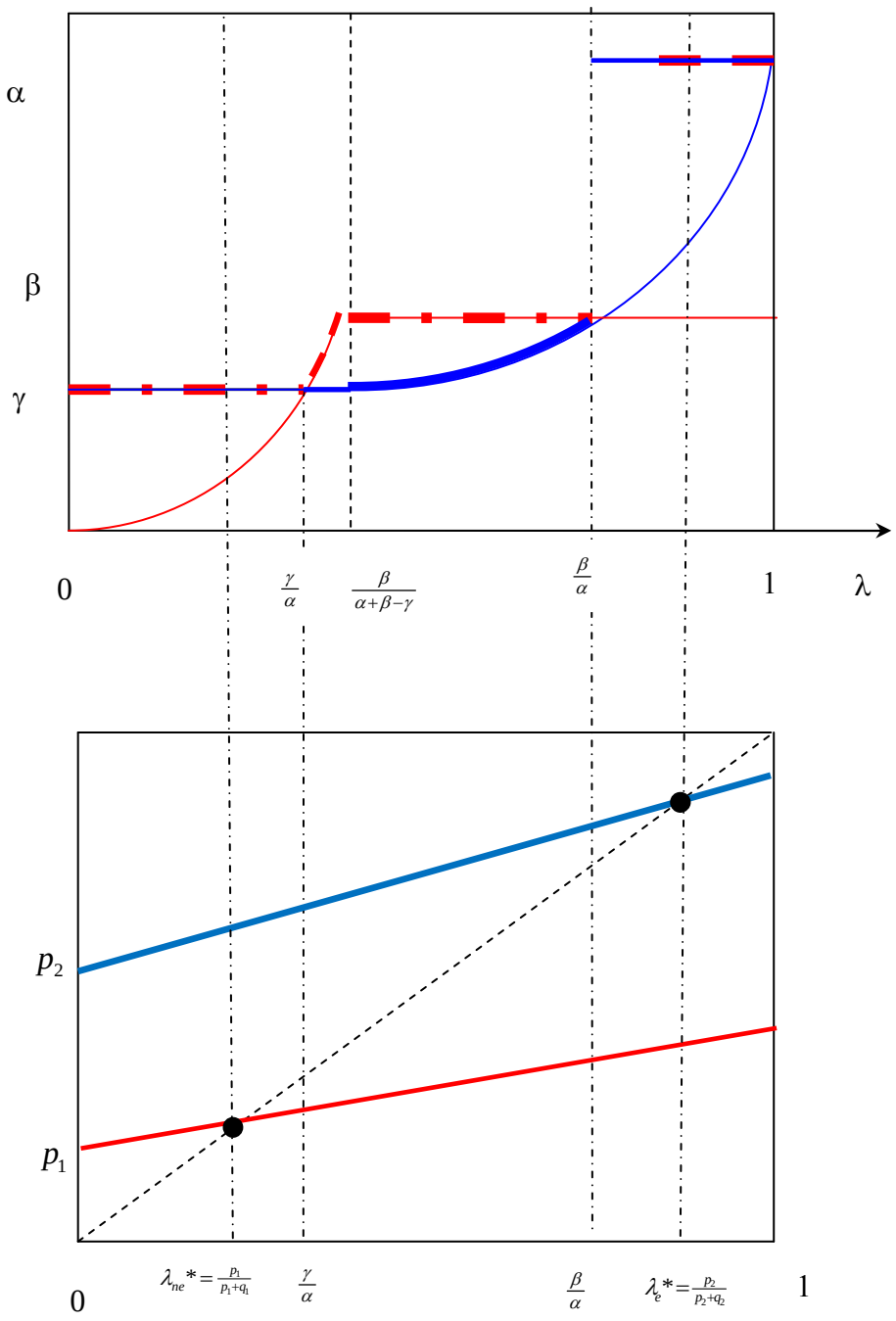
