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# On the Political Economy of Education Subsidies

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Standard models of public education provision predict an implicit transfer of resources from higher-income individuals toward lower-income individuals. Many studies have documented that public higher education involves a transfer in the reverse direction. We show that this pattern of redistribution is an equilibrium outcome in a model in which education is only partially publicly provided and individuals vote over the extent to which it is subsidized. We characterize economies in which poorer individuals are effectively excluded from obtaining an education and their tax payments help offset the cost of education obtained by others. We show that increased inequality in the income distribution makes this outcome more likely and that the efficiency implications of this exclusion depend on the wealth of the economy.

## 1. INTRODUCTION

Societies intervene in the area of education in a variety of ways. That they should choose to do so is perhaps not surprising: plausible economic justifications for intervention are plentiful and range from the existence of market imperfections of various sorts (especially imperfect capital markets), to externalities from education both static and dynamic, to public goods arguments.<sup>1</sup> The factors that determine the extent and the forms that these interventions take seem far less obvious, however. Heterogeneity among individuals, whether in terms of income, ability or locality, tends to generate conflicting preferences as to the kind of policies that are most desirable. There may be widespread disagreement in the choice of, for example, the optimal degree of subsidization of education, the quality of education, the rules that should determine an individual's eligibility for particular subsidies (e.g. guaranteed student loans, scholarships, or financial aid), or the desirability of barriers to entry such as entrance examinations or enrollment restrictions. In the absence of a social planner that chooses policies to maximize a well-defined welfare function, an analysis is required to understand how heterogeneity and the political system interact to generate different features of the educational system.<sup>2</sup>

1. In a rather different vein, K. E. Lommerud (1989) discusses the role of relative income concerns as an additional justification for the provision of educational subsidies and J. R. Lott (1990) suggests that the public provision of schooling is undertaken by the state since it lowers the opposition to wealth transfers by indoctrinating students with the "correct" set of beliefs.

2. There is a growing literature that examines political forces as a determinant of economic outcomes. Early examples are Schumpeter (1947), Downs (1957), and Buchanan and Tullock (1962). More recent studies include Meltzer and Richard (1981), Alesina (1987), Persson and Tabellini (1990), and Fernandez and Rodrik (1991). See also the readings in Persson and Tabellini (1994).

A standard textbook treatment (see e.g. Atkinson and Stiglitz (1980)) of public education provision considers the case of a publicly provided private good, financed by a proportional income tax. Such a model has implications for both the resources devoted to education and for the redistribution of income implicit in the financing scheme. In this setting, if collective choices are determined by majority vote then the outcome involves a net transfer of resources from higher-income individuals to lower-income individuals.<sup>3</sup> This prediction of the standard model appears to be at odds with a well-documented fact concerning public higher education: Children from higher-income families are more likely to attend college than are those from lower-income families, and hence the net effect of public support for higher education is a transfer of resources from lower-income individuals to higher-income individuals.<sup>4</sup>

One explanation for this apparent discrepancy is that those individuals who do not attend college may nevertheless benefit from the fact that others do because of complementarities in production, spillovers, or effects on growth. Johnson (1984) and Creedy and Francois (1990) formally show that this possibility can resolve the apparent discrepancy. A second explanation is that majority voting is not an appropriate mechanism to capture how policies are decided upon and that in reality political power is concentrated among wealthier individuals.

In this paper we put forward a third possibility. We argue that there is a connection between the fact that subsidies to public education redistribute income toward higher-income individuals and the fact that education is only *partially* publicly provided. An outline of our argument follows. If credit constraints affect education decisions, then a vote on the extent to which education is subsidized is also implicitly a vote over who receives the subsidy. By choosing to subsidize only partially the cost of an education, higher-income individuals can effectively exclude poorer individuals from receiving this education and simultaneously extract resources from them. This endogenously determined exclusion is the novel feature of our analysis of redistributive schemes.

We develop this argument formally in a model which is deliberately simplified in order to highlight the fundamental forces at work. At the economic level, individuals are assumed to be *ex ante* identical in every respect except for their initial income. Education is a discrete investment good and capital markets are imperfect. An individual's cost of acquiring an education can be uniformly subsidized through a proportional income tax levied on the general public. The subsidy, however, is available only to those individuals who choose to acquire an education. Since we assume that all individuals would benefit from obtaining an education, an individual's income and the subsidized cost of education are the sole determinants of whether she will do so. The tax rate, and hence the extent to which education is subsidized, is determined by majority vote.

Several results emerge from our analysis. First, we show that under certain conditions the majority voting equilibrium consists of a positive subsidy to education but with only the rich and middle class obtaining an education, i.e. the poor subsidize the education of higher-income individuals. Second, in a sense which is made precise in the paper, we find that the efficiency consequences of subsidization with excludability (relative to an equal-subsidy system) may be positive for a poor economy, but never for a wealthy economy.

3. Saint-Paul and Verdier (1993) and Glomm and Ravikumar (1992) provide models where this result obtains. They examine economies in which all individuals obtain the same education but the amount spent on education (and hence human capital accumulation) is determined by majority vote over tax rates. See also Stiglitz (1974).

4. Studies which document this fact include Bishop (1977), Hansen and Weisbrod (1969), Radner and Miller (1970), Peltzman (1973) and Jackson and Weathersby (1975) for the United States and Psacharopoulos (1986) for several developing countries.

Third, we argue that economies with more unequal income distributions are more likely to perpetuate this inequality over time. Lastly, we point out that there are instances in which wealthier individuals would profit from making education more costly since this affects their ability to exclude others and extract resources from them.

The paper is organized as follows. Section II lays out the structure of the model and Section III examines preferred tax rates. Section IV defines equilibrium outcomes and Section V discusses some of the more interesting implications. Section VI concludes.

## II. THE MODEL

In order to study in as stark and simple a framework as possible some of the interactions between income distribution, the political system and education, we choose to abstract away from considerations that may be generated by other factors such as income smoothing concerns, intergenerational bequest motivations, and heterogeneity both in preferences and in abilities among individuals. We place emphasis instead on the affordability of education in an economy in which each individual would benefit by acquiring an education, but may be prevented from doing so by imperfect capital markets. In the context of the U.S. this model is perhaps best thought of as representing higher education, since affordability of primary and secondary education is not an issue. For less-developed countries, noting that the cost of education includes foregone income, it may be natural to think in terms of primary or secondary education.

