CES Working Paper Series

EDUCATION, INEQUALITY,
AND GROWTH:
A PUBLIC CHOICE PERSPECTIVE

Mark Gradstein
Moshe Justman

Working Paper No. 45

Center for Economic Studies
University of Munich
Schackstr. 4
80539 Munich
Germany
Telephone: 089-2180-2748
Telefax: 089-397303

CES Working Paper No. 45
September 1993

EDUCATION, INEQUALITY, AND GROWTH: A PUBLIC CHOICE PERSPECTIVE

Abstract

This paper presents an overlapping generations model of growth in an economy with heterogeneous individuals in which public choice determines the parameters of public policy. Education is the engine of growth, and its external effects imply sub-optimality of the private education system. Two modes of government intervention, subsidization of education, and public provision of education are compared with regard to growth, income distribution, welfare, and popularity. Factors which play a crucial role in this comparison include the magnitude of the external benefits of education, the excess burden of government intervention, and the extent of heterogeneity in the population.

Mark Gradstein
Moshe Justman
Ben Gurion University
Department of Economics and
Monaster Center for Economic Research
Beer Sheva
Israel
Fax: (972) 57-273262

Education, Inequality, and Growth: A Public Choice Perspective

1. Introduction

Positive externalities associated with the accumulation or employment of human capital play a central role in the new theory of endogenous growth (e.g., Romer, 1986, Lucas, 1988, Azariadis and Drazen, 1990). They generally imply that private provision of schooling leads to sub-optimal accumulation of human capital, and in "representative agent" models -- as nearly all models in this vein are -- such externalities indicate an optimal intervention, e.g., in the form of a schooling subsidy. This raises the question of which education policy would be adopted by a heterogeneous population working through a mechanism of public choice such as majority voting, and how would it perform with regard to growth, income distribution, and individual welfare.

Glomm and Ravikumar (1992) address this issue in the context of an overlapping generations model, but do not allow for technical externalities associated with education.[1] Consequently, the excess burden generated by public intervention in their model (affecting the allocation of time between study and leisure) implies that a regime of private education induces more (immediate) investment in education than does public provision.[2] Nonetheless, a majority of individuals in their model always prefer universal public education over private education, provided only that the distribution of income is typically skewed, i.e. its mean exceeds its median. In adopting public education, the majority is willing to sacrifice education and growth in the short run, at least, for redistribution.

While shedding light on the dynamics of income distribution and growth under regimes of private and public education, such a representation does not fully capture the potential advantages of intervention in education. Public education serves not only to redistribute earning capacity from the rich to the poor -- hence its popularity when the poor are in the majority -- but can also compensate for the externalities of education. Moreover,

Glomm and Ravikumar consider only one type of intervention: a uniform public school system with compulsory participation and voluntary attendance. Other forms of intervention, *viz.*, education subsidies, may compare more favorably with private education.

The present paper addresses these issues by incorporating externalities in an overlapping generations model in which education is a key factor of production,[3] and a heterogeneous population optimizes its investment in education over time while choosing its education policies by majority vote. This captures the dual motivation for public intervention in education -- internalizing the external benefits of education and reducing inherited inequality of opportunity -- while taking into account the excess burden induced by the taxes that must be raised to fund such intervention.

Three principal regimes are considered: purely private provision, private provision with government subsidies funded by proportional taxation, and public provision funded by proportional taxation with compulsory participation and attendance. We derive the growth path of the economy under different regimes and characterize the growth of average income and changes in income distribution as functions of the policy regime and of parameters of utility and production.

The structure of the paper is as follows. In the next section we describe a basic overlapping generations model with education as a factor of production. In Section 3 we characterize equilibrium under each of the three education regimes considered in this paper: purely private provision, private provision with government subsidies, and public provision (the latter two funded by proportional taxation). These are then compared with each other with regard to growth performance, in Section 4, and with regard to popular support, in Section 5. The paper ends with some brief concluding remarks.

2. The overlapping generations economy

Consider an overlapping generations economy in which individuals live for two periods: in the first period they study, and in the second they allocate their time between work and leisure. In each period t there is a continuum of heterogeneous families in the economy, indexed by i, each comprising a parent and an offspring. Thus total population remains constant over time. Families are differentiated by the innate abilities of the parent, a_{it}, and of the offspring, a_{it+1}, and by the education level of the parent, k_{it}. The distribution of "ability" in the population, in each generation, is exogenous, and the initial distribution of parental education, k_{i0}, is given. Subsequently, we shall make specific assumptions regarding the nature of these distributions. The distribution of education in the population in future generations is a function of the initial distribution of education and ability, of future distributions of ability, and of individual and collective decisions of the population in each period.