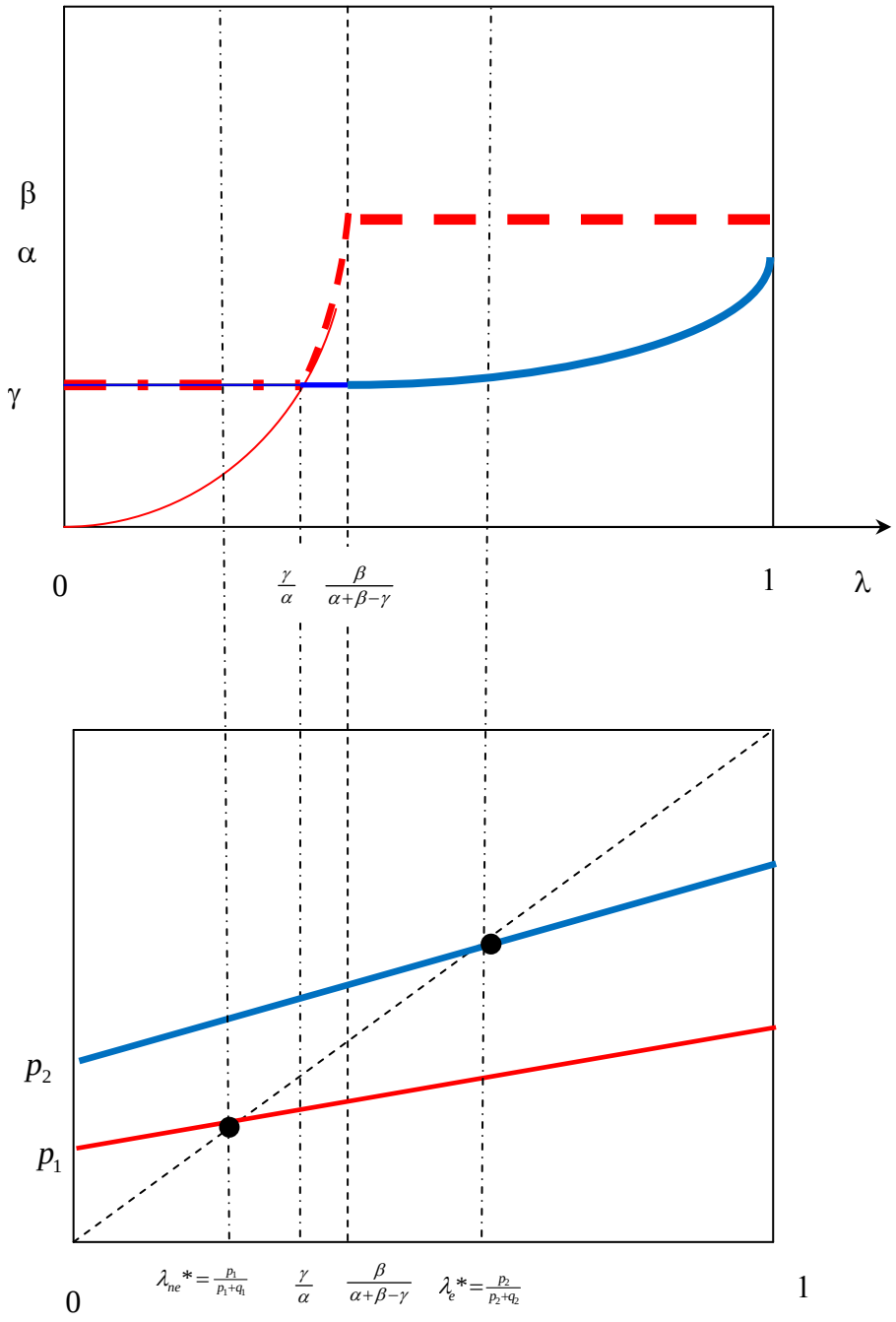