The economy consists of a continuum of two-period-lived agents with total mass equal to one. There is a single consumption good and individuals have a linear utility function defined over first- and second-period consumption. There is no discounting.<sup>5</sup> The agents belong to one of three groups, differentiated by their initial income (equivalently, endowment of the consumption good) which is assumed to take on the values  $y_1$ ,  $y_2$ , or  $y_3$ .<sup>6</sup> We assume that  $y_1 > y_2 > y_3$ , and will often refer to the three groups of agents as rich, middle class, and poor respectively. The fraction of agents in group  $i$  is written as  $\lambda_i$ .<sup>7</sup>

In the first period of life, each agent decides whether to obtain an education. The choice is zero-one and the unsubsidized cost of obtaining an education is  $E$ .<sup>8</sup> The benefit from education for an individual from group  $i$  is that second-period income equals  $f(y_i)$ . By contrast, an individual who does not obtain an education in the first period receives a second-period income equal to  $y_i$ .<sup>9</sup> We assume

$$f(y_i) - E > y_i \quad \forall i. \quad (1)$$

This ensures that, in the absence of government intervention, all individuals desire an education.<sup>10</sup>

5. We have chosen a linear utility function since it allows closed-form solutions and highlights the nature of the tensions among income groups. No discounting reduces notation without changing the nature of the results.

6. This model takes initial income heterogeneity as given, but it would not be difficult to generate this endogenously as a result of, for example, parents having differing preferences over their offspring's education, or from a stochastic element in lifetime income, whereupon the variables in our model should be interpreted as expected values.

7. The model can easily be generalized to  $n > 3$  discrete groups. The assumption of three groups, however, significantly reduces the number of voting equilibrium candidates.

8. We have deliberately chosen to model the acquisition of education as a discrete choice. In terms of our results, what matters is that as a result of capital market imperfections some individuals should find themselves at a corner with respect to their choice to invest in education.

9. We assume that there are no spillovers from educated to non-educated individuals and that the returns to education are unaffected by the number of individuals that obtain an education. These simplifications are not necessary but allow us to focus on other factors.

10. Note that  $f(y_i) = F$  is a special case of the model.

The market structure does not necessarily permit all individuals to obtain an education. Individuals are assumed not to have access to credit markets and hence cannot borrow against future earnings to finance expenditures on education when young. It follows that period-one income is a determinant of whether an individual obtains an education.<sup>11</sup> Hence, in the absence of government intervention, an individual's utility given initial income  $y_i$  is:<sup>12</sup>

$$u_i = y_i + \gamma_i \tag{2}$$

where

$$\gamma_i = \begin{cases} f(y_i) - E & \text{if } y_i \geq E, \\ y_i & \text{if } y_i < E. \end{cases} \tag{3}$$

A second factor that determines whether a given individual receives an education is the extent to which education is subsidized. In our model education is (endogenously) a partially publicly provided private good that is subsidized solely via a proportional tax  $\theta$  on period-one income.<sup>13</sup> The proceeds from taxation are distributed equally among all individuals that receive an education. Note, therefore, that it is possible that although all individuals are taxed, not all receive a subsidy. It is this feature of excludability that distinguishes our analysis from the rest of the literature, and in particular from Perotti (1993), the model closest to ours.<sup>14</sup>

Before proceeding to the equilibrium analysis it is useful to analyse the relationship between the tax rate, individual actions and utilities. Consider first the relationship between the tax rate, the government subsidy to education and the fraction of the population that receives an education. With a tax rate equal to  $\theta$ , tax revenues  $T(\theta)$  are given by:

$$T(\theta) = \theta \sum \lambda_i y_i = \theta \mu \tag{4}$$

where  $\mu$  is total or (since the mass of agents is one) average income. If  $N(\theta)$  represents the mass of agents who receive an education, then the per person subsidy  $s(\theta)$  is given by

$$s(\theta) = \theta \mu / N(\theta). \tag{5}$$

Since  $N$  and  $s$  are jointly determined by  $\theta$ , to determine the values of these that are mutually consistent we solve:

$$\text{Max } j \text{ s.t. } (1 - \theta)y_j - E + \theta \mu / (\sum_{i < j} \lambda_i) > 0 \tag{6}$$

where  $\sum_{i < j} \lambda_i = 0$  for  $j = 1$ . Given this  $j$  we find the greatest value of  $\rho_j \in (0, 1]$  such that

$$(1 - \theta)y_j - E + \theta \mu / (\sum_{i < j} \lambda_i + \rho_j \lambda_j) \geq 0 \tag{7}$$

where  $\rho_j(\theta)$  is the fraction of individuals of type  $j$  that receive an education given  $\theta$ .

11. We do not model here the particular microfoundations underlying the capital market failure. This would merely complicate the model and its exact features are not critical. We stress that the essential feature is not that individuals are unable to borrow at all, but rather that access to credit markets is such that initial income remains a determinant in an individual's decision to acquire education.

12. Our specification implies that individuals may spend all their income on education. This could be generalized to include expenditures on other goods as long as individual income remains a binding constraint on the purchase of education for some individuals.

13. Thus we are implicitly constraining our system from resorting to lump-sum taxation and other schemes.

14. This model also assumes credit constraints, that education is a discrete investment good, and that tax rates are determined by majority vote. Tax proceeds, however, provide equal lump-sum transfers to all individuals, independently of whether they obtain an education and there are assumed to be spillovers from educated to non-educated individuals.

Note that for a given value of  $s(\theta)$ , an individual from group  $i$  can obtain an education if and only if  $(1 - \theta)y_i - E + s(\theta) \geq 0$ . Clearly, if an individual from group  $j$  can afford to be educated then so can all individuals from group  $i$  for all  $i < j$ , i.e. if  $\rho_j \in (0, 1]$  then  $\rho_i = 1$  for all  $i < j$ . Thus, (6) and (7) allow us to determine  $N(\theta) = (\sum_{i < j} \lambda_i) + \rho_j \lambda_j$ , which in turn determines  $s(\theta)$ . Whenever  $0 < \rho_j(\theta) < 1$ , we assume that the fraction  $\rho_j(\theta)$  of agents from group  $j$  that obtain an education is randomly selected.