The earning capacity of each parent, reflected perfectly in the wage rate, w_{it}, is a function of individual ability and education, and of the average level of education in the parent generation, $\bar{k}_t$. As is standard in the literature we assume a Cobb-Douglas technology:

$$w_{it} = a_{it}k_{it}^{\alpha}\bar{k}_t^{\beta} \qquad (1)$$

where $0 < \alpha,\beta < 1$ are constants. Education may exhibit decreasing ($\alpha+\beta < 1$), constant ($\alpha+\beta = 1$), or, as is commonly assumed in the endogenous growth literature, increasing ($\alpha+\beta > 1$) returns to scale. In either case, there is a direct interdependence among parents in the same cohort: individual education generates a positive externality through the joint input $\bar{k}_t$. We assume that each parent is endowed with one unit of time per period, and that actual income, y_{it}, is the product of earning ability and time allocated to work. Denoting time allocated to leisure by n_{it}, we have:

$$y_{it} = w_{it}(1-n_{it}) \qquad (2)$$

Parents make all relevant decisions in this economy: they allocate their time between work and leisure; they allocate their income between current family consumption, c_{it}, and investment in their offspring's education, k_{it+1}:

$$c_{it} + k_{it+1} = y_{it} \tag{3}$$

and they make collective decisions on education policy through majority voting. Their utility derives from current consumption and leisure, and from their offspring's expected earning capacity,[4] w_{it+1}, where

$$w_{it+1} = a_{it+1} k_{it+1}^{\alpha} \bar{K}_{t+1}^{\beta} \tag{4}$$

depends on the offspring's innate ability and education level, and on the (expected) education of the offspring's cohort. Assuming additively separable logarithmic utility we have:

$$u_{it}(c_{it}, n_{it}, w_{it+1}) = \ln c_{it} + \eta \ln n_{it} + \delta \ln w_{it+1} \tag{5}$$

where η and δ are positive constants; and we make the standard assumption that δ, reflecting the bequest motive, satisfies $\delta \leq 1$.

The positive externality associated with education implies that private provision will not yield an optimal outcome -- indicating a potential role for government intervention. Our analysis focuses on two alternative modes of intervention: *public provision*, where the government sets a uniform level of education determined by majority vote for all individuals in the economy and finances it by a proportional income tax; and an *education subsidy*, again determined by majority vote and financed by a proportional income tax. Public provision is used widely at primary and secondary school levels; subsidies are frequently used to promote higher education. These two regimes are compared with each other, and with the benchmark case of private education, with regard to their impact on (average) growth and the distribution of income, and with regard to their welfare implications, and popularity.

3. Education regimes

The following formal definitions characterize each education regime and allow us to derive the equilibrium explicitly in each case. Under all regimes we assume that the initial endowments of ability, a_{i0}, and education, k_{i0}, are given, and that the first-period wage rate, w_{i0}, derives from them via equation (1).

3.1. Private provision

Under private provision of education, in each period t the parent of each family i first decides on the allocation of time between leisure, n_{it}, and work, $1- n_{it}$; and then allocates the income produced (deriving from innate ability, time spent working, individual education, and the average level of education of the parent's cohort) between current consumption, c_{it}, and individual investment in the offspring's education, k_{it+1}. Hence, each parent can be said to maximize individual utility, (5), subject to equations (1), (2), and (4), and the budget constraint, (3).

Each such decision thus depends on the parent's expectations regarding average investment in education; and in equilibrium all the individually optimal choices are mutually consistent.[5] Straightforward calculation reveals that the optimal allocation of time to leisure is uniform across households and over time, and equals:

$$n_{it}^P = n^P = \frac{\eta}{1+\delta(\alpha+\beta)+\eta} \qquad (6)$$

and each parent allocates $\delta\alpha/(1+\delta\alpha)$ of income to education. Therefore, $y_{i0}^P = w_{i0}(1-n^P)$, and for $t \geq 1$,

$$y_{it}^P = a_{it}\left(\frac{\delta\alpha}{1+\delta\alpha}\right)^{\alpha+\beta}(y_{it-1}^P)^{\alpha}(\bar{y}_{t-1}^P)^{\beta}(1-n^P) \qquad (7)$$

where $\bar{y}_{t-1}^P$ is the average of y_{it-1}^P. The utility level of parent i in period t under private provision is then:

$$u_{it}^P = \ln [y_{it}^P/(1+\delta\alpha)] + \eta \ln n^P + \delta \ln [a_{it+1} (\delta\alpha/(1+\delta\alpha))^{\alpha+\beta} (y_{it}^P)^{\alpha} (\bar{y}_t^P)^{\beta}] \quad (8)$$

3.2. Public provision

In a regime of public provision it is assumed that, in each period t, parents vote on a communal level of education for their offspring, $k_{it+1} \equiv \bar{k}_{t+1}$, and then decide individually on the amount of labor each wants to supply. Income is produced, and wages are then taxed proportionally at a rate, τ, that fully funds the desired level of education, i.e.,

$$\bar{k}_{t+1} = \tau \bar{y}_t \quad (9)$$

and τ is the share of national income spent on education. Children are educated at a uniform level from tax revenues, and all disposable income is consumed. Again, parents' votes and individual decisions depend on their expectations regarding the current aggregate labor supply curve (which links the education level to the tax rate); we require that in equilibrium parents fully appreciate the tax implications of their education preferences.

The heterogeneity of the population notwithstanding, straightforward derivation shows that all parents prefer the same tax rate:

$$\tau = \frac{\delta(\alpha+\beta)}{1+\delta(\alpha+\beta)} \quad (10)$$

Note that the proportion of income devoted to schooling under public provision is greater than under private provision, and varies directly with the magnitude of the externality, β. If there is no externality ($\beta = 0$) total spending on education as a function of total income is the same as under private provision.

