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Research Article

Optimal Educational Investment: Domestic Equity and International Competition

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We construct a family of models to analyse the effect on optimal educational investment of (i) society's preferences for equity and (ii) competition between countries. The models provide insights about the impact of a variety of parameters on optimal policy. In particular, we identify a form of "overeducation" that is new to the literature and provide a counterexample to a common finding in the literature on fiscal federalism.

1. Introduction

Economists' interest in education often focuses upon the rate of return to schooling investments. Yet it is a characteristic of the education system in many countries that, for the most part, schooling is funded out of the public purse. While one might imagine that governments should seek to "equalise rates of return in all directions" [1], it is often the case that the authorities have broader objectives that inform their educational investments. For example, a government may have preferences about equity as well as efficiency. Or it may, for various reasons, be concerned to ensure that its own investment in its people's skills does not fall behind investments made by other countries.

We examine these issues by developing, in the next section, a series of models that can aid our understanding of how, under a variety of conditions, the optimal provision of publicly funded education is determined.

2. The Model

In this section we present a family of related models of education and the tax system in order to provide insights into how governments can reach decisions about the optimal funding of education where (i) society has preferences about equity and (ii) decisions have impacts across countries. The basic structure of the model builds on the analysis of Johnes [2].

2.1. Equity. Suppose that the disposable income of individual i is given by

$$Y_i = (Y_0 + s_i b)(1 - \tau), \tag{1}$$

where Y_0 is a basic income to be defined more precisely later, s_i is a binary variable that indicates whether the ith individual has undertaken schooling or not, τ is the proportional rate of income tax, and b is the income premium associated with schooling. Both Y_0 and b are assumed exogenous. Tax revenues are used solely for the purpose of financing education which, we assume, takes place instantaneously. This distinguishes the model from a family of models typified by that of Bovenberg and Jacobs [3], where taxation also serves a redistributive purpose. In our model we keep the tax system simple in order to facilitate the extension to the international case in Section 2.2 below. In the present model, tax revenues fund education as a means of achieving the redistribution of income, but they could equally fund any investment that achieves this goal. Investments in health, for example, could equally be modelled in this way. For simplicity we consider only one public good.

Denote by λ the proportion of the population n that undertakes education. Total tax revenue is given by

$$\tau n(Y_0 + \lambda b). \tag{2}$$

Suppose that the cost of providing schooling to each individual is an increasing function of λ, and is, more precisely,

Table 1: Optimal rates of tax and education under various parameter assumptions in the model of income distribution.

	$\sigma = 0.5$		$\sigma = 0.75$		$\sigma = 0.9$		$\sigma = 1$	
	τ^*	λ^*	τ^*	λ^*	τ^*	λ^*	τ^*	λ^*
$b = 0.5$ $\gamma = 2$	0.09	0.2237	0.14	0.2827	0.16	0.3035	0.17	0.3136
$b = 0.2$ $\gamma = 3$	0.03	0.1010	0.05	0.1308	0.07	0.1551	0.08	0.1660

Note. Throughout it is assumed that $Y_0 = 1$.

given by $\gamma\lambda$. The total cost of education is then $\gamma\lambda^2 n$, and this must equal the expression in (2) in order for the exchequer's books to balance. Solving for λ, which must lie within the unit interval, and assuming a unique real root yields

$$\lambda = \frac{\left[\tau b + \sqrt{(\tau^2 b^2 + 4\gamma\tau Y_0)}\right]}{2\gamma}. \quad (3)$$

The sum of disposable incomes is given by

$$\begin{aligned} V &= n(1-\tau)(Y_0 + b\lambda) \\ &= n(1-\tau)\left\{ Y_0 + \frac{b\left[\tau b + \sqrt{(\tau^2 b^2 + 4\gamma\tau Y_0)}\right]}{2\gamma} \right\}. \end{aligned} \quad (4)$$

To close the model, we introduce a social welfare function, maximisation of which yields solutions for the optimal tax rate and the optimal level of education. We begin with a particularly simple variant of the model in which social welfare equals

$$W = n(1-\tau)(Y_0 + \lambda\sigma b), \quad (5)$$

and where $0 \le \sigma \le 1$ represents a weight attached to the premium earned by higher income (educated) individuals. In this way, society expresses its preferences concerning the income distribution.