The value of the tax rate is chosen by majority vote. To determine an individual's preferences over any two tax rates, it is essential to understand how utility is affected by different values of  $\theta$ . Having determined the values of the  $\rho_i$ 's, it is possible to express the expected utilities of each of the three groups as a function of the tax rate  $\theta$ :

$$EU_i(\theta) = (1 - \theta)y_i + \rho_i(\theta)[s(\theta) - E + f(y_i)] + (1 - \rho_i(\theta))y_i. \tag{8}$$

A few preliminary results are helpful. First note that each of the functions  $\rho_i(\theta)$  is non-decreasing in  $\theta$ . Second, and following directly from the assumption that all individuals would wish to obtain an education if they could afford to, if  $0 < \rho_i(\theta) < 1$  an individual from group  $i$  must just be able to afford an education, i.e.  $E - s(\theta) = (1 - \theta)y_i$ . Furthermore, in that case the tax revenue must be insufficient to subsidize any more members of that group, i.e.  $[\sum_{i < j} \lambda_i + \rho_j \lambda_j]s(\theta) = \theta \mu$ .

Some additional notation facilitates the characterization of the  $EU_i$ 's. Let  $\hat{\theta}_i$  be the maximum value of  $\theta \in [0, 1]$  for which  $\rho_i(\theta)$  is equal to zero. If  $y_i \geq E$ , let  $\hat{\theta}_i$  equal zero. Thus,  $\hat{\theta}_2$  is, therefore, the value of  $\theta$  at which for any strictly positive increase in the tax rate it becomes possible for some  $y_2$  individuals to obtain an education. Lastly, define  $\bar{\theta}_i$  to be the smallest value of  $\theta \in [0, 1]$  for which  $\rho_i(\theta) = 1$ . Note that such a number may not exist in the unit interval, whereupon  $\bar{\theta}_i$  is undefined. So  $\bar{\theta}_i$  is the smallest value of  $\theta$  at which all individuals in group  $i$  can afford an education.

### III. PREFERRED TAX RATES

In this section we examine the preferred tax rates of individuals. We also contrast the effects of the combination of redistributive taxation and excludability on preferred tax rates with those of a purely redistributive scheme. By a "purely redistributive scheme" we refer to the case in which a proportional tax is used to finance equal per capita lump-sum transfers to *all* individuals. As is well known, in this case  $y_1$  individuals always prefer a tax rate of zero,  $y_3$  individuals always prefer a tax rate of one, and  $y_2$  individuals prefer a tax rate of zero or one depending upon whether  $y_2$  is greater or less than mean income,  $\mu$ . This outcome illustrates the simple fact that individuals whose income is below the mean favour redistribution whereas those whose income is above the mean oppose redistribution.

The novel feature of our model is that, depending upon the tax rate, transfers are not made to all individuals. Before addressing the implications of this for preferred tax rates, it is instructive to consider the case in which the groups who receive transfers are exogenously determined and independent of the tax rate chosen.

To begin with, consider the case where only  $y_1$  individuals receive the subsidy. It is trivial to show that  $y_1$  individuals would prefer a tax rate of one whereas the other two groups each prefer a tax rate of zero. Next, suppose that both  $y_1$  and  $y_2$  individuals receive the subsidy and consider the impact of a marginal increase in the tax rate on the lifetime income of a  $y_1$  individual. On the margin, her tax payments increase by  $y_1$  and her subsidy increases by  $\mu / (\lambda_1 + \lambda_2)$ . Since these effects are independent of the initial level of the tax

rate, it follows that  $y_1$  individuals prefer either a tax rate of zero or tax rate of one, depending upon whether  $y_1$  is greater than  $\mu/(\lambda_1 + \lambda_2)$ , or equivalently whether  $[(y_1 - y_2)/y_3](\lambda_2/\lambda_3)$  is greater than one.

Note that three factors favour a preferred tax rate of one: (i) a small middle class relative to the size of the poor, (ii) a middle class similar to rich, and (iii) high income for the poor. These factors capture a key tension: On the one hand positive taxation hurts  $y_1$  individuals by forcing them to distribute toward the (relatively) poorer  $y_2$  individuals. On the other hand, positive taxation allows them to extract resources from the poor. Thus, the closer  $y_2$  is to  $y_1$ , the smaller the  $y_2$  group, and the more that  $y_3$  individuals can contribute to tax proceeds (i.e. the larger is  $y_3$ ), the better the case for positive taxation from the viewpoint of a  $y_1$  individual. It is also easy to see that  $y_2$  individuals always prefer a tax rate of one. In particular, it is now irrelevant whether  $y_2$  is greater or smaller than  $\mu$ . Lastly, the case in which all three groups receive the subsidy is the pure redistributive scheme already discussed.

The simplified case of exogenously specified transfer recipients is informative because it indicates how restricted redistribution has very different implications for the preferred tax rate of a particular group. In our model, the determination of preferred tax rates is more complicated; the tax rate determines both the amount of income being redistributed and the identity of those individuals who receive transfers. Nonetheless, it is possible to provide a complete characterization of the  $EU_i(\theta)$  (and hence preferred tax rates) as a function of the model's parameters. This is done in Proposition 1.

**Proposition 1.** (i)  $EU_i(\theta)$  is continuous and  $EU_i(0) < EU_i(\bar{\theta}_i)$  for  $\bar{\theta}_i \in (0, 1) \forall i$ .

(ii)  $EU_1(\theta)$  is increasing and concave on  $[0, \bar{\theta}_1]$ , linearly increasing on  $[\bar{\theta}_1, \hat{\theta}_2]$  with marginal utility of  $(\mu/\lambda_1) - y_1$ , linearly decreasing on  $[\hat{\theta}_2, \bar{\theta}_2]$  with marginal utility  $y_2 - y_1$ , linear on  $[\bar{\theta}_2, \hat{\theta}_3]$  with marginal utility of  $[\mu/(\lambda_1 + \lambda_2)] - y_1$ , linearly decreasing on  $[\hat{\theta}_3, \bar{\theta}_3]$  with marginal utility  $y_3 - y_1$ , and linearly decreasing on  $[\bar{\theta}_3, 1]$  with marginal utility  $\mu - y_1$ .

