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# Redistributive taxation vs. education subsidies: fostering equality and social mobility in an intergenerational model\*

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## Abstract

Redistributive taxation and education subsidies are common policies intended to foster education attendance of poor children. However, this paper shows that in an intergenerational framework, these policies can raise social mobility only for some investment situations but not in general. I also study the impact of both policies on the aggregate skill ratio and inequality. While redistributive taxation can raise social mobility but at the same time never reduces inequality, education subsidies can, under some conditions, achieve both simultaneously. Unfortunately, these conditions necessarily require a population in which the skill ratio is already quite high.

*Keywords:* Redistributive taxation; Education subsidies; Intergenerational mobility; Inequality

*JEL classification:* D91; H23; H24; I21; J24; J62; O15

## 1. Introduction

Educational decisions determine a great part of future income<sup>1</sup> and therefore potential inequality within and across generations. The wage gap, needed to induce investment, implies that it is easier for rich parents than for poor ones to invest in the education of their children. Recently, Rumberger (2009) has found a strong effect of adult economic status on college completion and children's earnings. In this context, several policy interventions that foster investment incentives of the poor and therefore equalize the distribution of human capital are possible. The present paper analyzes the impact of two of them - redistributive taxation and education subsidies<sup>2</sup> - on the

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<sup>1</sup>One of the earliest studies that shows a positive effect of schooling on earning is by Mincer (1958). A critical discussion on the Mincer equation and its assumptions is given by Björklund and Kjellström (2002). There is also evidence that the return to schooling has increased over the last decades (OECD, 2009, Indicator A7).

<sup>2</sup>In the present context, subsidies are transfer payments to the households that invest in education.

aggregate proportion of educated people as well as on social mobility and inequality.<sup>3</sup>

The paper is related to a great number of intergenerational models focusing on potential multiplicity of steady states (SS), inequality, and social mobility. This body of literature starts with Gary S. Becker. In a paper with Nigel Tomes, he shows that there is a unique equilibrium which is characterized by social immobility and inequality (Becker and Tomes, 1979). Here, wages of the skilled and unskilled are exogenous and not determined by the measures of both occupation types. Inequality in this model is mainly driven by luck. Some other papers, assuming endogenously determined wages and homogenous agents, find a continuum of SSs which mostly are also characterized by inequality and the absence of social mobility (Banerjee and Newman, 1993; Galor and Zeira, 1993; Freeman, 1996; Mookherjee and Ray, 2003).<sup>4</sup> In these models the equilibrium outcome is determined by initial conditions, i.e., there is great history dependence. But according to Maoz and Moav (1999), Mookherjee and Napel (2007), and Napel and Schneider (2008), these results are strongly connected to the assumption of homogenous agents.<sup>5</sup> If children are heterogenous with respect to their inherent talent it becomes possible that a poor parent invests in his highly talented child and also that a rich parent rejects investment in his low-talented child. Thus, steady states with social mobility (SSM) are fostered by heterogeneity. In Mookherjee and Napel (2007), steady states are characterized by inequality and social mobility. They are locally unique; and under some conditions, global uniqueness is provided.

Although there are many intergenerational models of human capital investment, I am aware of only one paper that investigates the impact of different policy interventions on long-run output. Mookherjee and Ray (2008) compare the effects of unconditional and conditional transfers on per capita outcome and welfare. However, using the simplifying assumption of homogenous education costs, they do not find any social mobility in equilibrium. Therefore, I analyze the workings of a redistributive tax and education subsidies in a model where education costs are heterogenous and a child's talent depends on his parent's talent. Instead of per capita outcome and welfare the focus is on the aggregate skill level, inequality, and social mobility.

It can be shown that generally, neither redistributive taxation nor education subsidies can both decrease inequality and increase social mobility. Depending on the type of SSM, i.e., the equilibrium investment decisions of all parents without any public intervention, the impact of both policies on inequality and social mobility is analyzed. While redistributive taxation and subsidization have similar outcomes for some types of SSMs, they have different effects on the skill ratio for other types. Under most circumstances there is a trade-off between the reduction of inequality and the increase of social mobility. However, the paper shows that in a situation where unskilled parents are indifferent in their investment decision for a child with low costs, education subsidies can reach both targets at the same time. Unfortunately, this result only holds for a population with a high initial aggregate skill ratio.

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<sup>3</sup>A higher degree of social mobility benefits intergenerational equity. Inequality within a generation is measured as the difference between skilled and unskilled wages.

<sup>4</sup>Galor and Zeira (1993) and Mookherjee and Ray (2003) find equal and unequal SSs.

<sup>5</sup>While Mookherjee and Napel (2007) assume that talent is independently and identically distributed, Napel and Schneider (2008) show that the results are robust if the child's talent depends on the talent of the parent. Maoz and Moav (1999) focus on the qualitative features of the convergence process that leads to a steady state. They also find that redistributive policy has a negative effect on growth in developed economies but a positive effect in developing countries.

The paper is organized as follows: the basic intergenerational model without policy intervention is presented in section 2. Section 3 studies the impact of redistributive taxation on the skill ratio as well as on inequality and social mobility. Section 4 does the same for education subsidies. Conclusions are discussed in section 5.