Substituting from (3) into (5) yields

$$W = n(1-\tau)\left\{ Y_0 + \frac{\sigma b\left[\tau b + \sqrt{(\tau^2 b^2 + 4\gamma\tau Y_0)}\right]}{2\gamma} \right\}. \quad (6)$$

It is possible, though tedious, to derive an analytical solution for the problem of maximising (6) with respect to τ. We denote this solution by τ^* and note that routine substitution of this into (3) yields the optimal level of education, λ^*. Clearly

$$\begin{aligned} \tau^* &= \tau^*(b, Y_0, \gamma, \sigma), \\ \lambda^* &= \lambda^*(b, Y_0, \gamma, \sigma). \end{aligned} \quad (7)$$

Since the analytical solutions for τ^* and λ^* are cumbersome and uninstructive, we proceed by way of numerical examples. In Table 1, we show the values of τ^* and λ^* that obtain for a variety of assumed values of σ. These are shown for various values of b, Y_0, and γ. In the upper panel, we have $b = 0.5$, $Y_0 = 1$, and $\gamma = 2$, while in the lower panel we have $b = 0.2$, $Y_0 = 1$, and $\gamma = 3$. The lower panel therefore represents a state in which returns to education are lower, and costs of education are higher, than in the upper panel.

Table 2: Optimal rates of tax and education under various parameter assumptions in the international model.

	Model	τ^*	λ^*	W^*
$\delta = 1$	Nash	0.03	0.1787	1.0326
	Cooperative	0.03	0.1787	1.0326
$\delta = 2$	Nash	0.08	0.3111	1.1129
	Cooperative	0.07	0.2895	1.1135
$\delta = 3$	Nash	0.12	0.4090	1.2268
	Cooperative	0.11	0.3894	1.2271

Notes. Throughout it is assumed that $\gamma = 1$, $\beta = 2.5$, $\theta = 0.5$, and $Y_0 = 1$. The value of welfare is reported as a *per capita* measure.

It is readily observed that investment in education and, consequently, also tax rates are lower in the lower panel than in the upper panel. This follows directly from the fact that returns to education are lower in the lower panel—with both the earnings premium to educated workers being lower and the cost of education being higher. It is also clear that investment in education, and tax rates, fall as society places more weight on equity. This result would, of course, need to be qualified in the case of a model where taxes also serve a redistribution role. Raising educational investment offers greater return in a society where the incomes of the educated workers carry more weight.

2.2. International Issues. The second variant of the model that we examine is chosen to provide insights into international issues. In order to build in some interaction between the two countries, we assume b a decreasing function of global education levels. This is to reflect the labour market impact on one country of the educational investments made by another country, through changes, for example, in comparative advantage. Some references in the received literature (e.g., [4]) suggest that, owing to complementarity effects, the impact of education in one country on the rate of return to education in another should be positive. Here we are adopting the alternative view that rising skill levels in one economy worsens the competitive position of workers in another, following, for example, Freeman [5]. Our model assumes no migration across countries. Hence assume that

$$b = \frac{\delta}{(\beta + \lambda_1 + \theta\lambda_2)}, \quad (8)$$

Table 3: Optimal rates of tax and education under various parameter assumptions in the international model with income distribution considerations.

	Model	τ^*		λ^*		W^*	
		$\sigma = 0.75$	$\sigma = 0.9$	$\sigma = 0.75$	$\sigma = 0.9$	$\sigma = 0.75$	$\sigma = 0.9$
$\delta = 1$	Nash	0.02	0.02	0.1451	0.1451	1.0193	1.0271
	Cooperative	0.02	0.02	0.1451	0.1451	1.0193	1.0271
$\delta = 2$	Nash	0.05	0.07	0.2418	0.2895	1.0703	1.0952
	Cooperative	0.05	0.06	0.2418	0.2665	1.0703	1.0955
$\delta = 3$	Nash	0.09	0.11	0.3480	0.3894	1.1458	1.1934
	Cooperative	0.09	0.10	0.3480	0.3691	1.1458	1.1937

Note. See notes to Table 2.

where λ_1 and λ_2, respectively, denote the proportion of the population in each country that undertakes education, and where β is a constant. For simplicity we assume that n, Y_0, and γ are identical across countries.