(iii)  $EU_2(\theta)$  is linearly decreasing on  $[0, \hat{\theta}_2]$  with marginal utility of  $-y_2$ , increasing and concave on  $[\hat{\theta}_2, \bar{\theta}_2]$ , linearly increasing on  $[\bar{\theta}_2, \hat{\theta}_3]$  with marginal utility of  $(\mu/(\lambda_1 + \lambda_2)) - y_2$ , linearly decreasing on  $[\hat{\theta}_3, \bar{\theta}_3]$  with marginal utility of  $y_3 - y_2$ , and linear on  $[\bar{\theta}_3, 1]$  with a marginal utility of  $\mu - y_2$ .

(iv)  $EU_3(\theta)$  is decreasing on  $[0, \hat{\theta}_3]$  with marginal utility of  $-y_3$ , increasing and concave on  $[\hat{\theta}_3, \bar{\theta}_3]$ , and linearly increasing on  $[\bar{\theta}_3, 1]$  with marginal utility of  $\mu - y_3$ .

*Proof.* See Appendix. ||

To illustrate some key results of Proposition 1 consider the shape of  $EU_2$  assuming that  $y_2 < E$ . If  $\theta$  is less than  $\hat{\theta}_2$ , the sole effect of a marginal tax increase is to decrease a  $y_2$  individual's lifetime income by  $y_2$  since in this interval no individual from this group can afford to obtain an education and hence the subsidy received is zero. For  $\theta$  between  $\hat{\theta}_2$  and  $\bar{\theta}_2$ , marginal increases in  $\theta$  allow more  $y_2$  individuals to obtain an education. Although  $y_2$  individuals who do not obtain an education are made worse off by the marginal increase, the overall effect on the expected utility of a  $y_2$  individual is positive. A marginal increase in  $\theta$  in the interval between  $\bar{\theta}_2$  and  $\hat{\theta}_3$  always increases the lifetime income of a  $y_2$  individual. At the margin, tax payments increase by  $y_2$  but the subsidy increases by  $\mu/(\lambda_1 + \lambda_2)$ , which necessarily exceeds  $y_2$ . Note that over this interval marginal increases in  $\theta$  serve only to redistribute income. Hence,  $y_2$  individuals, who are the poorest individuals receiving the subsidy, prefer more redistribution to less. Next consider a marginal tax increase for  $\theta$  in the interval  $[\hat{\theta}_3, \bar{\theta}_3]$ . Throughout this interval, since  $y_3$  individuals

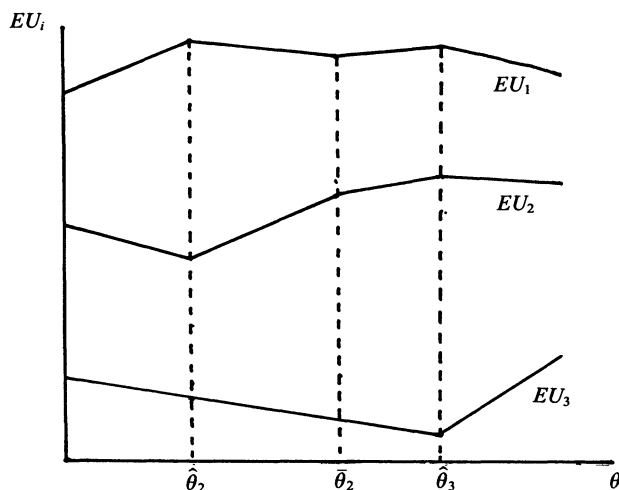


FIGURE 1

can just afford an education, it follows that the marginal increase in the subsidy must exactly offset the marginal increase in tax payments for a  $y_3$  individual. Hence, the marginal increase in the subsidy must be  $y_3$ . Since the marginal increase in tax payments for a  $y_2$  individual is  $y_2$ , it follows that  $EU_2$  is strictly decreasing over this interval. Lastly, for  $\theta$  greater than  $\hat{\theta}_3$  there are opposing effects. On the one hand, tax payments increase at the margin by  $y_2$ , but on the other hand the subsidy increases by  $\mu$ . Either effect may dominate and the Proposition lays out the exact conditions which determines the net effect. Figure 1 indicates one possible configuration of the  $EU_i$ 's.

We next examine some of the interesting implications of Proposition 1 for preferred tax rates. In contrast to the case of purely redistributive taxation, it is now the case that the total wealth of the economy matters (in particular, the relationship between mean income and  $E$ ), and hence we consider two separate cases. The first, we refer to as a "poor" economy and corresponds to the case where  $\mu \leq E < \mu / (\lambda_1 + \lambda_2)$ . The second we refer to as a "wealthy" economy, and corresponds to  $\mu > E$ .<sup>15</sup> The important distinction is that in a wealthy economy there is more than sufficient wealth to allow all individuals to obtain an education, whereas in a poor economy there is sufficient wealth to send the rich and middle class to school, but not necessarily anyone else. In the wealthiest extreme of a poor economy ( $\mu = E$ ), allowing everyone to obtain an education would exhaust all of the economy's resources.

Proposition 1 has implications for the possible preferred tax rates for each individual in each of these two cases. Table 1 shows the possible configurations.

Note that in contrast with either the pure redistributive case or the case of redistribution with exogenously determined subsidy recipients, interior preferred tax rates now emerge. This is a consequence of income groups wishing to restrain the tax rate in order not to allow some other group to obtain an education and thus share the subsidy.

In a wealthy economy,  $y_1$  and  $y_2$  individuals each face a similar situation; they face the tradeoff between sharing the proceeds of a lower tax rate among fewer individuals

15. Although these two cases are not exhaustive, the others are of less interest. Furthermore, they correspond to even poorer economies for which one would probably not view majority voting as a compelling description. For completeness, however, Table 2 includes these cases.