α
β
γ
0
$\frac{\gamma}{\alpha}$
$\frac{\beta}{\alpha+\beta-\gamma}$
$\frac{\beta}{\alpha}$
1
λ
p_2
p_1
0
$\lambda_{ne}^* = \frac{p_1}{p_1+q_1}$
$\frac{\gamma}{\alpha}$
$\frac{\beta}{\alpha}$
$\lambda_e^* = \frac{p_2}{p_2+q_2}$
1

Figure 4-b



In the dynamic analysis above, the equilibrium with no schooling is largely driven by two fundamental factors. First, in poor economies, the babysitter effect is dominated by the cost of education. Second, there exists an intergenerational market failure in which households in future generations cannot compensate the present

generation for the expansion of resources required to establish an education system. Under such conditions, the state has an important, if not a crucial, role in preventing an underdevelopment trap.

In the analysis above we illustrated how a tax-funded public education system can pull an economy with low a level of decency out of poverty. However, this form of financing detrimentally affects the present consumers in order to achieve growth. Thus, a policy that, on one hand, would be a strict Pareto improvement, and, on the other hand, will pull the economy out of its underdevelopment trap is to form a mechanism that will substitute the missing intergenerational market for loans. If the world interest rate is sufficiently low, the government can take foreign loans to fund the public education system. The government uses the borrowed resources from all periods until the steady state of high production equilibrium is reached to return the loan. When the high production equilibrium is reached and the babysitter effect dominates the cost of education an education tax can be introduced. Under our assumptions the allocation of resources in this equilibrium Pareto dominates the allocation when an education system is absent.

Public education versus the police

We have demonstrated that the public education policy might affect the economy's output. This effect, however, applies only in the long run while in the short run it is possible that education will not change output at all. We may therefore be interested in analyzing another policy that may reduce crime rates and raise output in the short run, namely, law enforcement and policing.

Let us assume that a police force can reduce the thieves' potential income from β to $\beta' = \beta - \varepsilon$ where ε is an increasing function of the public expenditure on

the police force denoted by *c*, where $\varepsilon(0) > 0$.[10]Let us also assume that before a police force is introduced, there is no public education system and the long run stationary equilibrium is $\lambda_{ne}^* = \frac{p_1}{p_1+q_1}$.We examine three cases:

In the case where $\beta<\gamma<\alpha$, theft does not pay more than any type of productive activity and therefore the unique equilibrium is where all adults, decent and indecent, produce α. In this equilibrium, output is not improved with the introduction of a police force, and furthermore, the police force costs *c*. For this case, it is never worthwhile to introduce a police force.

When $\lambda_{ne}^* = \frac{p_1}{p_1+q_1} \le \frac{\gamma}{\alpha}$ then in the two cases where $\gamma<\beta<\alpha$ and $\gamma<\alpha<\beta$ a police force might be efficient in increasing output only if the police manages to sufficiently reduce β. This happens only if the following proposition holds.

Proposition 2: Suppose that $\lambda_{ne}^* = \frac{p_1}{p_1+q_1} \le \frac{\gamma}{\alpha}$ and $\gamma<\beta$ a police force has a positive effect on output if and only if there exists $\beta' < \gamma$ such that $\varepsilon^{-1}(\beta - \beta') < (1-z)(\alpha - \gamma)$.

Proof: If the police force is sufficiently effective so that $\beta' \le \gamma$ then there will be no thieves and output will change from $(1-z)\gamma$ to $(1-z)\alpha - c$.

The police force will therefore have a positive effect on output if and only if $(1-z)\gamma < (1-z)\alpha - \varepsilon^{-1}(\beta - \beta')$ (note that $c = \varepsilon^{-1}(\beta - \beta')$) if and only if $\varepsilon^{-1}(\beta - \beta') < (1-z)(\alpha - \gamma)$.□

[10] Alternatively, we may assume that the police does not reduce thieves' potential income β but rather increase the probability of a thief to be caught and fined or imprisoned. This is equivalent to the model outlined above, and the results of the model therefore carry through.

If Proposition 2 does not hold (i.e., if $\varepsilon^{-1}(\beta-\beta')\geq(1-z)(\alpha-\gamma)$ for all $\beta'<\gamma$) then introducing a police force will not improve production. Then, only a public education system can pull the economy out of its poverty trap. From now on we discuss the case where proposition 2 holds.

Even if Proposition 2 holds, the introduction of a police force has no long-term effect on output. The police force can only reduce the number of active thieves in each period separately but cannot reduce the number of indecent adults in the population. Note also that cost *c* has to be paid separately in each and every period. Once public funding of the police is stopped, the number of thieves immediately returns to its previous level. However, if $(1-z)\alpha<\alpha-e$ and Proposition 2 holds then once a police force is active, it is a dominant strategy for every individual to pay for a public education system.

When $\gamma<\beta<\alpha$, if a police force is introduced in the non education case, lowering β will not help. As long as $\beta>\gamma$, there will be stealing in the economy, and output will not change. In the public education case, it is also not worthwhile to have a police force, because in this case the output is already α, and only goes down to α-*c* with the introduction of the police.

