How to Finance Education – Taxes or Tuition Fees?

NIKOLAJ MALCHOW-MØLLER
Centre for Economic and Business Research (CEBR), and Department of Economics, University of Southern Denmark

AND

JAN ROSE SKAKSEN
Deaprtment of Economics, Copenhagen Business School, and Centre for Economic and Business Research (CEBR)

January 26, 2005

Abstract

The fact that education provides both a productive and a consumptive (non-productive) return may have important implications for the optimal way of financing education through taxes and tuition fees. We show that while tuition fees and high marginal labour income taxes are almost perfect substitutes as tax instruments when the consumption share in education is exogenous, this is not the case when it is endogenous. With an endogenous consumption share, the first-best system involves regressive income taxes and high tuition fees, although a progressive labour income tax system may be the optimal second-best response to politically imposed low tuition fees.

JEL: H21, H24.

Keywords: Consumption; education; intrinsic value; optimal taxes; tuition fees.

1 Introduction

How should higher education by financed? In the US, there has been a long tradition of charging tuition fees, whereas the dominating system in Europe – and in particular in Scandinavia – has been to provide education almost free of charge, instead relying on general taxes to finance the costs. The choice of financing scheme is not irrelevant, however, as tuition fees and income taxes may have quite different implications for the incentives to acquire education. The first aim of this paper is, therefore, to consider how taxes and tuition fees affect the educational choice of students. The second, and main, aim is to determine the optimal tax and tuition fee system in different situations.

An important premise of this paper is that education comes with two kinds of returns. First, it raises productivity, which is reflected in higher wages. Second, it yields a consumption value such as the value of being more knowledgeable, having a higher social status, or finding a more interesting job, see, *e.g.*, Becker (1964), Heckman (1976), and Lazear (1977). Furthermore, the relative importance of these returns is likely to vary across different types of education, and hence becomes subject to individual control.

In this paper, we assume that both types of return influence the choice of education. In other words, we consider not only the *level* of education but also the relative amounts of consumption and production value, *i.e.* the *type* of education chosen. This has important implications for the tax system as only the productive return to education can be taxed through income taxes.

We set up a simple general-equilibrium model, in which we analyse how the incentives for education are affected by labour income taxes and tuition fees. As a benchmark, we analyse a set-up where the share of consumption value in education is exogenously given. In this case, we find that high marginal income taxes and high tuition fees are almost perfect substitutes. In particular, if tuition fees are low, labour income taxes must be progressive to achieve the first-best outcome.

In our general specification, where the share of consumption value in education is endogenous, we find that progressive taxes and tuition fees have very different implications for the choice of education. Specifically, we find that the first-best allocation requires regressive labour income taxes and high tuition fees. On the other hand, if tuition fees are fixed ex-ante, only a second-best allocation can be reached. In this case, tuition fees and marginal income taxes again become substitutes, despite the distortions caused by the latter.

Hence, low tuition fees induce high marginal (progressive) income taxes both when the share of consumption value in education is exogenous and when it is endogenous. In the latter case, however, progressiveness is only a second-best response. The Scandinavian system of high marginal income taxes could thus be an optimal second-best response to the politically imposed low tuition fees.

In the literature, there are a number of papers which are related to our work, in the sense that they consider the interaction between taxation and educational choice. In Trostel (1993), it is found that a proportional income tax significantly reduces investments in education. One reason for this is that the (pecuniary) cost of education is not tax-deductible, see also Nerlove, Razin, Sadka, and Weizsäcker (1993). A second reason is that income taxes reduce labour supply, which decreases the degree of utilisation of human capital and hence the return to human capital, see also Lucas (1990).

Nielsen and Sørensen (1997) argue that a proportional tax on labour income is not in itself distortionary with respect to investments in education if the cost of investment is the time spent in school rather than a pecuniary cost. With a tax on capital income, a proportional labour income tax will in fact lead to overinvestment in education, since investments in human capital will then be taxed relatively less than financial investments. This in turn justifies a progressive labour income tax.