TABLE 1  
*Preferred tax rates*

	Wealthy economy	Poor economy
$y_1$	$\hat{\theta}_2, \hat{\theta}_3$	$\hat{\theta}_2, \hat{\theta}_3$
$y_2$	$\hat{\theta}_3, 1$	$\hat{\theta}_3$
$y_3$	1	0, 1

(i.e. precluding the groups below them from obtaining an education) versus sharing the proceeds from a higher tax rate with more individuals. In a poor economy  $y_1$  individuals again face this tradeoff, but there is no longer any incentive for  $y_2$  individuals to choose a tax rate that allows any  $y_3$  individuals to obtain an education. (Recall the above discussion about the shape of  $EU_2$  over the internal  $[\hat{\theta}_3, \bar{\theta}_3]$ .) Observe that in both a wealthy and poor economy it is possible for all  $y_1$  and  $y_2$  individuals to prefer  $\hat{\theta}_3$ , i.e. a tax such that the poor do not obtain an education but still help cover the costs of education for the rich and the middle class.

A final implication of Proposition 1 that we note is that individual preferences over tax rates in many cases are not single-peaked.<sup>16</sup> This is illustrated in Figure 1. This feature is intimately related to excludability: as long as an individual is not receiving a transfer, higher tax rates decrease utility, but when this individual's group first begins to receive the transfer, higher tax rates increase utility. As our discussion following Proposition 1 indicated, utility thereafter can alternate between decreasing and increasing as a function of  $\theta$ .

#### IV. MAJORITY VOTING EQUILIBRIUM

In this section we examine the equilibrium outcomes. Recall that the tax rate is chosen by majority vote.

*Definition.* An equilibrium is a tax rate  $\theta^*$ ,  $0 \leq \theta^* \leq 1$  such that for all  $\theta' \in [0,1]$ , the fraction of agents with  $EU_i(\theta^*) \geq EU_i(\theta')$  is strictly greater than 0.5.

There is one case for which the equilibrium is immediate. If any  $\lambda_i$  is at least as great as 0.5, then this group's preferred tax rate is clearly the majority voting equilibrium. The following analysis, therefore, focuses only on the case where  $\lambda_i < 0.5$  for all  $i$ . Thus the sum of any two of the  $\lambda_i$ 's exceeds 0.5. Hereafter, therefore,

*Assumption.*  $\lambda_i < 0.5$  for all  $i$

For a tax rate  $\theta^*$  to be a majority voting equilibrium it must win against all alternatives, and, in particular, against all local alternatives. This gives the following result:

**Theorem 1.** *If  $\theta^*$  is a majority voting equilibrium then at least one of the  $EU_i$ 's has a local maximum at  $\theta^*$ .*

*Proof.* Assume that no group has a local maximum at  $\theta^*$ . This implies that if  $\theta^*$  equals zero,  $EU_i(\theta)$  must be upward sloping at 0 for all  $i$ . But then there exists some  $\theta > 0$  which all three groups prefer to 0. This rules out 0 as a candidate. If  $\theta^*$  equals one, then

16. As is well known, this feature implies that a majority voting equilibrium may not exist.

$EU_i(\theta)$  must be decreasing for all  $i$  as  $\theta$  approaches 1 from below. Again, this implies that there must be some  $\theta < 1$  which is preferred by all three groups, ruling out 1 as a candidate. Now assume that  $0 < \theta^* < 1$ . Since  $\theta^*$  is not a local maximum for any of the  $i$ 's, either a small decrease or increase in  $\theta$  must increase utility for at least two of the groups, which is sufficient to rule out  $\theta^*$  as a majority voting equilibrium.  $\parallel$

This theorem establishes that the potential majority voting equilibria must lie in the set  $\{0, \hat{\theta}_2, \hat{\theta}_3, 1\}$ . This set can be further reduced, however, by noting that an implication of Proposition 1 is that both groups two and three strictly prefer a tax rate of zero to a tax rate of  $\hat{\theta}_2$  (for  $\hat{\theta}_2$  not equal to zero). This follows directly from the fact that at  $\hat{\theta}_2$  both groups two and three pay taxes but do not receive an education. This leaves  $\{0, \hat{\theta}_3, 1\}$  as the only equilibrium candidates. In particular, there is only one possible interior equilibrium.<sup>17</sup>

Table 2 gives the equilibrium outcomes for each and every possible configuration of the parameters describing the economy. (The Appendix contains some details relevant for the construction of this table.) It is divided into four panels each corresponding to economies in which the ratio of total income to the cost of education is progressively greater. Panels 3 and 4 correspond to what we have referred to as poor and wealthy economies respectively. Our subsequent discussion focuses on these cases since, as alluded to in footnote 15, majority voting is a less plausible decision mechanism for the very poor economies of Panels 1 and 2. As mentioned previously, there are some cases where a majority voting equilibrium does not exist (labelled NE).<sup>18</sup> Whenever an equilibrium exists, however, it is unique. Non-single-peaked preferences also give rise to the possibility of outcomes other than that preferred by the median voter (indicated by NMV in Table 2).<sup>19</sup>

## V. DISCUSSION

Here we focus on what we believe to be the more interesting implications of Table 2. This model nests the case of pure redistribution (this occurs when  $y_3 \geq E$ ) and for some other parameter configurations produces the same results. Our discussion focuses on those instances where different outcomes arise.

As documented in the introduction, a situation that characterizes the provision of (higher) education in many countries, is that costs are subsidized using general tax revenues although the rich and middle classes benefit disproportionately since their children are more likely to obtain this education. We find that in both wealthy and poor economies this outcome may emerge as a result of majority voting, i.e. the equilibrium tax rate is positive yet only the rich and middle class individuals obtain an education.

The fact that "exploitation" of the poor emerges as a majority voting equilibrium in this model is significant for two reasons. First, it indicates that this outcome need not be

17. The existence of a sole interior equilibrium is an artifact of the three income group distribution and of the lack of other economic disincentives for tax rates of one; larger sets of interior equilibria are easily obtained by increasing the numbers of income groups. It is also easy to introduce assumptions to bound the tax rate away from one.