For the case where $\gamma<\alpha<\beta$, here too if we start with no education, lowering β will not help unless we can lower it below γ. However, if we are at the 'educated' level and we manage to lower β so that it falls below α, the police will make production rise to α-*c*-*e* which might well be higher than $\alpha-\beta\left(\frac{q_2}{p_2}\right)-e$.

From this analysis we may conclude that policing is ineffective in most cases, and is effective only after the introduction of public education.

3.2 A dynamic model with social effects

Decency and indecency do not only reflect personal moral traits, but also cultural norms and values that pass on from one generation to the next through social interactions between the old and the young. We now introduce a model where this social effect is another determinant of moral character. In this new setting, the impact of education is manifested not only in its direct effect on individuals' moral character, as modeled above, but also in its indirect feedback on cultural legacies.

We show that interactions between decent adults and young individuals might lead to a threshold effect. If the number of decent individuals λ is below some critical point, the level of interaction between decent adults and young individuals is low, λ declines, and the economy is trapped in poverty. If, on the other hand, λ is slightly above that critical point, then the interaction between decent adults and young individuals is sufficiently high, λ rises, and the economy grows to a high level of decency and output.

When the number of indecent individuals $1-\lambda$ is high and the economy is trapped in poverty, compulsory schooling that educates children to high morality might negate the threshold effect and therefore pull the economy out of poverty. Furthermore, unlike the model without social effect, when λ exceeds a certain critical point, public education is no longer needed.

We start our analysis with the following assumptions:

Assumption 4: The probability that a child who was born at period *t* will become a decent adult at period *t*+1 is affected by three factors:

(4-a) Social interaction

When the number of decent adults a child interacts with is high, the probability that the child will become a decent adult increases. We denote this social effect by $so(\lambda_{t-1})$.

(4-b) The parental effect

A child who was born at period *t* to a decent parent is more likely to become decent at period *t*+1 than a child who was born to an indecent parent. We denote by $g(\lambda_{t-1}) > 0$ the average parental effect representing the difference between having a decent and an indecent parent, and by $g(\lambda_{t-1})\lambda_{t-1}$ the total parental effect. We assume that the total parental effect $g(\lambda_{t-1})\lambda_{t-1}$ is a monotonically increasing function of λ_{t-1}.[11]

(4-c) The schooling effect

The probability that a child who was born at period *t* will become a decent adult at period t+1 increases if he attends school. We denote this effect by $e(\lambda_{t-1})$. We assume that when λ rises, the schooling effect weakens. Thus, $e(\lambda_{t-1})$ is a decreasing function of λ_{t-1}.

We further assume that:

(4-*d*) The probability of a child to become a decent adult is a monotonically non-decreasing function of λ_{t-1} in all cases. Thus, p_1,p_2,p_3, and p_4 as presented in Table 1 below are monotonically non-decreasing and strictly smaller than 1.

[11] This assumption implies that the elasticity of the average parental effect with respect to the number of decent adults at period t is higher or equal to minus one(i.e., $-1 \leq \frac{g'(\lambda_{t-1})\cdot\lambda_{t-1}}{g(\lambda_{t-1})}$).

Table 1

A child who was born to an indecent parent and did not attend school	A child who was born to a decent parent and did not attend school	A child who was born to an indecent parent and attended school	A child who was born to a decent parent and attended school
$p_1 = \underbrace{so(\lambda_{t-1})}_{social\ effect}$	$p_2 = \underbrace{so(\lambda_{t-1})}_{social\ effect} + \underbrace{g(\lambda_{t-1})}_{Parental\ effect}$	$p_3 = \underbrace{so(\lambda_{t-1})}_{social\ effect} + \underbrace{e(\lambda_{t-1})}_{Schooling\ effect}$	$p_4 = \underbrace{so(\lambda_{t-1})}_{social\ effect} + \underbrace{g(\lambda_{t-1})}_{Parental\ effect} + \underbrace{e(\lambda_{t-1})}_{Schooling\ effect}$

Assumption 5 The functions $so(\lambda_{t-1})$ and $g(\lambda_{t-1})$ satisfy the following conditions:

(5-a) $so(\lambda_{t-1})$ is a monotonically increasing convex function, and differentiable at least three times.