Alstadsæter (2003a) extends the model of Nielsen and Sørensen (1997) by arguing that education also has a consumption value which is not taxed. In her model, the consumption value of education is exogenous, and this serves to strengthen the case for a progressive income tax in order to prevent overeducation.[1]

While all these studies consider taxation and educational choice, they focus exclusively on the *level* of education. Furthermore, they assume that the cost of education is either a time cost or a pecuniary cost. In contrast, our paper includes: i) an endogenous consumption value of education; ii) taxes *and* tuition fees; and iii) a time cost *and* a pecuniary cost of education. However, our stylised model leaves out other aspects which are potentially important. First, we have ignored the possibility of credit constraints, which might in itself be an important argument for low tuition fees. Second, we have not considered the implications of a heterogeneous labour force. As a consequence, distributional concerns in the education policy are ignored. Third, we have assumed away any endogenous changes in labour supply – apart form those stemming from the division of time between work and education. Despite these simplifications, the model adds an important dimension to be taken into account when deciding on how to finance education.

The paper is organised as follows. The model is presented in Section 2. In

[1] In a more recent paper, Alstadsæter (2003b), the consumption share in education is made endogenous as in our model, but the implications for the tax system are not considered.

Section 3, we consider how taxes affect the educational choice, and in Section 4, we derive conditions for the optimal tax system. Section 5 concludes.

2 The Model

Following Nielsen and Sørensen (1997) and Alstadsæter (2003a), we set-up an overlapping-generations model of a small open economy with perfect international mobility of capital and an internationally immobile labour force. For simplicity, we assume that there is no exogenous productivity growth, and that the population size is fixed, such that each generation is of size unity and lives for two periods. Hence, an old and a young generation are alive at each point in time.

In both periods, leisure is demanded inelastically by the representative agent. In her first period of life, the agent divides her non-leisure time between labour supply and education, whereas in the second period, she spends all her non-leisure time on the job. Education in period 1 raises the effective labour supply in period 2 and also provides a direct utility gain – a so-called *consumption value*. Furthermore, the agent can transfer resources between periods by saving and borrowing at the international interest rate.

We consider a system of dual income taxation where tax rates on capital income and labour income are set separately and independently of each other. Moreover, in order to focus on labour income taxation, we assume the tax on capital income to be exogenously given.[2] Furthermore, capital income is taxed according to the residence principle, implying that all savings by residents are taxed at the same rate. With respect to labour income, we assume one tax rate applying to income up to the level of an uneducated individual, and another rate for income above this level. Hence, the latter becomes a tax on the productive return to education.

Government expenditures are taken as exogenous. However, in the event of a reform, the public debt level may be adjusted to keep the utility of the current old generation unaffected (see below).

[2] Nielsen and Sørensen (1997) follow a similar approach. They argue that a positive capital tax is required to compensate for the distortion of the labour-leisure choice caused by labour income taxes. Since leisure is demanded inelastically in the present model, it seems sensible to also treat capital income taxes as exogenous.

2.1 The Households

The representative agent of each generation lives for two periods with lifetime utility given by:

$$U = U\left(C, hE\right), \quad U_1', U_2' > 0 \quad and \quad U_{11}'', U_{22}'' < 0 \tag{1}$$

where C is consumption in period 2, E is the time spent on education in period 1, and h is the share of E having consumption value, *i.e.* a direct utility effect. Correspondingly, $1-h$ is the share of E having production value, *i.e.* it raises the effective labour supply of the agent in period 2. For simplicity, and without loss of generality, we assume that all consumption takes place in period 2. Furthermore, we assume that both C and hE are normal goods.

We can think of E as the level of education, and h as the type. We assume that h is a continuous variable, $h \in [0,1]$, implying that the representative agent is able to choose any mix of production and consumption value.

The agent is endowed with one unit of time in both periods. Assuming that the demand for leisure is inelastic and normalised to zero, the time budgets are given by:

$$L_1 + E = 1 \qquad and \qquad L_2 = 1 \tag{2}$$

where L_1 and L_2 are the labour supplies in the two periods.