18. Non-existence of majority voting equilibrium due to non-single-peaked preferences has been dealt with either by imposing more institutional structure (see e.g. Shepsle and Weingast (1987)) or by considering a less restrictive rule for selecting outcomes (see e.g. the concept of uncovered set in McKelvey (1986) and Miller (1980)). Our main interest is in providing a benchmark by considering only outcomes consistent with majority voting. Hence we do not pursue any other alternatives here.

19. In a poor economy, for example, (see Panel 3B) an equilibrium of zero is possible, supported by a coalition of the rich and the poor. A similar situation arises in the analysis of Dewatripont and Roland (1992) concerning restructuring of an economy. Non-monotonic preferences give rise to coalitions between groups with the maximum degree of heterogeneity.

TABLE 2  
Voting equilibria

Parameter Restrictions	$\hat{\theta}_1$	$\hat{\theta}_2$	$\hat{\theta}_3$	Equilibrium	
1. $\mu/\lambda_1 \leq E$	1	0	0	0	
2. $\mu/\lambda_1 > E \geq \mu/(\lambda_1 + \lambda_2)$	$\hat{\theta}_2$	0	0	0	
	$\hat{\theta}_2$	1	0	0 or NE (NMV)	
3. $\mu/(\lambda_1 + \lambda_2) > E \geq \mu$					
A. $y_2 < E$					
a. $y_1 < \mu/(\lambda_1 + \lambda_2)$	$\hat{\theta}_2$	$\hat{\theta}_3$	0	NE	
	$\hat{\theta}_3$	$\hat{\theta}_3$	0	$\hat{\theta}_3$	
	$\hat{\theta}_2$	$\hat{\theta}_3$	1	NE	
	$\hat{\theta}_3$	$\hat{\theta}_3$	1	$\hat{\theta}_3$	
b. $y_1 > \mu/(\lambda_1 + \lambda_2)$	$\hat{\theta}_2$	$\hat{\theta}_3$	0	0 or NE (NMV)	
	$\hat{\theta}_2$	$\hat{\theta}_3$	1	NE	
B. $y_2 \geq E$					
a. $y_1 < \mu/(\lambda_1 + \lambda_2)$	$\hat{\theta}_3$	$\hat{\theta}_3$	0	$\hat{\theta}_3$	
	$\hat{\theta}_3$	$\hat{\theta}_3$	1	$\hat{\theta}_3$	
b. $y_1 > \mu/(\lambda_1 + \lambda_2)$	0	$\hat{\theta}_3$	0	0 (NMV)	
	0	$\hat{\theta}_3$	1	0 or NE (NMV)	
4. $\mu > E$					
A. $y_2 < E$					
	$\hat{\theta}_2$	1	1	1	
	$\hat{\theta}_3$	1	1	1	
	$\hat{\theta}_2$	$\hat{\theta}_3$	1	NE	
	$\hat{\theta}_3$	$\hat{\theta}_3$	1	$\hat{\theta}_3$	
B. $y_2 \geq E, y_3 < E$					
a. $y_1 < \mu/(\lambda_1 + \lambda_2)$	i. $y_2 < \mu$	$\hat{\theta}_3$	$\hat{\theta}_3$	1	$\hat{\theta}_3$
		$\hat{\theta}_3$	1	1	1
		$\hat{\theta}_3$	$\hat{\theta}_3$	1	$\hat{\theta}_3$
	ii. $y_2 \geq \mu$	0	$\hat{\theta}_3$	1	NE
		0	1	1	1
		0	$\hat{\theta}_3$	1	0 or NE (NMV)
b. $y_1 > \mu/(\lambda_1 + \lambda_2)$	i. $y_2 < \mu$	0	$\hat{\theta}_3$	1	NE
		0	1	1	1
	ii. $y_2 \geq \mu$	0	$\hat{\theta}_3$	1	0 or NE (NMV)
		0	$\hat{\theta}_3$	1	0 or NE (NMV)
C. $y_3 \geq E$					
a. $y_2 > \mu$	0	0	1	0	
b. $y_2 < \mu$	0	1	1	1	

due to poorer individuals being attributed less weight in the political process. Second, it shows that this result need not be a consequence of positive spillovers from educated to non-educated individuals and may be detrimental to the poor rather than beneficial.

The key to obtaining the above outcome is a situation in which  $y_1$  individuals profit more by not excluding  $y_2$  individuals and simultaneously  $y_2$  individuals prefer to exclude  $y_3$  individuals. It is easy to derive explicit expressions providing conditions under which this occurs. Consider for example, a wealthy economy in which  $y_3 < E$ . It is straightforward to show that  $y_2$  individuals prefer  $\hat{\theta}_3$  to one if and only if:

$$E - \mu + (1 - \hat{\theta}_3)(y_2 - y_3) > 0, \tag{9}$$

and  $y_1$  individuals prefer  $\hat{\theta}_3$  to  $\hat{\theta}_2$  if and only if:

$$y_2 - y_3 + \hat{\theta}_3(y_3 - y_1) - \hat{\theta}_2(y_2 - y_1) > 0, \tag{10}$$

where simple manipulation of the equation in (7) yields:

$$\hat{\theta}_2 = (E - y_2) \left/ \left( \frac{\mu}{\lambda_1} - y_2 \right) \right., \tag{11}$$

and

$$\hat{\theta}_3 = (E - y_3) \left/ \left( \frac{\mu}{\lambda_1 + \lambda_2} - y_3 \right) \right. . \tag{12}$$

Note that for  $y_2$  close to  $y_1$  inequalities (9) and (10) are both necessarily satisfied.

This above configuration has interesting implications concerning economies that have similar *per capita* incomes but different income distributions. Increasing  $\lambda_1$  and  $\lambda_3$  but holding mean income constant (i.e. a mean-preserving increase in spread), the left-hand sides of (9) and (10) both increase, so an equilibrium tax rate of  $\hat{\theta}_3$  becomes more likely. In this sense, increased inequality makes it more likely that the poor are excluded in equilibrium.<sup>20</sup> Although our model is effectively static, this result has some potentially interesting dynamic implications.<sup>21</sup> Since exclusion of the poor from higher education may be expected to increase future income inequality, exclusion at one date enhances the possibility of future exclusion. Thus, inequality may beget further inequality. Alternatively, economies with a large middle class relative to the poor and rich may be expected to produce more educated individuals.