(5-b) $so(0) = \varepsilon$, $so(1) = \eta$ where $0 < \varepsilon < \eta < 1$

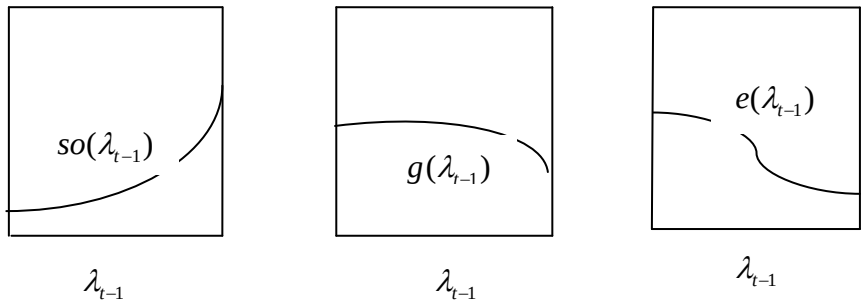
(5-c) $so'(0) = 0$ and $so''(0) > 0$

(5-d) $g(\lambda_{t-1})$ is a weakly concave function and differentiable at least three times.

(5-e) $g(0) > 0$ and $g'(0) = 0$

Figure 5 shows possible instances of $so(\lambda_{t-1})$ and $g(\lambda_{t-1})$.

Figure 5



Social effect

Average parental effect (per decent adult)

Schooling effect

If there is no public education, decency evolves according to the following difference equation:

$$\begin{aligned}\lambda_t &= \psi(\lambda_{t-1}) \\ &= \underbrace{so(\lambda_{t-1})}_{Social\ \ effect} + \underbrace{\lambda_{t-1}\cdot g(\lambda_{t-1})}_{Total\ \ parental\ \ effect}\end{aligned} \tag{8}$$

whereas with public education, decency evolves according to:

$$\begin{aligned}\lambda_t &= \psi(\lambda_{t-1}) + e(\lambda_{t-1}) \\ &= \underbrace{so(\lambda_{t-1})}_{Social\ \ parental\ \ effect} + \underbrace{\lambda_{t-1}\cdot g(\lambda_{t-1})}_{Total\ \ parental\ \ effect} + \underbrace{e(\lambda_{t-1})}_{Schooling\ \ effect}\end{aligned} \tag{9}$$

From assumptions (4-b) and (5-a) it follows immediately that the dynamical system presented in equation (8) is monotonically increasing.

Proposition 3: The dynamical system described in equation (8) has at least one non-trivial stationary equilibrium.

Proof: Let us define:

$$\begin{aligned}G(\lambda_{t-1}) &= \psi(\lambda_{t-1}) - \lambda_{t-1} \\ &\equiv \lambda_{t-1}\cdot\left[g(\lambda_{t-1}) - 1\right] + so(\lambda_{t-1})\end{aligned}$$

Obviously,

$$G(0) = 0\cdot\left[g(0) - 1\right] + (so(0)) = so(o) = \varepsilon > 0$$

$$G(1) = 1\cdot\left[g(1) - 1\right] + (so(1)) = so(1) - g(1) - 1 < 0$$

Since $G(\lambda_{t-1})$ is a continuous function, according to the *Intermediate Value Theorem* there exists at least one point $\overline{\lambda} \in (0,1)$ such that $G(\overline{\lambda}) = 0$, and there is at least one stationary equilibrium.□

Proposition 4: If the conditions (1)-(3) below hold, then the equation (8) has an S-shape as is shown in the Figure 6 below:

1) $H(1) = \underbrace{g''(1)}_{(-)} + \underbrace{2g'(1)}_{(-)} + \underbrace{so''(1)}_{(+)} < 0$

2) $so'''(\lambda_{t-1}) \leq 0$

3) $g'''(\lambda_{t-1}) \leq 0$

Proof: The second derivative of the difference equation $\lambda_t = \psi(\lambda_{t-1})$ is given by

$H(\lambda_{t-1}) = \lambda_{t-1} \cdot g''(\lambda_{t-1}) + 2g'(\lambda_{t-1}) + so''(\lambda_{t-1})$

$H(0) = 0 \cdot g''(0) + 2g'(0) + so''(0)$

$H(1) = g''(1) + 2g'(1) + so''(1)$

According to assumptions (5-a) and (5-e)

$H(0) > 0$

Due to the first assumption in this proposition, H(1)<0.