## 2. Model

Assume an overlapping generations model that involves a unit mass of families. At each point in time, a family consists of a parent and a child. The parent can work as a skilled ( $s$ ) or an unskilled ( $n$ ) worker. The aggregate skill ratio of the population at time  $t$  is denoted by  $\lambda_t$ . Skilled work requires a costly education while unskilled work does not. Education costs, i.e., any kind of monetary costs like tuition fees, private lessons, expenditures for books, etc., depend on the talent<sup>6</sup> of the child and must be financed out of the parent's current income. The latter assumption goes back to Loury (1981). One can argue that this is an unrealistic assumption, but qualitative results are robust as long as capital markets are imperfect. Empirical evidence suggests the importance of borrowing constraints on the determination of intergenerational inequality (Gaviria, 2002). Heckman and Krueger (2003) give a detailed discussion on credit constraints. For simplicity, I assume that there are only two possible types of talent, with corresponding education costs  $x^l$  for a highly talented child and  $x^h$  for a low-talented child, respectively; the child's talent is private information of the parent. The fractions of both types of talent are exogenously given and fixed over time. The talent of a child depends on the talent of his parent in a Markovian way. Thus, for  $i, j \in \{l, h\}$  the conditional probability  $p_{i \rightarrow j}$  denotes the probability that a parent with education costs  $x^i$  has a child with education costs  $x^j$ . Although the model assumes a restrictive talent distribution, the qualitative results persist if there are  $r$  discrete ability types. In such a setup,  $x^l$  and  $x^h$  would refer to the costs of the respective marginal unskilled investor and skilled non-investor at a local point  $\lambda_t$ . The model with  $r$  discrete cost types can then be used to approximate a model with a continuous distribution of talents (Mookherjee and Napel, 2007).

The economy produces a single consumption good with a Cobb-Douglas production function  $H = \lambda_t^\gamma (1 - \lambda_t)^{1-\gamma}$  with  $\gamma \in (0, 1)$ . Wages are given by the marginal productivities. Thus, in equilibrium, wages are

$$w_t^s \equiv \gamma \left( \frac{1 - \lambda_t}{\lambda_t} \right)^{1-\gamma} \quad (1)$$

and

$$w_t^n \equiv (1 - \gamma) \left( \frac{\lambda_t}{1 - \lambda_t} \right)^\gamma. \quad (2)$$

Clearly there are interdependencies between families' investment decisions via  $\lambda_t$ . These interdependencies crucially drive the results for the policy implications.<sup>7</sup> Investment in education requires  $w_t^s > w_t^n$  and therefore  $\lambda_t < \gamma$  in equilibrium. Empirical

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<sup>6</sup>Here, 'talent' should be perceived as 'potential to benefit from education' as, e.g., in De Fraja (2005).

<sup>7</sup>The following results are not robust against the assumption of a linear technology and continuously distributed talents. In this case, the investment decisions would not depend on the aggregate skill ratio but would mainly be driven by the conditional probabilities  $p_{i \rightarrow j}$ ,  $i, j \in \{l, h\}$ , and the fixed difference between skilled and unskilled wages.

evidence for the described wage structure is given by Katz and Murphy (1992). They especially show that skilled wage premia decrease if the supply of skilled work increases.

Parents' bequest motive is assumed to be altruistic. In particular, parents maximize

$$U(c_t, w_{t+1}^k) = \ln(w_t^k - Dx) + \delta \ln(w_{t+1}^k) \quad (3)$$

where  $c_t \equiv w_t^k - Dx$  denotes the parent's own consumption;  $w_t^k$  and  $w_{t+1}^k$  with  $k \in \{s, n\}$  are the incomes of the parent and the child, respectively;  $x$  denotes the child's education costs; and the parameter  $\delta \in (0, 1)$  states the altruism motive. The binary variable  $D$  is 1 in the case of investment, and 0 otherwise. Thus, in the case of non-investment the parent can consume his whole income while his child only gets the lower wage of an unskilled worker. In the case of investment, the parent can only consume his income minus education costs  $x$ , but the child's income is given by the skilled wage.

The remaining analysis concentrates on the utility function given in equation (3), but the results also hold as long as the set of the aggregate skill level  $\lambda$  for that unskilled parents invest in a child with low costs  $x^l$  is a closed interval or a singleton. Thus, a utility function with constant elasticity and relative risk aversion of at least one instead of the logarithmical function would lead to the same results.<sup>8</sup>

Given the utility function (3) the subjective benefit  $B(\cdot)$  and the subjective costs  $C^k(\cdot)$  from investment are

$$B(\lambda_{t+1}) \equiv \delta \left( \ln w_{t+1}^s - \ln w_{t+1}^n \right) \quad (4)$$

and

$$C^k(\lambda_t, x) \equiv \ln w_t^k - \ln(w_t^k - x). \quad (5)$$

The subjective benefit from investment is influenced by the skill ratio in the child's working period  $t + 1$  and is independent of the occupation type, whereas subjective costs depend on the skill ratio in the parent's working period  $t$ , on the occupation type of the parent and on the child's talent. It is clear that a parent invests (does not invest) in the education of his child with education costs  $x$  whenever the subjective benefit is higher (lower) than the subjective costs. If subjective benefit equals subjective costs, skilled (unskilled) parents are assumed to invest with market clearing probability  $\alpha$  ( $\beta$ ).

Let us define  $\hat{x}^k(\lambda)$ ,  $k \in \{s, n\}$  as the critical cost function of the skilled and unskilled, respectively, i.e.,

$$\hat{x}^k(\lambda) \equiv \left( 1 - \left( \frac{w^n(\lambda)}{w^s(\lambda)} \right)^\delta \right) w^k(\lambda). \quad (6)$$

Thus,  $\hat{x}^k(\lambda)$  denotes the education costs of a child that makes his parent with occupation  $k$  just indifferent in his investment decision. Depending on the aggregate skill ratio  $\lambda$ , parents with occupation  $k$  invest (do not invest) in a child if his education

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<sup>8</sup>This condition is already mentioned in Mookherjee and Napel (2007) as *double crossing property (DCP)*. Taking the results of Mookherjee and Ray (2009) into account, the results are, in general, not stable with respect to all kinds of bequest motives, i.e., if parents are paternalistic, partly paternalistic or non-paternalistic.