Next we address the efficiency implications of excludability. The simple structure of the model implies that total income is increasing in the number of individuals that obtain an education. In particular, total income is maximized when the number of people obtaining an education is maximized. This particular result is due to the linear structure of the model and is not to be taken as a literal prescription for optimal human capital accumulation in reality. We take a pure redistributive scheme as our benchmark and ask how introducing excludability affects the results. It should be clear that a pure redistributive scheme need not maximize output—nonetheless it is a useful benchmark since it allows us to focus on the effect of excludability.

The efficiency effects of introducing excludability depend strikingly on the wealth of the economy. In a poor economy excludability never decreases efficiency and in some cases enhances it, whereas in a wealthy economy, introducing excludability never enhances efficiency and in some cases decreases it. The intuition behind this result is straightforward; in a poor economy spreading resources evenly can preclude everyone from obtaining an education, whereas consolidating resources can allow more individuals to obtain an education. In a wealthy economy the reverse is true.<sup>22</sup> The degree of inequality, discussed previously, therefore, also has important efficiency implications. A more unequal economy

20. Note that the cases of restricted redistribution discussed in Section III provide some intuition for this result. In particular, there we found that the  $y_1$  individuals are more likely to prefer taxation when sharing with  $y_2$  individuals if  $y_2$  is much closer to  $y_1$  than to  $y_3$ , or  $\lambda_3$  is large relative to  $\lambda_2$ .

21. Building on the earlier work of Becker and Tomes (1979) and Loury (1981), recent work by Galor and Zeira (1993) and Ljungqvist (1993) studies the evolution of income distribution in dynamic models in which credit constraints affect educational attainment. In these models, however, there is no endogenous choice of policy; all features of the educational system are taken to be exogenous. Durlauf (1991) is an exception.

22. Perotti (1993) shows that pure redistributive schemes may be bad for growth in poor economies if education is discrete and individuals are credit constrained.

is more likely to generate an equilibrium tax rate of  $\hat{\theta}_3$  (relative to a tax rate of one) with the attendant negative efficiency consequences.

The asymmetry between the effects of excludability in wealthy and poor economies provides an interesting perspective on their adoption and continued presence. The prior results suggest that at an early stage of development a scheme with excludability may have some desirable consequences for society as a whole. Once an economy becomes wealthier, there may no longer be a positive role for this feature, but because it allows the rich and middle class to extract resources from the poor it may be difficult to alter the system. Note that there are several instances where the only effect of the system with excludability relative to no redistribution is to transfer resources from the poor to the rich and middle class without any effect on the number of individuals who obtain an education (see e.g. the seventh entry in Panel 4 of Table 2).

Finally, this model has implications for individual incentives to change the “height” of the barrier to education, i.e.  $E$ . In a pure redistributive system, reductions in  $E$  holding individual incomes constant (or equivalently, proportional increases in income holding  $E$  constant) make all individuals better off. This is not true in the presence of excludability. For example, as an economy switches from being “poor” to being “wealthy”, the majority voting equilibrium can switch from  $\hat{\theta}_3$  to one (see 3a and 4A in Table 2) thus making  $y_1$  individuals strictly worse off. Although it is beyond the scope of this paper to endogenize this possibility, it would be in the interest of  $y_1$  individuals (and possibly  $y_2$  individuals) in cases like the above to support actions which increase the size of this barrier. These actions could take several forms—imposing additional entrance requirements which are more difficult for poorer individuals to meet, locating colleges in places which increase living and/or transportation costs for potential students, or maintaining higher quality of education (e.g. higher teacher to student ratios and more highly paid teachers).<sup>23</sup>

## VI. CONCLUSION

Many studies have found that public support for higher education involves a transfer of resources from lower-income individuals to higher-income individuals. Standard models of redistribution or public provision of goods and services under majority voting predict transfers of resources in the reverse direction and are thus unable to provide an explanation of the above. Within a simple setting we have shown that transfers of resources from lower income groups to higher income groups are possible if individuals vote over the extent to which they subsidize education.<sup>24</sup> If education is only partially subsidized, poorer individuals who are credit constrained cannot afford to obtain an education and are thereby excluded from benefiting from the subsidies.

We find that increased inequality in the income distribution makes it more likely to obtain a net transfer of resources away from the poor. Furthermore, our model has interesting implications for the efficiency consequences of subsidies to higher education relative to a system of pure income redistribution. In a poor economy, subsidizing education may enhance efficiency by increasing attainment, whereas in a wealthy economy efficiency never is enhanced and may be decreased by reducing educational attainment.

23. Even for a wealthy economy with an equilibrium tax rate of  $\hat{\theta}_3$  it may be in the interest of the  $y_1$  and  $y_2$  individuals to increase  $E$ : The ability to extract more income from the poor may outweigh the negative effects of a higher  $E$ .

24. It would be interesting to incorporate several additional features into the model, such as endogenizing the cost and quality of education, allowing for the (endogenous) existence of private alternatives (see Glomm and Ravikumar (1992)) and extending the analysis to a dynamic framework.

We also show that there are instances in which wealthier individuals would profit from making education more costly since this affects their ability to exclude others and extract resources from them.

A basic message of our analysis is that when the degree of subsidization of publicly provided services is chosen endogenously, implications for redistribution of income, efficiency, and future income distribution may be very different than those implicit in a system of total public provision. Similar analysis may be relevant for other partially publicly provided goods and services, such as health care.

APPENDIX

1. Proof of Proposition 1

Continuity of the  $EU_i$ 's follows directly from the fact that the  $\rho_i(\theta)$ 's are continuous. At  $\bar{\theta}_i$ ,  $EU_i=f(y_i)$ . At  $\theta=0$ ,  $EU_i=2y_i$ . Given  $f(y_i)-E > y_i$  and  $y_i < E$  (i.e.  $\bar{\theta}_i > 0$ ) it follows that  $f(y_i) > 2y_i$  and hence that  $EU_i(0) < EU_i(\bar{\theta}_i)$  for  $\bar{\theta}_i \in (0,1]$ .