All parents also desire the same amount of leisure (and thus offer the same amount of labor):

$$n_{it}^G = n^G = \frac{\eta}{1+\eta} \quad (11)$$

Initial income is $y_{i0}^G = w_{i0}(1-n^G)$, and income in later periods is defined recursively by the equation:

$$y_{it}^G = a_{it}(\tau\bar{y}_{t-1}^G)^{\alpha+\beta}(1-n^G) \tag{12}$$

Consumption is $c_{it}^G = (1-\tau)y_{it}^G$, and maximal (parental) utility is:

$$u_{it}^G = \ln[(1-\tau)y_{it}^G] + \eta \ln n^G + \delta \ln [a_{it+1}(\tau\bar{y}_t^G)^{\alpha+\beta}] \tag{13}$$

3.3. Subsidization of education

The third regime we consider is one in which education is provided privately but subsidized at the proportional rate s. This subsidy is financed by a proportional income tax at the rate T, and as with public provision we stipulate that the budget is always balanced, i.e., $s\bar{k}_{t+1} = T\bar{y}_t$; and T/s is the share of national income spent on education. In each period, parents first vote on the desired education subsidy (taking full account of its tax implications); then allocate their time between labor and leisure; and, finally, allocate their (after-tax) income between the (subsidized) education of their offspring and current consumption. As in the previous case, all parents in all generations prefer the same subsidy and tax rates and desire the same amount of leisure:

$$s = \frac{\beta}{\alpha+\beta} \tag{14}$$

$$T = \frac{\delta\beta}{1+\delta(\alpha+\beta)} \tag{15}$$

$$n_{it}^S = n^S = \frac{\eta}{1+\delta\alpha+\eta} \tag{16}$$

Note that $T/s = \tau$, where τ is the tax rate under public provision. Thus, in this model, the same proportion of national income is spent on education under public provision as under subsidization -- though costs and benefits are distributed differently under the two regimes. The subsidy level varies positively with the magnitude of the external effect; if there is no

external effect -- $\beta = 0$ -- then all parents prefer that no subsidy be given, i.e. they prefer a purely private regime.

Equation (16) gives us initial income as $y_{i0}^S = w_{i0}(1-n^S)$, and in later periods income is:

$$y_{it}^S = a_{it}\,(T/s)^{\alpha+\beta}(y_{it-1}^S)^{\alpha}(\bar{y}_{t-1}^S)^{\beta}\,(1-n^S) \tag{17}$$

Individual (parental) utility is:

$$u_{it}^S = \ln \frac{(1-T)y_{it}^S}{1+\delta\alpha} + \eta \ln n^S + \delta \ln [a_{it+1}\,(T/s)^{\alpha+\beta}(y_{it}^S)^{\alpha}(\bar{y}_t^S)^{\beta}] \tag{18}$$

Comparison of equations (6), (11), and (16) yields results (i)-(iii) of Proposition 1; (10), (14), and (15) yield (iv) and (v); and (vi) derives from the balanced budget constraint and uniformity in parents' allocation of resources to education.

Proposition 1.

(i) Labor supply is greatest under private provision and smallest under public provision: $1-n^P \geq 1-n^S \geq 1-n^G$.

(ii) Labor supply under private provision equals labor supply under public provision if and only if there is no demand for leisure, i.e., $\eta = 0$ and $n^P = n^S = n^G = 0$.

(iii) If $\eta > 0$, then labor supply under subsidization strictly exceeds labor supply under public provision; and if there is a positive external effect ($\beta > 0$) as well then labor supply under private education strictly exceeds labor supply under subsidization.

(iv) The chosen level of subsidy is zero and subsidization coincides with private provision if and only if there is no external effect ($\beta = 0$).

(v) The share of total resources allocated to education is the same under subsidization as under public provision; and if $\beta > 0$ that share is strictly larger than under private provision.

(vi) Subsidization does not redistribute income: $Ty_{it}^S = sk_{it}^S$.

4. Growth and distribution

We turn now to a comparison of growth performance and income distribution over time under alternative regimes. For this purpose we assume that the initial distribution of parental education is lognormal; that innate ability is independently distributed in each generation with a lognormal distribution, the mean of its logarithm equals zero and its variance equals ϕ^2; and that its distribution in each cohort is statistically independent of the initial distribution of education.[6] It follows that the initial wage distribution is also lognormal, say with parameters (γ_0, σ_0^2), as is initial income. The mean of $\ln y_{i0}^J$ (J = P, S, G denoting the education regime) equals:

$$\mu_0^J = \gamma_0 + \ln(1-n^J) \tag{19}$$

and its variance is σ_0^2. Initial mean income is then:

$$\bar{y}_0^J = \exp(\gamma_0 + \ln(1-n^J) + \sigma_0^2/2) \tag{20}$$

All future income distributions are also lognormal, and equations (7), (12), and (17) that define individual income in each period as a function of (individual and average) income in the previous period allow us to calculate the parameters of income distribution for $t \geq 1$ recursively. (We assume here that it is impossible to switch from one regime to another; the implications of switching regimes are considered in the following section.)