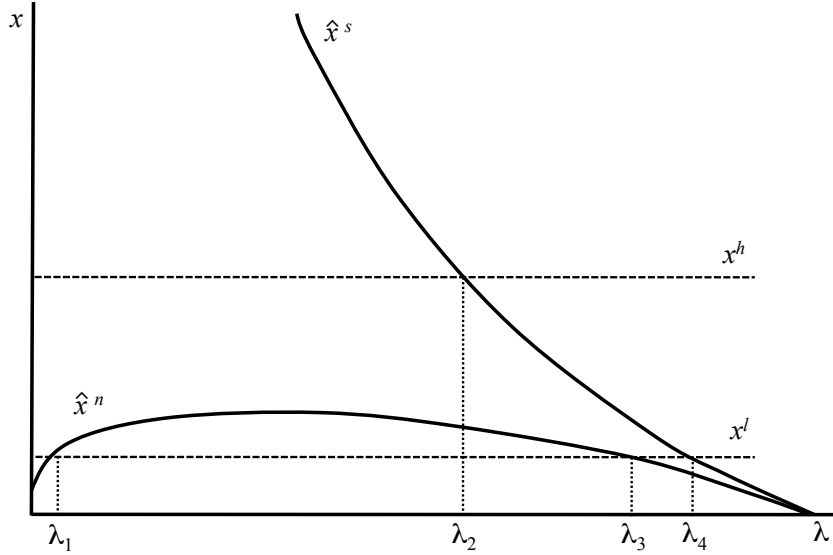


Figure 1: Critical cost functions of the skilled ( $\hat{x}^s$ ) and unskilled ( $\hat{x}^n$ )

costs are lower (higher) than  $\hat{x}^k(\lambda)$ . Figure 1 illustrates a situation where unskilled parents invest in a child with education costs  $x^l$  for  $\lambda \in (\lambda_1, \lambda_3)$  and never invest in a child with education costs  $x^h$ . Analogously, skilled parents invest in the low cost type for  $\lambda \in (0, \lambda_4)$  and in the high cost type for  $\lambda \in (0, \lambda_2)$ .

The situation of the population can be described by the occupation and cost distribution, which is denoted by

$$\pi(t) \equiv \{\pi_{sl}(t), \pi_{sh}(t), \pi_{nl}(t), \pi_{nh}(t)\} \quad (7)$$

where  $\pi_{k^i}(t)$  is the fraction of agents with occupation  $k \in \{s, n\}$  and education costs  $x^i$ ,  $i \in \{l, h\}$  at time  $t$ . Thus, the aggregate skill ratio of the population equals  $\lambda_t = \pi_{sl}(t) + \pi_{sh}(t)$ .

The dynamics of the model depends on the skilled fraction since it determines the investment decisions of the parents and therefore the transition matrix, which describes the evolution from state  $\pi(t)$  to a new state  $\pi(t+1)$ . To make this clearer, e.g.,

$$\pi(t) \cdot \begin{pmatrix} p_{l \rightarrow l} & \alpha \cdot p_{l \rightarrow h} & 0 & (1 - \alpha) \cdot p_{l \rightarrow h} \\ p_{h \rightarrow l} & \alpha \cdot p_{h \rightarrow h} & 0 & (1 - \alpha) \cdot p_{h \rightarrow h} \\ p_{l \rightarrow l} & 0 & 0 & p_{l \rightarrow h} \\ p_{h \rightarrow l} & 0 & 0 & p_{h \rightarrow h} \end{pmatrix} = \pi(t+1) \quad (8)$$

describes a situation where all parents at time  $t$  invest in a child with education costs  $x^l$  and skilled parents additionally are indifferent in the investment decision for a

child with education costs  $x^h$ . Skilled parents invest in such a child with probability  $\alpha$ . Summing up, the dynamics can be described by a time-heterogenous Markov chain.

Whenever the current skill ratio  $\lambda_t$  and the expectations about the next period  $\lambda_{t+1}^e$  induce a total skill ratio  $\lambda_{t+1} = \lambda_{t+1}^e$  the sequence  $\{\lambda_t\}_{t=0,1,2,\dots}$  describes a competitive equilibrium.

The analysis only focuses on equilibria with stationary skill ratios (SS), i.e.,  $\lambda_t = \lambda_{t+1} \equiv \lambda^*$ . In this case, the transition matrix is stationary and the Markov chain becomes a homogenous one. Since a situation without mobility is at odds with reality, the analysis is additionally restricted to steady states with mobility (SSM), i.e., equilibria with stationary skill ratios in which the number of unskilled investors is positive and equals the number of skilled non-investors.

Since investment of the unskilled, because of their wage disadvantage, always requires investment of the skilled, and investment in a child with education costs  $x^h$  always requires investment in a child with education costs  $x^l$ , there are four different types of SSMs that are summarized in Table 1. In the table, *yes* denotes strict investment, *no* denotes strict non-investment, and  $\alpha$  ( $\beta$ ) denotes that skilled (unskilled) parents are indifferent and invest with market-clearing probabilities.