Note also that the third derivative of the difference equation $H'(\lambda_{t-1}) = \lambda_{t-1} \cdot g'''(\lambda_{t-1}) + 3g''(\lambda_{t-1}) + so'''(\lambda_{t-1})$ is not positive, and therefore the second derivative is monotonically non-increasing. Thus, according to the *Intermediate Value Theorem* there exists a single $\hat{\lambda} \in (0,1)$ such that the difference equation $\lambda_t = \psi(\lambda_{t-1})$ is convex for all $\lambda_{t-1} \in [0, \hat{\lambda}]$, and concave for all $\lambda_{t-1} \in [\hat{\lambda}, 1]$.□

Multiple equilibria poverty traps and education

Suppose that as in case 3 above in which $\gamma < \beta < \alpha$, the equilibrium aggregate output is determined by the number of decent individuals. Suppose also that assumptions (4) and (5) as well as the conditions in Proposition 5 hold, and therefore the dynamical system $\lambda_t = \psi(\lambda_{t-1})$ is an S-shaped monotonically non-decreasing function. We also assume that the probability functions $so(\lambda_{t-1})$ and $g(\lambda_{t-1})$ are such

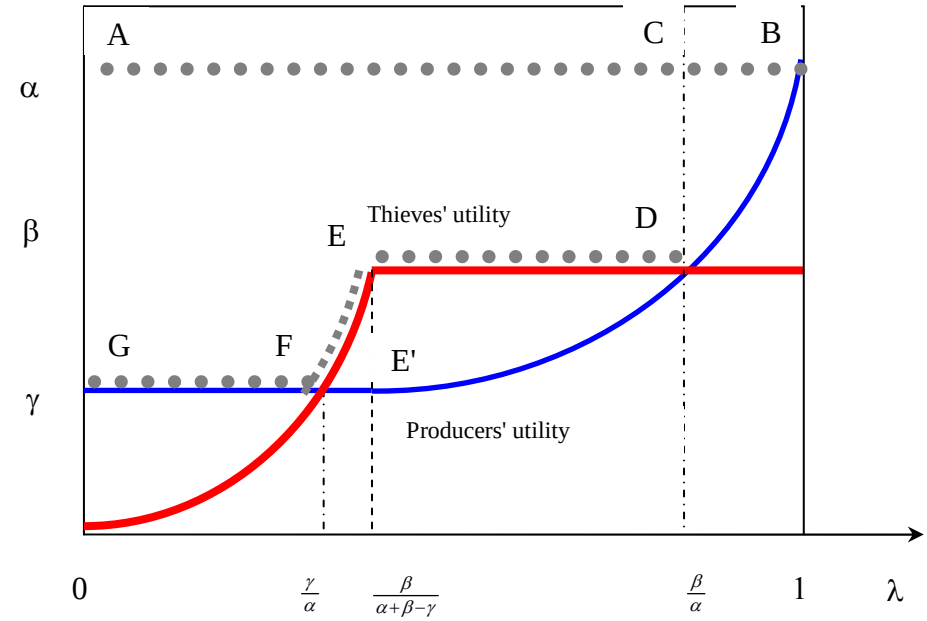
that the dynamical system $\lambda_t = \psi(\lambda_{t-1})$ has three stationary equilibria, where two are locally stable.[12] See points λ_1^*, λ_2^* and λ_3^* in Figure 6 below.

Figure 6 displays the evolution of decency as well as the return to each occupation. When the number of decent individuals at period t=0 is lower than λ_2^*, the size of the population of decent adults converges to the low stationary equilibrium level $\lambda_1^* < \frac{\gamma}{\alpha}$, and in the long run, the economy is trapped in poverty with output per capita γ. If, on the other hand, the number of decent individuals is even slightly higher than λ_2^*, the size of the population of decent adults will converge to the high stationary equilibrium level $\lambda_3^* > \frac{\beta}{\alpha}$, and in the long run the economy grows to a high level (α) of output per capita (see Figure 6).

Figure 7 below presents the effect of public education on the evolution of decency and output. If the schooling effect is sufficiently high, it negates the threshold effect. Under such conditions, the role of education is to pull the economy out of poverty by creating a sufficient level of decency that raises the number of decent adults to above λ_2^*. After level λ_2^* has been reached, public education is no longer needed since the social intergenerational interaction effect will be sufficient to raise the per capita output to α on its own. Thus, unlike the case without social effect, in order to pull the economy out of its poverty trap, investment in public education is needed only for a limited time.