Under *private provision*, denoting the mean of $\ln(y_{it}^P)$ by μ_t^P, we have for $t \geq 1$:

$$\mu_t^P = A^P + \ln(1-n^P) + (\alpha+\beta)\mu_{t-1}^P + \beta\sigma_{t-1}^2/2 \tag{21}$$

where

$$A^P = (\alpha+\beta)\ln[\frac{\delta\alpha}{1+\delta\alpha}] \tag{22}$$

and σ_t^2, the variance of $\ln(y_{it}^P)$, can be calculated from (7):

$$\sigma_t^2 = \phi^2 + \alpha^2\sigma_{t-1}^2 = \phi^2(1-\alpha^{2t})/(1-\alpha^2) + \alpha^{2t}\sigma_0^2 \tag{23}$$

Thus σ_t^2 converges monotonically to $\phi^2/(1-\alpha^2)$, and declines over time if $\sigma_0^2 > \phi^2/(1-\alpha^2)$, i.e., if the initial dispersion of education is sufficiently large compared with the dispersion of ability in the population. Mean income in period t is:

$$\bar{y}_t^P = \exp(\mu_t^P + \sigma_t^2/2) \tag{24}$$

Under *public provision*, the mean of $\ln(y_{i1}^G)$ is

$$\mu_1^G = A^G + \ln(1-n^G) + (\alpha+\beta)\mu_0^G + (\alpha+\beta)\sigma_0^2/2 \tag{25}$$

where

$$A^G = (\alpha+\beta)\ln\tau \tag{26}$$

Public provision of education implies that variation in income derives only from differences in ability, hence the variance of $\ln(y_{it}^G)$ is uniformly ϕ^2 for $t \geq 1$ -- less than under private education. Thus $\bar{y}_1^G = \exp(\mu_1^G + \phi^2/2)$, and for $t \geq 2$,

$$\mu_t^G = A^G + \ln(1-n^G) + (\alpha+\beta)\mu_{t-1}^G + (\alpha+\beta)\phi^2/2 \tag{27}$$

and

$$\bar{y}_t^G = \exp(\mu_t^G + \phi^2/2) \tag{28}$$

Under *subsidization*, for $t \geq 1$, the mean of $\ln(y_{it}^S)$ is:

$$\mu_t^S = A^S + \ln(1-n^S) + (\alpha+\beta)\mu_{t-1}^S + \beta\sigma_{t-1}^2/2 \tag{29}$$

where

$$A^S = (\alpha+\beta)\ln(T/s) \tag{30}$$

and its variance is σ_t^2, as defined in equation (23): the same as for private education, and greater than under public provision. Mean income is

$$\bar{y}_t^S = \exp(\mu_t^S + \sigma_t^2/2) \tag{31}$$

When there are decreasing returns to scale ($\alpha + \beta < 1$) the foregoing analysis implies convergence to a finite steady state and allows us to derive average output in the steady state explicitly. Denoting it by $\bar{y}_\infty^J$ for J = P, G, S, we have

$$\bar{y}_\infty^P = \exp\{[(\alpha+\beta)\ln(\frac{\delta\alpha}{1+\delta\alpha}) + \ln(1-n^P) + \phi^2/2(1+\alpha)]/(1-\alpha-\beta)\} \tag{32}$$

$$\bar{y}_\infty^G = \exp\{[(\alpha+\beta)\ln\tau + \ln(1-n^G) + \phi^2/2]/(1-\alpha-\beta)\} \tag{33}$$

$$\bar{y}_\infty^S = \exp\{[(\alpha+\beta)\ln(T/s) + \ln(1-n^S) + \phi^2/2(1+\alpha)]/(1-\alpha-\beta)\} \quad (34)$$

This highlights the principal forces that determine average household income in the steady state under the three regimes: returns to scale ($\alpha + \beta$) increase average income in all three cases; the external benefits of education (β) increase the share of total income allocated to education under public provision or subsidization (τ or T/s respectively); the demand for leisure, amplifying the excess burden associated with public provision and, to a lesser extent, subsidization, reduces average income; and the dispersion of innate ability increases average income, more so under public provision than under the other regimes. We thus obtain

Proposition 2. When there are decreasing returns to scale, average household income converges to a steady state in each of the three regimes. Comparison of steady states reveals that a strong external effect favors public intervention over private provision with respect to average income; a strong propensity for leisure favors private provision over subsidization and subsidization over public provision; and a large dispersion of innate ability favors public provision over subsidization and subsidization over private provision.

Comparing subsidization with private provision in the general case, we find that if $\eta > 0$ then $\bar{y}_0^P > \bar{y}_0^S$ because of the excess burden generated by subsidization (this follows from equation (20) and Proposition 1(iii)).[7] Equations (21)-(24) and (29)-(31) then imply that $\bar{y}_0^S$ eventually overtakes $\bar{y}_0^P$ if and only if the rate of growth of average income under subsidization always exceeds the rate of growth under private provision, which holds if and only if:[8]

$$F(\eta,\beta;\ \delta,\alpha) = 1 + \eta + \delta(2\alpha+\beta) + \alpha\delta^2(\alpha+\beta)(1-\eta) > 0 \quad (35)$$

Insert Figure 1 Here

For given α and δ this inequality divides the (η,β) plane into two regions (see Figure 1). Growth is stronger under subsidization than under private provision in the lower region, and weaker in the upper region: (35) is satisfied if $\eta < 1+ 1/\delta\alpha^9$ or if $\beta < 1/\alpha\delta^2 - 1$.