Since an SSM of type II is unstable in the sense that it diminishes whenever there is a small exogenous shock, this type of SSM is not considered for the remaining analysis which is based on changes in the upward ( $u(\cdot)$ ) and downward ( $d(\cdot)$ ) social mobility flows. The upward mobility flow denotes the number of children with unskilled parents that get an education while the downward mobility flow is the number of children with skilled parents that do not get an education. Both flows depend on the aggregate skill ratio and equal

$$u(\lambda) \equiv \{\beta(\pi_{nl}p_{l \rightarrow l} + \pi_{nh}p_{h \rightarrow l})\} \quad (9)$$

and

$$d(\lambda) \equiv \{(1 - \alpha)(\pi_{sl}p_{l \rightarrow h} + \pi_{sh}p_{h \rightarrow h})\}, \quad (10)$$

respectively. The expression  $\pi_{ki}p_{i \rightarrow j}$  with  $k \in \{s, n\}$  and  $i, j \in \{l, h\}$  denotes the fraction of parents with occupation  $k$  and education costs  $x^i$  weighted with the conditional probability that a parent with education costs  $x^i$  has a child with costs  $x^j$ . If the unskilled invest with strict preferences in the cost type  $x^l$  (see SSM types I and III),  $\beta = 1$  holds; otherwise it is  $\beta \in (0, 1)$  (see SSM types IV). Analogously, it is  $\alpha = 0$  if the skilled strictly do not invest in the cost type  $x^h$  (see SSM types III and IV), and

	Type I	Type II	Type III	Type IV
Skilled invest in $x^l$ -type	yes	yes	yes	yes
Unskilled invest in $x^l$ -type	yes	$\beta$	yes	$\beta$
Skilled invest in $x^h$ -type	$\alpha$	$\alpha$	no	no
Unskilled invest in $x^h$ -type	no	no	no	no

Table 1: Four possible types of SSMs

$\alpha \in (0, 1)$  otherwise (see SSM types I). Although the RHSs of equations (9) and (10) do not directly depend on the aggregate skill ratio  $\lambda$ , they depend on the parameters  $\alpha$  and  $\beta$ , respectively, that are determined by  $\lambda$ .

According to equation (9), the upflow is characterized by one upward jump and a corresponding downward jump. If the aggregate skill ratio is small, unskilled wages are low and investment in education is not possible for unskilled parents. An increase in the skill ratio raises the wage of the unskilled and makes it beneficial to invest in a child with low costs, resulting in an upward jump of the upward flow. Nevertheless, an increase in the skill ratio also reduces the wage premium so that unskilled parents stop investment in the low cost type if the skill ratio becomes ‘too high’. This leads to a downward jump of the upward flow. Between upward and downward jumps, the flow strictly decreases because an increasing skill ratio means that the number of unskilled investors shrinks. In contrast, the downward flow by equation (10) is increasing in the aggregate skill ratio with one upward jump. If the aggregate skill ratio is very small, wages of the skilled are so high that they even invest in a child with high costs. However, an increase of the skill ratio decreases skilled wages and therefore skilled parents will start non-investment for low-talented children, resulting in an upward jump of the downward flow. Finally, an increasing number of skilled results in an increasing number of skilled non-investors; the downward flow increases.<sup>9</sup> It can easily be seen and is already mentioned in Mookherjee and Napel (2007) that there exists the possibility for a limited multiplicity of SSMs.<sup>10</sup> More precisely, two SSMs can simultaneously occur in the present setup (e.g., see Figure 2).

### 3. Redistributive taxation

In this section, the effect of redistributive taxation on an existing SSM is analyzed. Due to redistributive taxation the number and types of SSMs can change. To simplify matters, only the marginal impact of redistributive taxation is focused on, and therefore a tax rate that is marginally higher than zero is introduced. The main target of this analysis is to understand how the incentives of skilled and unskilled parents change and how these changes affect the skill ratio in the steady state, inequality, and social mobility.

The introduction of a small tax rate  $\tau$  results in post-tax wages

$$w_{\tau,t}^s \equiv w_{\tau}^s(\lambda_t) = (1 - \tau)w_t^s + \tau(\lambda_t w_t^s + (1 - \lambda_t)w_t^n) \quad (11)$$

and

$$w_{\tau,t}^n \equiv w_{\tau}^n(\lambda_t) = (1 - \tau)w_t^n + \tau(\lambda_t w_t^s + (1 - \lambda_t)w_t^n) \quad (12)$$

with  $w_t^s$  and  $w_t^n$  defined as in equations (1) and (2). Thus, redistributive taxation amounts to an unconditional transfer from the skilled to the unskilled. While this policy increases the wage of unskilled workers, it decreases the wage of skilled workers. This directly gives Lemma 1.

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<sup>9</sup>Analogously, in the case of  $r$  discrete types of talents, the upflow is characterized by up to  $r - 1$  upward jumps as well as corresponding downward jumps, while the downward flow is characterized by  $r - 1$  upward jumps.

<sup>10</sup>In the case of  $r$  discrete types of talents, up to  $2(r - 1)$  SSMs can co-exist.



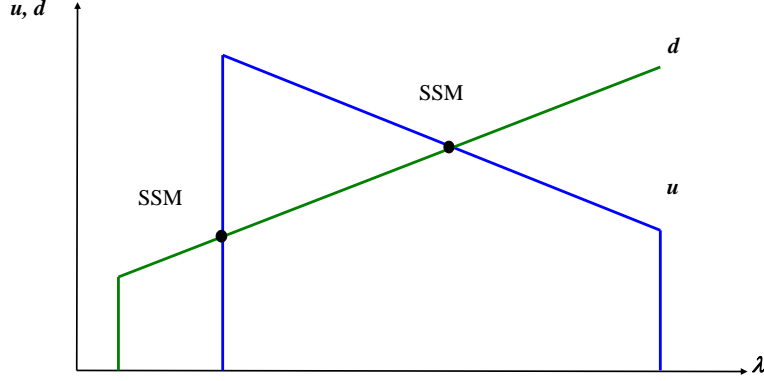


Figure 2: Mobility flows for a case with two SSMs

LEMMA 1. *Subjective benefit of investment ( $B_\tau$ ) is reduced by redistributive taxation. Subjective costs of investment are lowered for the unskilled ( $C_\tau^n$ ) but raised for the skilled ( $C_\tau^s$ ).*