Noting that the balanced budget constraint

$$\tau_j n\left(Y_0 + \lambda_j b\right) = \gamma \lambda_j^2 n, \quad j = 1, 2, \tag{9}$$

implies

$$\tau_j n\left[Y_0 + \frac{\delta \lambda_j}{(\beta + \lambda_1 + \theta \lambda_2)}\right] = \gamma \lambda_j^2 n, \quad j = 1, 2; \tag{10}$$

we may solve a pair of simultaneous cubic equations

$$\gamma \lambda_j^3 + \gamma(\beta + \theta \lambda_k)\lambda_j^2 - \tau_j(\delta + Y_0)\lambda_j - \tau_j Y_0(\beta + \theta \lambda_k) = 0, \quad j = 1, 2, \ k = 1, 2, \ j \neq k \tag{11}$$

to establish the levels of λ_1 and λ_2 as

$$\lambda_j^* = \lambda_j(\tau_1, \tau_2, \gamma, \theta, \beta, \delta, Y_0), \quad j = 1, 2. \tag{12}$$

Equations (12) are analogous to (3) in the earlier model.

Define social welfare within each country, in analogous fashion to (5), as

$$W_j = n\left(1 - \tau_j\right)\left[Y_0 + \frac{\sigma \delta \lambda_j^*}{\left(\beta + \lambda_j^* + \theta \lambda_k^*\right)}\right], \quad j = 1, 2. \tag{13}$$

To keep matters simple, suppose $\sigma = 1$. The maximisation of W_j with respect to τ_j can proceed either with the two countries competing with one another, following Nash [6], or with them playing cooperatively. In neither case is there a straightforward analytical solution, so we proceed by way of example. Results are shown for a variety of parameter assumptions in Table 2. By symmetry, each country has the same optimal tax rate and education level as the other in both the Nash and the cooperative case.

The results indicate that the Nash solution implies higher tax and education levels than the cooperative solution. The intuition behind this result is straightforward. Starting from a cooperative position, each country, taking the other's behaviour as given, has an incentive to raise its own investment in education. Consequently, Nash behaviour leads to a type of "overeducation" that is new to the literature. In contrast with the overeducation identified by authors such as Daly et al. [7] and Dolton and Vignoles [8], where some graduates fail to find work commensurate with their qualifications, the overinvestment in education that we observe in the present model represents a shortfall in welfare due to competition between countries.

The results reported here provide a striking contrast to a finding that is common in the fiscal federalism literature—namely that competition between tax jurisdictions leads to lower tax rates [9]. When, as in this model, the tax is spent on activity that is welfare enhancing, competition can have the opposite effect.

In the above analysis a positive value has been assumed for θ. It is conceivable, however, that $\theta < 0$, indicating complementarity of human capital stocks across countries. This could lead to undereducation as each country fails to take into account the positive externalities associated with its education investments.

2.3. Equity in the International Model. Extension of the model of the previous section to include values of $\sigma < 1$ is straightforward, requiring no change to (8) through (13), and only a minor change in the programming. Results for a variety of parameter assumptions appear in Table 3. These results follow the patterns identified in the earlier sections of the paper and hence do not require extensive discussion here. As the returns to education, here measured by δ, increase, so does the optimal level of educational investment in either the Nash or the cooperative model, other things being equal. Likewise as σ rises, indicating weaker preferences for equity, so the optimal level of educational investment increases. It is worth noting, moreover, that as σ rises, the gap between the Nash and cooperative equilibria tends to widen.

3. Conclusion

The notion that competition between countries leads to the setting of tax rates that differ from those that would obtain in the absence of such competition is a familiar one. In this paper, we have extended this to examine the international competition in tax and government expenditure, where the expenditure takes the form of educational investments that in themselves yield gains in the form of enhanced income. We have also examined the operation of the model in the context of alternative societal preferences for equity.

The type of overeducation identified in this paper is new to the literature, and it is not at all clear how extensive this effect might be in practice, where not all of the restrictions of the present theoretical model apply. An interesting avenue for future research might therefore be to evaluate this effect. It is suggested that multicountry computable general equilibrium models could prove to be a useful tool in this endeavour.

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