Subsidization involves a tradeoff between the advantage of compensating for external effects and the disadvantage of imposing an excess burden, and this disadvantage varies directly with the value of leisure, η. If η is sufficiently small, then $\bar{y}_t^S$ will eventually overtake $\bar{y}_t^P$ whatever the value of β. Note also that (35) holds if $\alpha + \beta < 1+ 1/\delta\alpha^2$, i.e., if returns to scale are at most moderately increasing, and particularly if they are decreasing or constant. To sum up,

Proposition 3. In the general case, a comparison of subsidization and private provision with regard to average household income reveals only two possibilities: either income growth is always stronger under subsidization and $\bar{y}_t^S$ must overtake $\bar{y}_t^P$ in the long run, or growth is always stronger under private provision and $\bar{y}_t^S$ never overtakes $\bar{y}_t^P$. Private provision generates stronger growth only when both returns to scale and the propensity for leisure are high.

Comparing subsidization with public provision, equations (19) and (20) imply that $\bar{y}_0^S \geq \bar{y}_0^G$ because of the excess burden created by public provision. In subsequent periods, equations (25)-(31) imply that a sufficient condition for average income under subsidization to exceed average income under public provision in all periods is:

$$(2/\alpha)\ln[(1-n^S)/(1-n^G)] + \beta\alpha\min\{\phi^2+\sigma_0^2, \phi^2/(1-\alpha^2)\} - \phi^2 > 0 \qquad (36)$$

(A detailed derivation is available from the authors on request.) This holds if η, δ and β are large enough and ϕ^2 is small enough; if $\phi^2 = 0$ it holds for all values of η, δ and β.[10] Summarizing we have:

Proposition 4. Comparison between subsidization and public provision reveals that average income is greater under subsidization than under public provision in all periods if

the value of leisure (η), the bequest motive (δ), and the external benefits of education (β) are large enough, or if the dispersion of ability (ϕ^2) is small enough; in particular, if the population is homogeneous with respect to ability ($\phi^2 = 0$), then average income is always higher under subsidization.

5. Choice of regime under majority voting

In this section we consider which of the allocation modes -- private provision, subsidization, or public provision -- is likely to emerge as the preferred outcome under majority voting. To do so we compare the utility that each provides the current generation, with specific reference to the utility of the pivotal median voter. Comparison of private provision with subsidization of education yields the following strong result:

Proposition 5. Assume a positive external effect ($\beta > 0$). Then for any distribution of parental education and ability, the equilibrium outcome under subsidized education is a Pareto improvement over private provision for parents in the current generation. The chosen subsidy is a Pareto optimal outcome if and only if labor supply is perfectly inelastic, i.e., iff $\eta = 0$.

To see that the subsidy is a Pareto improvement over private provision note that parents are in unanimous agreement regarding the preferred level of subsidization.[11] A positive external effect implies a non-zero subsidy, and if labor supply is not perfectly elastic then the excess burden that arises from funding the subsidy implies that it is not Pareto optimal.

The comparison of subsidization with public provision is not so clear cut. Given an initial distribution of parental education and ability, the utility differential for the parent of family i in period 0 is:[12]

$$u_{i0}^S - u_{i0}^G = \eta \ln (n^S/n^G) + [1 + \delta(\alpha+\beta)]\ln[(1-n^S)/(1-n^G)] + \delta\alpha\ln(y_{i0}^S/\overline{y}_0^S) \qquad (37)$$

where $n^S/n^G \leq 1$ and $[(1-n^S)/(1-n^G)] \geq 1$, with equality in both iff $\eta = 0$. This differential is clearly an increasing function of individual income: subsidization is relatively more

desirable for those with high income while public provision is more desirable for those with low income. This reflects the redistributive property of public provision. It is also an increasing function of β (strictly increasing if $\eta > 0$): a larger external effect implies stronger political support for subsidization.[13]

For the median voter we have

$$u_{m0}^S - u_{m0}^G = \eta \ln (n^S/n^G) + [1 + \delta(\alpha+\beta)]\ln[(1-n^S)/(1-n^G)] - \delta\alpha\sigma_0^2/2 \qquad (38)$$

Clearly, a majority for subsidization over public provision depends on a strong external effect (large β) and limited dispersion of income (small σ_0^2).[14] Differentiation of (38) reveals that it is also an increasing function of η, the value of leisure: a larger η increases the greater excess burden imposed by public provision. Indeed, if $\eta = 0$ and labor supply is perfectly inelastic then the right hand side of equation (38) is negative (strictly negative if $\sigma_0^2 > 0$), and public provision is preferred. Figure 2(a) illustrates the tradeoff, for the median voter, between β and σ_0^2 implied by (38), for given α, δ, and η; Figure 2(b) illustrates a similar tradeoff between η and σ_0^2, for given α, δ, and β.

Insert Figures 2(a) and 2(b) Here

Proposition 6. In choosing between public provision and subsidized education, public support for subsidization increases with the magnitude of the externality and the value of leisure, and decreases with the initial degree of income inequality.

The effect that income distribution has on the relative popularity of different modes of intervention implies that the majority choice of education regime may change over time. Specifically, assume that initially σ_0^2 is high, so that public schooling is preferred. This lowers the variance of $\ln y_{it}$ to ϕ^2, possibly tilting the balance to subsidization. But then σ_t^2 will increase over time, approaching its asymptotic value $\phi^2/(1-\alpha^2)$), and may cross the threshold value of the variance that produces a majority for public provision, in which case the variance of $\ln y_{it}$ will again fall to ϕ^2, and so on. In this case a cyclical change of the

two regimes over time is indicated: under subsidization income inequality rises until it reaches an "unacceptable" level at which point public provision is adopted, reducing income inequality and allowing subsidization to be restored.