Thus, for skilled parents, investment incentives shrink due to increased costs and decreased benefit. However, for unskilled parents, two counteracting effects appear. On the one hand, investment becomes easier as a result of decreased costs (*cost effect*); on the other hand, return on investment in human capital drops due to a lowered wage gap (*wage premium effect*). Let  $\hat{\lambda} \in (0, \gamma)$  be defined as the solution of

$$w^n(\lambda) - \frac{w^n(\lambda)^{\delta+1}}{w^s(\lambda)^\delta} = w_\tau^n(\lambda) - \frac{w_\tau^n(\lambda)^{\delta+1}}{w_\tau^s(\lambda)^\delta}, \quad (13)$$

i.e.,  $\hat{\lambda}$  is the skill ratio at which the critical cost functions of the unskilled with and without redistributive taxation intersect.<sup>11</sup> At  $\hat{\lambda}$ , redistributive taxation has no influence on the investment incentives of the unskilled agents. Up to  $\hat{\lambda}$ , it raises investment incentives of the unskilled, while for all  $\lambda \in (\hat{\lambda}, \gamma)$ , the reverse is true. The change in

<sup>11</sup>Existence and uniqueness of  $\hat{\lambda}$  are equal to a single point of intersection of  $C^n(\lambda) - C_\tau^n(\lambda)$  and  $B(\lambda) - B_\tau(\lambda)$ . While the difference in costs is a convex function in  $\lambda$ , the difference in benefit has an S-shaped form, i.e., it is concave for  $\lambda < \frac{1-2\gamma+2\tau\gamma}{2\tau}$  and convex otherwise. This directly follows from the second order derivative. Considering that at the lower bound of the investment interval, the cost difference is higher than the difference in benefits and that both differences are zero at the end of the investment interval, i.e., at  $\lambda = \gamma$ , both functions intersect at a unique  $\hat{\lambda}$ .

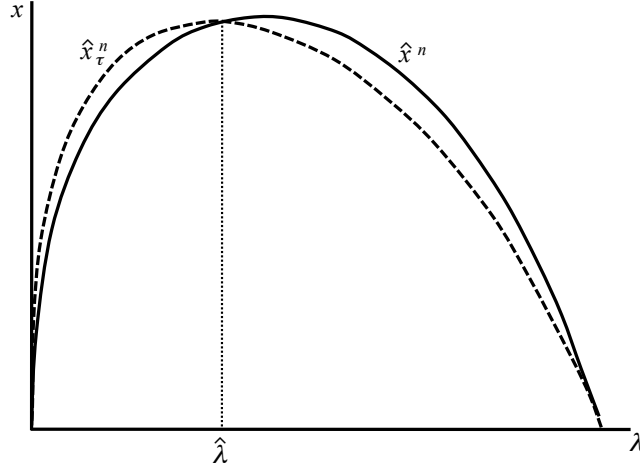


Figure 3: Critical cost function of the unskilled with (dashed line) and without (solid line) redistributive taxation

the critical cost function of the unskilled is illustrated in Figure 3.

The change in the investment incentives directly implies that the downflow weakly increases due to redistributive taxation. The upflow never decreases if the pre-tax SSM satisfies  $\lambda^* \in (0, \hat{\lambda})$ , but it never increases if  $\lambda^* \in (\hat{\lambda}, \gamma)$  holds. Thus, the social mobility upflow can only be raised due to redistributive taxation if the population before the policy intervention is characterized by a low skill ratio. Proposition 1 summarizes the results for the change in the skill ratio.

**PROPOSITION 1.** *The aggregate skill ratio decreases due to redistributive taxation in the case of a type-I or type-IV SSM. It is unchanged in the case of a type-III SSM.*

*Proof:* The results for all cases are illustrated in Figure 4. While solid lines illustrate mobility flows without taxation, dashed lines illustrate mobility flows with redistributive policy. Let  $\lambda^*$  denote the SSM before taxation while  $\lambda_\tau^*$  is the stationary skill ratio after taxation. Focusing on an SSM of type I, the investment incentives of the skilled are decreased by the policy, while the investment incentives of the unskilled near the initial skill ratio  $\lambda^*$  are not influenced. This implies that the skilled start non-investment in at least some high-skilled children at  $\lambda_\tau^* < \lambda^*$ . Thus, the stationary skill ratio decreases. An SSM of type IV can appear at the lower bound of the interval where unskilled parents invest in a child with low costs, i.e., when  $\lambda^* < \hat{\lambda}$  holds, or at the upper bound of this interval, i.e., when  $\lambda^* > \hat{\lambda}$  holds. Redistributive taxation shifts this investment interval to the left. Therefore,  $\lambda_\tau^* < \lambda^*$  holds, i.e., the stationary skill ratio is smaller with than without taxation. For an SSM of type III, i.e., an SSM where all agents have strict investment incentives, a small tax rate  $\tau$  does not change investment incentives at the initial SSM  $\lambda^*$ . Therefore, stationary skill ratios before and after taxation are equal.  $\square$