[12] it is easy to verify that the functions
$so(\lambda_{t-1}) = \frac{1}{8} + \frac{1}{8}(\lambda_{t-1})^2$ and $g(\lambda_{t-1}) = \frac{8}{5}\left(\lambda_{t-1} + \frac{1}{20}\right) - \frac{69}{250}\left(\lambda_{t-1} + \frac{1}{2}\right)^2$ satisfy assumptions (4) and (5), and that the dynamical system created by these functions has three stationary equilibria , where two are locally stable.

Figure 6


A
C
B
α
β
Thieves' utility
E
D
G
F
E'
γ
Producers' utility
0
$\frac{\gamma}{\alpha}$
$\frac{\beta}{\alpha+\beta-\gamma}$
$\frac{\beta}{\alpha}$
1
λ

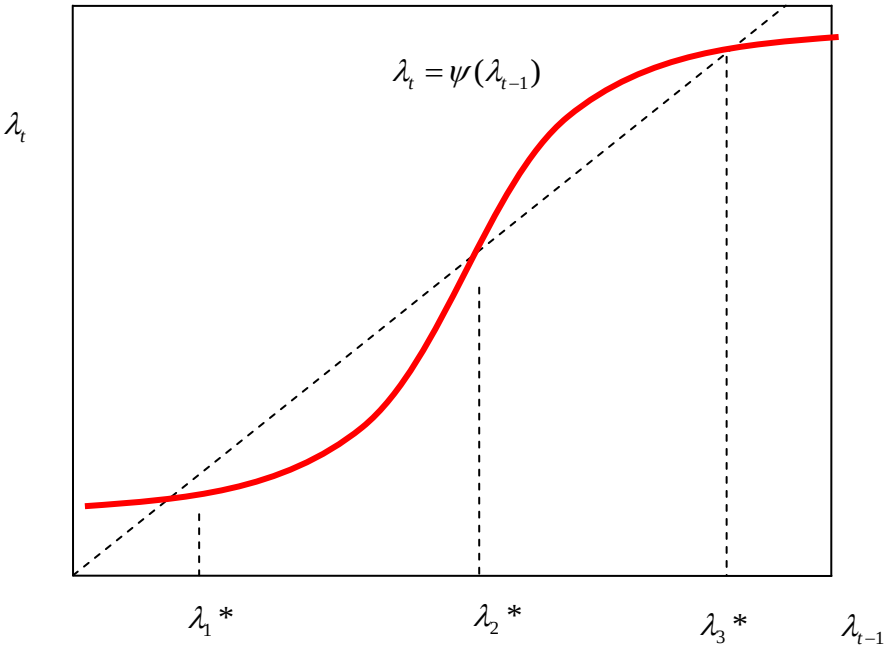
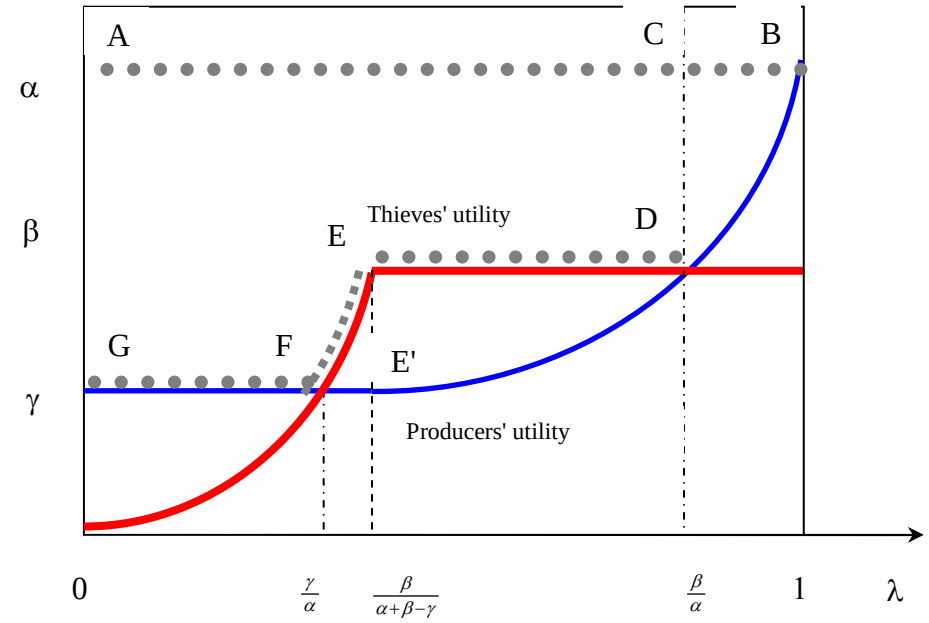