The conditions for the stability or instability of the education regime can be derived from equation (38) and are summarized as follows:

Proposition 7.

(i) If the distribution of ability in the population is sufficiently dispersed, *viz.*, if

$$\frac{\phi^2}{2} \geq [(1+\delta\alpha+\delta\beta)\ln((1-n^S)/(1-n^G)) + \eta\ln\frac{1+\eta}{1+\delta\alpha+\eta}]/\delta\alpha \qquad (39)$$

then public provision is stable, in the sense that once adopted it is always preferred.

(ii) If the distribution of ability is sufficiently uniform, *viz.*., if

$$\frac{\phi^2}{2} \leq [(1+\delta\alpha+\delta\beta)\ln((1-n^S)/(1-n^G)) + \eta\ln\frac{1+\eta}{1+\delta\alpha+\eta}](1-\alpha^2)/\delta\alpha \qquad (40)$$

then subsidization is stable in the same sense.

(iii) If the value of $\phi^2/2$ is intermediate, so that neither inequality is satisfied, then public provision and subsidization will alternate cyclically over time.

6. Concluding remarks

In this paper we use a growth model with overlapping generations and a heterogeneous population to compare different policy regimes for providing education, a factor of production with which external benefits are associated. Policy parameters and the type of regime that is selected are the subject of public choice, and regimes are compared with respect to the growth they generate, their impact on income distribution, and their popularity.

The analysis highlights the main forces at work: government intervention internalizes some of the external benefits of education but also creates an excess burden through the taxes it levies to finance its activities -- a burden that is heavier under public provision than under subsidization. Public provision also redistributes income among families.

The relative magnitude of these factors shapes the comparison of regimes with respect to growth and popularity. Subsidization is always preferred over private provision, and except for extreme parameter values, also induces stronger growth. The comparison between subsidization and public provision depends on the weight of the excess burden, the magnitude of the external effect, and the heterogeneity of the population. A high value of leisure (increasing the excess burden) and a strong external effect favor subsidization over public provision with regard to both growth and popularity; skewness of the initial distribution of income increases the popularity of public provision.

FOOTNOTES

1. Other models linking income distribution and growth via a political process appear in Alesina and Rodrik, 1991, Fernandez and Rogerson, 1992, Perotti, 1992, and Persson and Tabellini, 1991.

2. The heterogeneity of the population is not essential for this result in their model; it would hold also for a homogeneous population of representative agents. Moreover, given their intergenerational structure, the quality of public schooling chosen by a homogeneous population is lower than would arise if the same population chose an education subsidy; cf. Proposition 1 below. This order may be reversed eventually, as income inequality declines more rapidly under public schooling, but if initial income inequality is not excessive then private education yields greater per capita income in the long run as well.

3. Recent empirical analyses in the spirit of the new growth theory, e.g., Levine and Renelt, 1992, and Mankiw et al., 1992, indicate a positive correlation between human capital and growth.

4. Various alternative formulations have been used to capture the intergenerational bequest motive. The formulation chosen here is similar to that used by Glomm and Ravikumar and leads to a simpler analysis than other alternatives.

5. Parental decisions depend only on the decisions of other parents in their cohort, hence intergenerational consistency holds trivially.

6. Aitchison and Brown, 1969, is the basic reference on the lognormal distribution.

7. However, *wages* under subsidization, w_{it}^S, always exceed wages under private provision, w_{it}^P, for each individual.

8. Detailed derivations are available upon request.

9. This holds if the allocation of time to leisure under subsidization does not exceed $1/(1+\delta\alpha)$; e.g, if $n^S \leq 1/2$.

10. In contrast to the previous comparison, growth rates may be higher in certain periods under subsidization and in other periods under public provision.

11. Note that subsidization is preferred even when it attains a lower average rate of growth than private provision, as equation (35) implies may happen.

12. This derives from equations (13) and (18) and the observation that $1-T = (1-\tau)(1+\delta\alpha)$, and $(y_{it}^S)^\alpha(\bar{y}_t^S)^\beta/(\bar{y}_0^G)^{\alpha+\beta} = (y_{it}^S/\bar{y}_t^S)^\alpha(\bar{y}_t^S/\bar{y}_0^G)^{\alpha+\beta}$.

13. From equations (11) and (16), neither n^S nor n^G depend on β.

14. The present framework allows us to consider other public decision making rules as well. For instance, if a qualitative majority rule is employed, then (38) is modified to $u_{d0}^S - u_{d0}^G = \eta \ln (n^S/n^G) + [1 + \delta(\alpha+\beta)]\ln[(1-n^S)/(1-n^G)] - \delta\alpha[\sigma_0^2/2 - (q_d - 1/2)\sigma_0]$, where d is the size of the decisive majority (that is, the minimal proportion of population required for a decision), q_d is the corresponding percentile of the distribution, and u_{d0}^J, j = S, G, denotes the utility of the decisive voter. Clearly, the larger is d the more likely is public provision to prevail because of the increased income differential between the decisive voter and the mean voter.