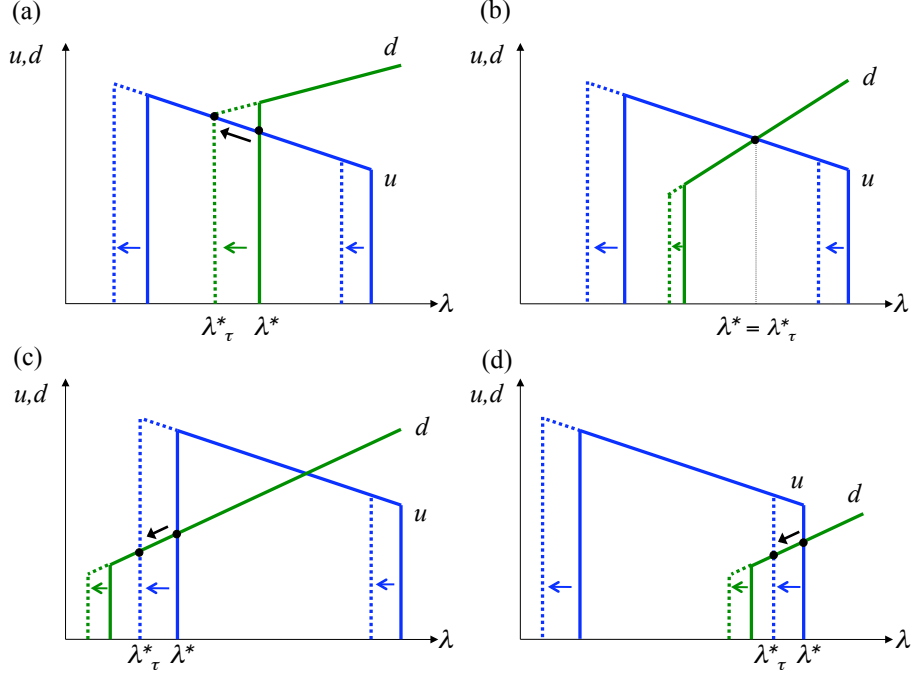


Figure 4: Change in skill ratio due to taxation for (a) SSM type I, (b) SSM type III, and (c) and (d) SSM type IV

Thus, redistributive taxation is not recommended as a policy targeting an increasing aggregate skill ratio. However, the change in the skill ratio is not only interesting for itself but also determines the change in inequality. Proposition 2 summarizes the impact of the tax on the level of inequality.

**PROPOSITION 2.** *A tax policy resulting in a constant or increased aggregate skill ratio reduces intragenerational inequality while a decreased skill ratio lowers and maybe overcompensates the direct tax effect and therefore can increase inequality.*

*Proof:* For an unchanged skill ratio, redistributive taxation increases the wage of the unskilled and decreases the wage of the skilled. Thus, for an unchanged skill ratio, inequality is reduced (*direct tax effect*). Since an increased aggregate skill ratio ceteris paribus leads to a reduction of the wage gap, the *direct tax effect* is enhanced by an *indirect tax effect* if the aggregate skill ratio is increased. Analogously, the *direct tax effect* is weakened and may be overcompensated due to a decreased aggregate skill ratio.<sup>12</sup>  $\square$

<sup>12</sup>The *indirect tax effect* that occurs due to a change in the aggregate skill ratio is already mentioned by Dur and Teulings (2001) and also plays a crucial role when Konrad and

Summing up, for a type-I or type-IV SSM, redistributive taxation may increase inequality while it is definitely reduced in case of a type-III SSM that is characterized by strict investment incentives of all agents.

The second point of interest is the change in social mobility due to redistributive taxation.

**PROPOSITION 3.** *Social mobility increases due to redistributive taxation if the SSM is of type I while it decreases if the SSM is of type IV. For a SSM of type III social mobility is not influenced by redistributive taxation.*

*Proof:* For an SSM of type I, the skill ratio is decreased by redistributive taxation (see Prop. 1). This implies, since the upward flow is strictly decreasing in the relevant range, increased upward mobility. Therefore, in the SSM, there must also be an increased downward mobility. For an SSM of type IV, the skill ratio also increases due to redistributive taxation (see Prop. 1). However, the strictly decreasing downward flow in this situation implies a reduction in the downward mobility, and therefore in the SSM also a decrease in the upward mobility. For an SSM of type III, the skill ratio does not change due to redistributive taxation (see Prop. 1). Therefore, upward and downward mobility flows do not change at  $\lambda^*$ . The results for the different types of SSM can also be inferred by Figure 4.  $\square$

Summarizing, redistributive taxation is in general not a good policy to reduce inequality and increase social mobility at the same time. However, it reduces inequality (for a constant level of social mobility) if the pre-tax SSM is of type III and it increases social mobility (with an ambiguous effect on inequality) if the SSM is of type I.

#### 4. Education subsidies

One may suspect that redistributive taxation is, in general, no good policy intervention because it amounts to an unconditional transfer. However, this section shows that education subsidies as a conditional transfer generally cannot decrease inequality and increase social mobility, either. In the analysis, the focus is again on the marginal effect of subsidization and therefore a subsidy rate  $\theta$  that is marginally higher than zero is assumed. Otherwise, the number and types of SSMs could change completely. Assume that education subsidies are available to all parents that choose to acquire education, and that they are independent of the parent's occupation type. They are paid proportional to the education costs of the child and are financed by a flat-rate tax levied on the general public (similar to Bovenberg and Jacobs (2005)). Considering practical applications, parents facing monetary education costs only have to pay the  $(1 - \theta)$ -fraction of these costs and can demand the remaining costs from the government. In equilibrium, the aggregate amount of subsidy  $\Theta(\lambda)$  for an exogenous and small subsidy rate  $\theta$  is

$$\Theta(\lambda) = \theta\lambda(\rho_l x^l + \alpha\rho_h x^h) + \theta(1 - \lambda)\beta\rho_l x^l, \quad (14)$$

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Spadaro (2006) show that not only low-talented but also highly talented agents may support redistribution.

where  $\rho_l$  and  $\rho_h$  denote the exogenous fractions of children with low and high education costs, respectively.<sup>13</sup> Considering a tax rate  $\tau_{\text{sub}}$  the aggregate tax amount in equilibrium is  $\tau_{\text{sub}}(\lambda w^s + (1 - \lambda)w^n)$ .<sup>14</sup> Thus, for a subsidy rate  $\theta$  that is exogenously fixed, the tax rate  $\tau_{\text{sub}}$  is endogenously determined by the government's budget restriction as

$$\tau_{\text{sub}} \equiv \frac{\theta\lambda(\rho_l x^l + \alpha\rho_h x^h) + \theta(1 - \lambda)\beta\rho_l x^l}{\lambda w^s + (1 - \lambda)w^n}. \quad (15)$$