$\lambda_t = \psi(\lambda_{t-1})$
λ_t
λ_1 *
λ_2 *
λ_3 *
λ_{t-1}

Figure 7


A
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Thieves' utility
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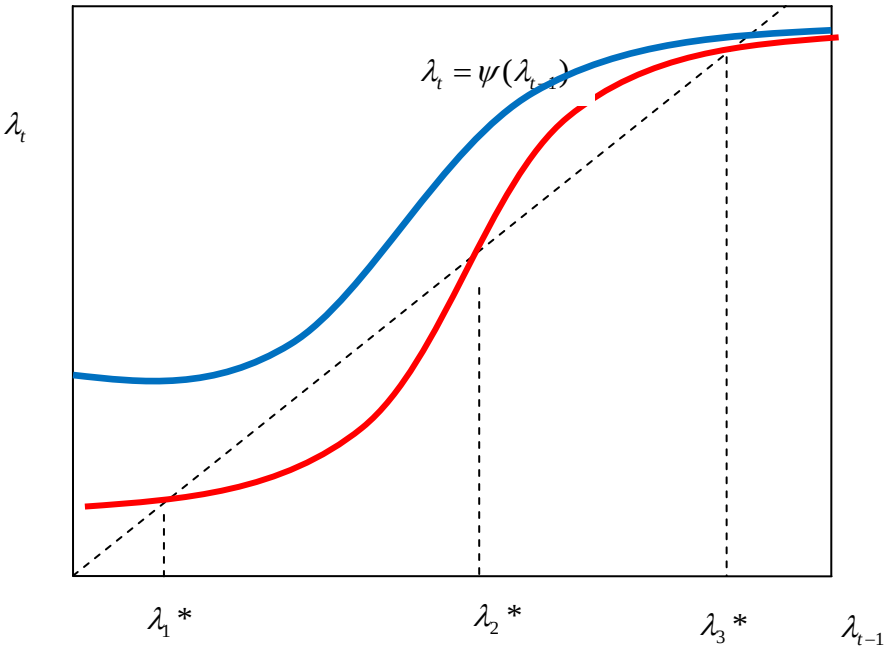
E'
Producers' utility
0
$\frac{\gamma}{\alpha}$
$\frac{\beta}{\alpha+\beta-\gamma}$
$\frac{\beta}{\alpha}$
1
λ


λ_t
$\lambda_t = \psi(\lambda_{t-1})$
λ_1 *
λ_2 *
λ_3 *
λ_{t-1}

4. Concluding remarks

This paper shows how public education may increase output by increasing decency and reducing rent seeking behavior.

The study demonstrates that the distribution of decency, or more specifically the percentage of decent individuals in the economy, significantly affects aggregate economic activity. It also shows that public education that educates infants to decent behavior might affect this distribution in the long run and therefore might have a long run effect on the macroeconomic equilibrium.

We studied two cases: one, where decency is not affected by cultural norms, and the other, where decency is affected by cultural norms and values that pass from one generation to the next through social interactions between old and young individuals.

For the first case, if initially governments do not invest in public education and do not compel schooling, the economy will be trapped in poverty, since parents do not have an incentive to send their children to schools. Once the government does invest in public education, decency will increase and output will rise. Under such conditions, continual schooling will keep output at high levels.

In the second case where decency is affected by cultural norms and values that pass from one generation to the next, we found that if the number of decent individuals is below some critical point, then the level of interaction between decent adults and young individuals is low, the number of decent individuals declines and the economy is trapped in poverty. If, on the other hand, the number of decent individuals is slightly above that critical point, the interaction between decent adults and young individuals is sufficiently high, the number of decent individuals rises and the economy will grow reaching to a high level of decency and output. Thus, compulsory schooling in poor economies is needed only for a limited time. When the number of

decent individuals exceeds a critical point, education for good character is no longer needed. Further research may shed light on this mechanism by which education affects decency and growth.

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