REFERENCES

Aitchison, J. and J.A.C. Brown, The Lognormal Distribution, London: Cambridge University Press, 1969.

Alesina, A. and D. Rodrik, "Distributive politics and economic growth," NBER WP 3668, 1991.

Azariadis, C. and A. Drazen, "Threshold externalities in economic development," Quarterly Journal of Economics, 105(1992), 501-26.

Fernandez, R. and R. Rogerson, "Income distribution, communities and the quality of education: A policy analysis," NBER WP 4158, 1992.

Glomm, G. and B. Ravikumar, "Public versus private investment in human capital: Endogenous growth and income inequality," J. Polit. Econ., 100(1992), 818-34.

Levine, R. and D. Renelt, "A sensitivity analysis of cross-country growth regressions," American Economic Review, 82(1992), 942-963.

Lucas, R.E., Jr., "On the mechanics of economic development," J. Monetary Econ., 22(1988), 3-42.

Mankiw, N.G., Romer, D., and D. Weil, "A contribution to the empirics of economic growth," Quarterly Journal of Economics, 152(1992), 407-37.

Perotti, R., "Income distribution, politics, and growth," American Economic Review Papers and Proceedings, 1992, 311-16.

Persson, T. and G. Tabellini, "Is inequality harmful for growth? Theory and evidence," NBER WP 3599, 1991.

Romer, P.M., "Increasing returns and long-run growth," J. Polit. Econ., 94(1986), 1002-37.

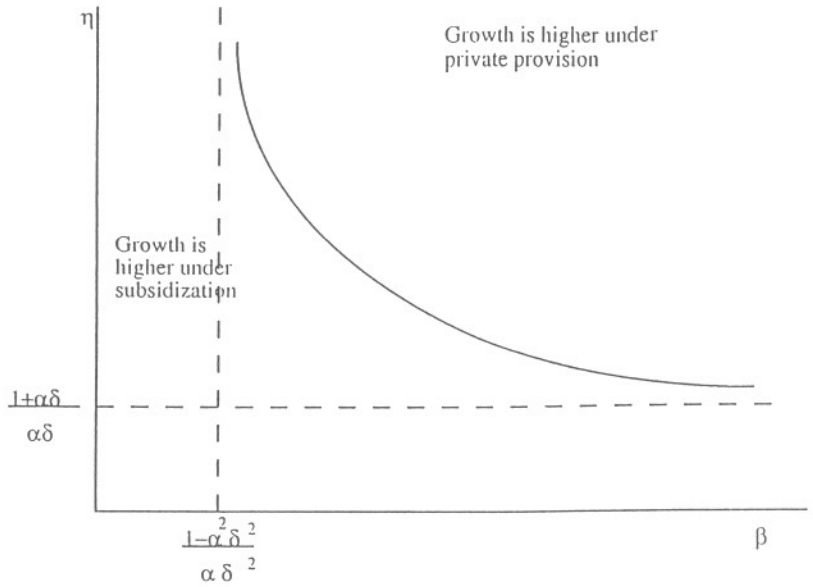
η
Growth is higher under private provision
Growth is higher under subsidization
1+αδ
αδ
1−α δ 2
α δ 2
β

Figure 1

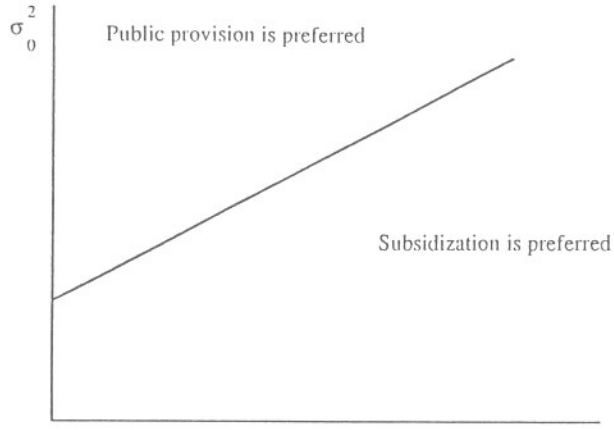

Figure 2(a)

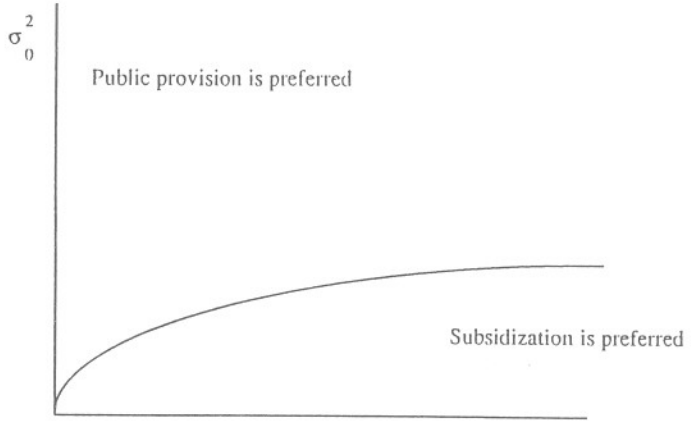

Figure 2(b)