For the remaining analysis  $\theta > \tau_{\text{sub}}$  is assumed to hold. This assumption is necessary to foster investment incentives of the agents<sup>15</sup> and can be guaranteed for at least a small exogenous subsidy rate.<sup>16</sup>

Considering the described policy intervention, equilibrium wages are

$$w_{\text{sub}}^s = (1 - \tau_{\text{sub}})w^s \quad \text{and} \quad w_{\text{sub}}^n = (1 - \tau_{\text{sub}})w^n \quad (16)$$

with  $w^s$  and  $w^n$  given as in equations (1) and (2). Replacing  $w^s$  and  $w^n$  in equations (4) and (5) by  $w_{\text{sub}}^s$  and  $w_{\text{sub}}^n$  gives subjective benefit and costs after subsidization.

**LEMMA 2.** *The subjective benefit of investment ( $B_{\text{sub}}$ ) does not change due to education subsidies. Subjective costs of the skilled ( $C_{\text{sub}}^s$ ) and unskilled ( $C_{\text{sub}}^n$ ) are reduced.*<sup>17</sup>

The lemma directly follows from the change in wages. Caused by the unchanged benefit and the reduced costs the investment incentives of all parents increase. Therefore, the upflow is never decreased due to the described policy while the downflow is never increased. The change in the mobility flows then gives Proposition 4.

**PROPOSITION 4.** *Education subsidies that are financed by a flat-rate tax levied on the general public increase the aggregate skill ratio if the SSM is of type I and do not change the skill ratio if the SSM is of type III. If the SSM is of type IV, subsidization decreases the skill ratio in a low-skilled population, i.e., if  $\lambda^* < \hat{\lambda}$  holds, but it increases the skill ratio in a high-skilled population, i.e., if  $\lambda^* > \hat{\lambda}$  holds.*

<sup>13</sup>Another common subsidy policy is a flat subsidy where every parent who invests gets a fixed subsidy amount  $\bar{\theta}$ . Since in this case, equation (14) can be rewritten as  $\Theta(\lambda) = \bar{\theta}\lambda(\rho_l + \alpha\rho_h) + \bar{\theta}(1 - \lambda)\beta\rho_l$  qualitative results of this section also hold for a flat subsidy. Even a flat subsidy only available for the unskilled can, in general, not increase social mobility and decrease inequality.

<sup>14</sup>All parameters that refer to the case of education subsidies are indexed with 'sub'.

<sup>15</sup>Subjective benefit is not influenced by the policy (see Lemma 2) and, easily checked again, only for  $\tau_{\text{sub}} < \theta$  subjective costs are smaller with than without education subsidies.

<sup>16</sup>Considering equation (15),  $\rho_l x^l + \alpha\rho_h x^h (< (\rho_l + \alpha\rho_h)x^h) < w^s$  and  $\beta\rho_l x^l < w^n$  are sufficient conditions to assure  $\tau_{\text{sub}} < \theta$ . As  $w^s \geq (1 - \theta)x^h$  and  $w^n \geq (1 - \theta)x^l$  are necessary conditions for investment, we can rewrite the sufficient conditions as  $(1 - \theta) \geq \rho_l + \alpha\rho_h$  and  $(1 - \theta) \geq \beta\rho_l$ . As the second condition always holds if the first condition is fulfilled and the right-hand side of the first condition is smaller than 1, there exists a  $\theta > 0$  so that the first condition and therefore  $\theta > \tau_{\text{sub}}$  holds.

<sup>17</sup>The fact that subjective benefit is not influenced by subsidization depends on the special form of the utility function. If the utility function is, e.g.,  $u(c) = \frac{c^{1-\phi}}{1-\phi}$  subsidization causes an increase in the subjective benefit.

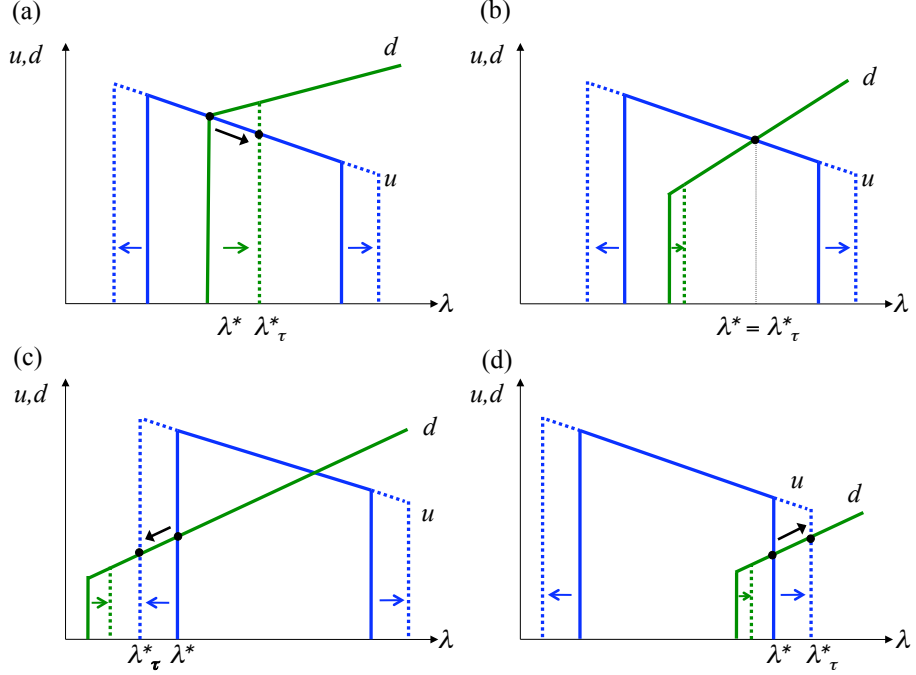


Figure 5: Change in skill ratio caused by education subsidies for (a) SSM type I, (b) SSM type III, and (c) and (d) SSM type IV