We prove (ii); the other statements can be demonstrated similarly. On  $[0, \bar{\theta}_1]$ ,  $EU_1(\theta)$  is given by  $EU_1(\theta) = \rho_1(\theta)[f(y_1)] + (1 - \rho_1(\theta))[(1 - \theta)y_1 + y_1]$  where  $\rho_1(\theta) = \theta\mu/[\lambda_1(E - (1 - \theta)y_1)]$ . Note that  $EU_1(\bar{\theta}_1) > EU_1(\theta)$  for all  $\theta \in [0, \bar{\theta}_1]$ . Calculation yields  $dEU_1/d\theta|_{\theta=0} = [\mu(f(y_1) - y_1 - E) + (\mu - \lambda_1 y_1)(E - y_1)] / ((E - y_1)\lambda_1)$  which is positive since  $f(y_1) > E + y_1$  and  $E > y_1$  (if  $\bar{\theta}_1 > 0$ ) and  $\mu > \lambda_1 y_1$ . Furthermore,  $d^2EU_1(\theta)/d\theta^2 = -2\mu(E - y_1)y_1[f(y_1) - y_1 - E] / [E - (1 - \theta)y_1]^3 \lambda_1 < 0$ . Since  $EU_1$  is increasing at zero, is concave throughout, and  $EU_1(\bar{\theta}_1) > EU_1(\theta)$  for all  $\theta \in [0, \bar{\theta}_1]$ , it follows that  $EU_1$  is increasing on the interval  $(0, \bar{\theta}_1)$ . On the interval  $[\bar{\theta}_1, \bar{\theta}_2]$ ,  $EU_1$  is given by  $EU_1(\theta) = (1 - \theta)y_1 - E + (\mu\theta/\lambda_1) + f(y_1)$ . Differentiation gives:  $dEU_1/d\theta = -y_1 + \mu/\lambda_1 > 0$ . On the interval  $[\bar{\theta}_2, \bar{\theta}_3]$ ,  $EU_1(\theta)$  is given by  $EU_1(\theta) = (1 - \theta)y_1 - (1 - \theta)y_2 + f(y_1)$ , since for  $0 < \rho_2(\theta) < 1$ ,  $s(\theta) = E - (1 - \theta)y_2$ . Differentiation gives  $dEU_1/d\theta = y_2 - y_1 < 0$ . On the interval  $[\bar{\theta}_3, \bar{\theta}_3]$ ,  $EU_1$  is given by  $EU_1(\theta) = (1 - \theta)y_1 - E + (\mu\theta/(\lambda_1 + \lambda_2)) + f(y_1)$ . Differentiation gives  $dEU_1/d\theta = -y_1 + \mu/(\lambda_1 + \lambda_2)$ . Marginal utility in this region is positive if  $y_1 < \mu/(\lambda_1 + \lambda_2)$  and negative if the reverse inequality holds. In the interval  $[\bar{\theta}_3, 1]$  we have  $EU_1(\theta) = (1 - \theta)y_1 - (1 - \theta)y_3 + f(y_1)$ . Differentiation yields  $dEU_1/d\theta = -y_1 + y_3 < 0$ . Finally, if  $\theta$  lies in the interval  $[\bar{\theta}_3, 1]$ ,  $EU_1$  is given by  $EU_1(\theta) = (1 - \theta)y_1 - E + \mu\theta$ . Differentiation gives  $dEU_1/d\theta = -y_1 + \mu$ . This is negative since  $\mu$  is simply the average of the  $y_i$ 's. This completes the proof of (ii). Parts (iii) and (iv) can be demonstrated similarly. ||

2. Constructing Table 2

Generically, each of the  $EU_i$ 's has a unique maximizer on  $[0,1]$ . The discussion that follows assumes that the maximizers are unique, although the case where uniqueness does not obtain is easily handled. We denote the maximizer for group  $i$  by  $\bar{\theta}_i$ .

As a first step in the characterization of equilibrium, note that  $\bar{\theta}_i$  necessarily corresponds to a local maximum of  $EU_i(\theta)$ , and hence Proposition 1 can be used to restrict the set of possible values of  $\bar{\theta}_i$ . Consequently, the possible values for  $\bar{\theta}_1$  are  $\{\bar{\theta}_2, \bar{\theta}_3\}$ , for  $\bar{\theta}_2$  are  $\{0, \bar{\theta}_3, 1\}$ , and are  $\{0,1\}$  for  $\bar{\theta}_3$ . For all groups  $EU_i(\bar{\theta}_i) > EU_i(0)$  (for  $\bar{\theta}_i \in (0,1]$ ), so zero can be a global maximizer for an individual of group  $i$  only if it is not feasible for all individuals in that group to obtain an education at any tax rate. Also, it is possible for a tax rate of one to be a global maximum for group one, but only if  $\bar{\theta}_3 = 1$ , i.e. only if there is no tax rate at which any individual of group three can obtain an education.

The following proposition helps establish which value is taken by  $\bar{\theta}_1$ .

**Proposition 2** Assume  $y_2 < E$ . Then  $EU_1(0) > EU_1(\bar{\theta}_2)$  if and only if  $y_1 > E$  and  $\mu/(\lambda_1 + \lambda_2) < y_1$ .

*Proof of Proposition 2.* If  $E > y_1$ , then  $EU_1(\theta) > EU_1(0)$  for  $0 < \theta \leq 1$ . If  $E \leq y_1$  then  $EU_1(0) = f(y_1) + y_1 - E$ , and  $EU_1(\bar{\theta}_2) = f(y_1) + (1 - \bar{\theta}_2)y_1 + \bar{\theta}_2\mu/(\lambda_1 + \lambda_2) - E$ . Hence  $EU_1(0) - EU_1(\bar{\theta}_2) = \bar{\theta}_2[y_1 - \mu/(\lambda_1 + \lambda_2)] - 0$  as  $y_1 - \mu/(\lambda_1 + \lambda_2)$ . ||

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