CES Working Paper Series

---

01 Richard A. Musgrave, Social Contract, Taxation and the Standing of Deadweight Loss, May 1991

02 David E. Wildasin, Income Redistribution and Migration, June 1991

03 Henning Bohn, On Testing the Sustainability of Government Deficits in a Stochastic Environment, June 1991

04 Mark Armstrong, Ray Rees and John Vickers, Optimal Regulatory Lag under Price Cap Regulation, June 1991

05 Dominique Demougin and Aloysius Siow, Careers in Ongoing Hierarchies, June 1991

06 Peter Birch Sørensen, Human Capital Investment, Government and Endogenous Growth, July 1991

07 Syed Ahsan, Tax Policy in a Model of Leisure, Savings, and Asset Behaviour, August 1991

08 Hans–Werner Sinn, Privatization in East Germany, August 1991

09 Dominique Demougin and Gerhard Illing, Regulation of Environmental Quality under Asymmetric Information, November 1991

10 Jürg Niehans, Relinking German Economics to the Main Stream: Heinrich von Stackelberg, December 1991

11 Charles H. Berry, David F. Bradford and James R. Hines, Jr., Arm's Length Pricing: Some Economic Perspectives, December 1991

12 Marc Nerlove, Assaf Razin, Efraim Sadka and Robert K. von Weizsäcker, Comprehensive Income Taxation, Investments in Human and Physical Capital, and Productivity, January 1992

13 Tapan Biswas, Efficiency and Consistency in Group Decisions, March 1992

14 Kai A. Konrad and Kjell Erik Lommerud, Relative Standing Comparisons, Risk Taking and Safety Regulations, June 1992

15 Michael Burda and Michael Funke, Trade Unions, Wages and Structural Adjustment in the New German States, June 1992

16 Dominique Demougin and Hans–Werner Sinn, Privatization, Risk–Taking and the Communist Firm, June 1992

17 John Piggott and John Whalley, Economic Impacts of Carbon Reduction Schemes: Some General Equilibrium Estimates from a Simple Global Model, June 1992

18 Yaffa Machnes and Adi Schnytzer, Why hasn't the Collective Farm Disappeared?, August 1992

19 Harris Schlesinger, Changes in Background Risk and Risk Taking Behavior, August 1992

20 Roger H. Gordon, Do Publicly Traded Corporations Act in the Public Interest?, August 1992

21 Roger H. Gordon, Privatization: Notes on the Macroeconomic Consequences, August 1992

22 Neil A. Doherty and Harris Schlesinger, Insurance Markets with Noisy Loss Distributions, August 1992

23 Roger H. Gordon, Fiscal Policy during the Transition in Eastern Europe, September 1992

24 Giancarlo Gandolfo and Pier Carlo Padoan, The Dynamics of Capital Liberalization: A Macroeconometric Analysis, September 1992

25 Roger H. Gordon and Joosung Jun, Taxes and the Form of Ownership of Foreign Corporate Equity, October 1992

26 Gaute Torsvik and Trond E. Olsen, Irreversible Investments, Uncertainty, and the Ramsey Policy, October 1992

27 Robert S. Chirinko, Business Fixed Investment Spending: A Critical Survey of Modeling Strategies, Empirical Results, and Policy Implications, November 1992

28 Kai A. Konrad and Kjell Erik Lommerud, Non–Cooperative Families, November 1992

29 Michael Funke and Dirk Willenbockel, Die Auswirkungen des "Standortsicherungsgesetzes" auf die Kapitalakkumulation – Wirtschaftstheoretische Anmerkungen zu einer wirtschaftspolitischen Diskussion, January 1993

30 Michelle White, Corporate Bankruptcy as a Filtering Device, February 1993

31 Thomas Mayer, In Defence of Serious Economics: A Review of Terence Hutchison; Changing Aims in Economics, April 1993

32 Thomas Mayer, How Much do Micro–Foundations Matter?, April 1993

33 Christian Thimann and Marcel Thum, Investing in the East: Waiting and Learning, April 1993

34 Jonas Agell and Kjell Erik Lommerud, Egalitarianism and Growth, April 1993

35 Peter Kuhn, The Economics of Relative Rewards: Pattern Bargaining, May 1993

36 Thomas Mayer, Indexed Bonds and Heterogeneous Agents, May 1993

37 Trond E. Olsen and Gaute Torsvik, Intertemporal Common Agency and Organizational Design: How much Decentralization?, May 1993

38 Henry Tulkens and Philippe vanden Eeckaut, Non–Parametric Efficiency, Progress and Regress Measures for Panel Data: Methodological Aspects, May 1993

39 Hans–Werner Sinn, How Much Europe? – Subsidiarity, Centralization and Fiscal Competition, July 1993

40 Harald Uhlig, Transition and Financial Collapse, July 1993

41 Jim Malley and Thomas Moutos, Unemployment and Consumption: The Case of Motor–Vehicles, July 1993

42 John McMillan, Autonomy and Incentives in Chinese State Enterprises, August 1993

43 Murray C. Kemp and Henry Y. Wan, Jr., Lumpsum Compensation in a Context of Incomplete Markets, August 1993

44 Robert A. Hart and Thomas Moutos, Quasi–Permanent Employment and the Comparative Theory of Coalitional and Neoclassical Firms, September 1993

45 Mark Gradstein and Moshe Justman, Education, Inequality, and Growth: A Public Choice Perspective, September 1993