*Proof:* The changes in the upward and downward mobility flows for all types of SSMs are illustrated in Figure 5. Again, solid lines represent the case without policy intervention while dashed lines are the social mobility flows with education subsidies. The skill ratio in an SSM of type I is determined by the indifference in the investment decision of skilled parents with respect to a child with high costs, i.e., an upward jump of the downward flow. With subsidization, skilled parents are indifferent in their decision to invest in a low-talented child at a higher aggregate skill ratio than without policy intervention. Thus, the skill ratio increases due to subsidization. For an SSM of type III, upflow and downflow do not change at  $\lambda^*$ . Thus, the skill ratio is not influenced. An SSM of type IV is characterized by the indifference in the investment incentives of the unskilled. Since investment incentives of the unskilled are increased due to subsidization, the skill ratio at which the upward flow jumps from zero to a positive value is smaller with than without subsidization, and the skill ratio at which the upward flow jumps from a positive value to zero is higher with than without subsidization. Thus, if  $\lambda^* < \hat{\lambda}$  holds, education subsidies decrease the skill ratio while they increase the skill ratio for  $\lambda^* > \hat{\lambda}$ .  $\square$

As wages  $w_{\text{sub}}^s$  and  $w_{\text{sub}}^n$  depend on the subsidy rate  $\theta$  only via the taxation rate  $\tau_{\text{sub}}$  education subsidies that are financed by a linear income tax affect inequality in

the same way as redistributive taxation does. Therefore, Proposition 2 also holds in the case of subsidization. Summarizing, education subsidies are an appropriate policy to reduce inequality under most circumstances, i.e., if the SSM is of type I, III, or in a high-skilled population of type IV. However, if the population is characterized by a low initial aggregate skill ratio and the unskilled are indifferent in their investment decision with respect to the cost type  $x^l$ , the impact on the wage gap is ambiguous.

Focusing on the impact of education subsidies on social mobility, one can obtain:

**PROPOSITION 5.** *Social mobility decreases due to education subsidies if the SSM is of type I. It is not influenced if the SSM is of type III. If the SSM is of type IV, social mobility is decreased by subsidization in a low-skilled population, i.e., if  $\lambda^* < \hat{\lambda}$  holds, but it is increased in a high-skilled population, i.e., if  $\lambda^* > \hat{\lambda}$  holds.*

*Proof:* All results are illustrated in Figure 5. The skill ratio in an SSM of type I is determined by the indifference in the investment decision of the skilled with respect to a child with high education costs. With education subsidies, skilled parents are indifferent in their investment decision for a low-talented child at a higher aggregate skill ratio than without subsidization. This implies, since the upward mobility flow is strictly decreasing, a decrease in social mobility. For an SSM of type III, investment incentives are not influenced by subsidization at  $\lambda^*$ . Thus, social mobility does not change due to the policy intervention. In a low-skilled population, the aggregate skill ratio decreases for an SSM of type IV (see Proposition 4). This increase implies a reduction in the social mobility because the downward flow increases in the aggregate skill ratio. In a high-skilled population, the aggregate skill ratio increases for an SSM of type IV (see Proposition 4). Therefore, the increasing downward flow results in an increase of the social mobility.  $\square$

Summing up, education subsidies increase social mobility only in a high-skilled population where the unskilled are indifferent in their investment decision with respect to a child with low education costs.

Comparing both types of policy intervention, redistributive taxation and education subsidies affect inequality and social mobility in the same way when the SSM is of type III or the SSM is of type IV and  $\lambda^* < \hat{\lambda}$  holds, but they have different effects in all other cases. Redistributive taxation can in no case simultaneously reduce inequality and increase social mobility. However, education subsidies can achieve this in a high-skilled population where the unskilled are indifferent in their investment decision, having a child with low education costs.

## 5. Concluding remarks

This paper shows that neither redistributive taxation nor education subsidies are always a recommended policy to help poor children become educated when parents decide on the education of their children and wages are endogenous. The impact of both policy interventions on the aggregate skill ratio as well as on inequality and social mobility depends on the initial investment decisions of all parents. Under some circumstances, both policies can definitely reduce inequality and under other circumstances, increase social mobility. However, only education subsidies can ensure both at the same time for at least one situation. Unfortunately, this situation requires that

the population without policy intervention is already characterized by a high skill ratio. Thus, if ‘skilled’ refers to primary education, one can say that the simultaneous improvement of intra- and intergenerational equity can only be reached in developed countries; if ‘skilled’ refers to higher education, it can only be reached in countries with a high initial level of university education. Finally, although both policies should increase social mobility, conditions under which social mobility is reduced due to public provision are provided. Only when the government is aware of the specific situation can it implement the right’ policy to raise the number of poor children that get educated. However, in a low-skilled population where unskilled parents are indifferent with respect to an investment in a child with low education costs, neither redistributive taxation nor education subsidies yield an increase in social mobility. Note that in the present model, a child’s future wage depends only on the education decision of its parents but not on the inherent talent of the child. Thus, this model does not consider a possible positive effect in aggregate productivity or growth if the most talented agents get educated (see e.g., Hassler and Rodríguez Mora (1998) and De Fraja (2002) for models that consider this effect). Additionally, the influence of the analyzed policies on social welfare could be an interesting starting point for further research. Such an approach seems to be complicated because even the special forms of the utility and production functions considered above do not allow quantifying the exact change in the skill ratio, but it can only determine the direction of change.

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