The private pecuniary cost of education in period 1 is ωE, where ω is the cost per time unit of education. We will refer to ω as a "tuition fee".[3] Education raises the effective labour supply in period 2 to $g\left(\left(1-h\right)E\right)L_2$, where $g\left(0\right) = 1$, $g' > 0$ and $g'' < 0$. Thus, effective labour supply is increasing in productive education, but at a decreasing rate.

Since all consumption takes place in period 2, savings in period 1 are given by:

$$S = \left(1 - t_l\right) W L_1 - \omega E \tag{3}$$

where W is the wage rate, and t_l is the basic tax rate that applies to all income below W. Labour income above W is taxed at the rate t_h. Hence, consumption in period 2 is given by the following budget constraint:

$$C = \left[1 + \left(1-\tau\right) r\right] S + \left(1 - t_l\right) W L_2 + \left(1 - t_h\right) W \left[g\left(\left(1-h\right)E\right) - 1\right] L_2 \tag{4}$$

[3] We assume throughout that ω cannot depend on h. Although h is interpreted as the type of education, the individual abilities to realise productive and consumptive returns from a given type of education may vary considerably.

where r is the rate of interest and τ is the tax on capital income. Using the expression for S in (3) and the time constraints in (2), the budget constraint can be rewritten as:

$$C = \frac{(1 - t_l) W (1 + p - E) - \omega E}{p} + (1 - t_h) W [g ((1 - h) E) - 1] \tag{5}$$

where:

$$p = \frac{1}{1 + r (1 - \tau)} \tag{6}$$

2.2 The Business Sector

The domestic business sector produces a good which is a perfect substitute for foreign goods. The price of this good is normalised to one. We assume that production is given by a standard neoclassical production function with constant returns to scale:

$$Y = F (K, N) \tag{7}$$

where Y is production, K is the input of capital, and N is the input of effective labour. Since there are two generations of workers at the labour market, the input of effective labour in the steady state is given by $N = L_1 - E + g ((1 - h) E) L_2$.

The assumption of constant returns to scale allows us to work with the production function in intensive form:

$$y = f (k) \tag{8}$$

where $y = \frac{Y}{N}$ and $k = \frac{K}{N}$.

Maximising profits implies that:

$$f' (k) = r \qquad and \qquad f (k) - rk = W \tag{9}$$

Since k is solely determined by the rate of interest at international capital markets, r, it follows that the before-tax wage rate, W, is also determined by r and is independent of domestic tax rates.

2.3 The Government

Since our focus is on the financing of education, we assume that other government expenditures, G, are exogenous and must be financed through tax revenues.

When considering optimal tax and tuition fee reforms in Section 4, we assume that the objective of the government is to maximise the utility of the current young generation and all future generations without reducing the utility of the current old generation. This is achieved by keeping the taxes on the old generation unchanged in the event of a reform, and instead adjusting the level of public debt, D. In other words, the reform is assumed only to apply to the current young and future generations. In this way, we ensure that the government achieves a strict Pareto improvement.[4]

The budget constraint of the government in the reform period is formally given by:

$$\begin{aligned} D = G + (\theta - \omega) E - t_l W (1 - E) \\ - t_l^0 W - t_h^0 W \left[g \left(E^0 \left(1 - h^0 \right) \right) - 1 \right] - \tau r S^0 \end{aligned} \quad (10)$$

where D is government debt at the end of the reform period, and θ are the social costs per time unit of education.[5] For simplicity, we have assumed that education is publicly provided. If education was privately provided, we should simply interpret $\theta - \omega$ as an education subsidy/tax. The net cost to the government of education is therefore the social cost minus the tuition fee, $\theta - \omega$. The superscript "0" in (10) indicates that these variables are predetermined for the current old generation and therefore not influenced by the tax reform. New tax rates apply exclusively to the current young and future generations. Thus, the term, $t_l W (1 - E)$, is the tax revenue from the young generation, whereas the last three terms in (10) all represent tax revenue from the current old generation.

If debt and tax rates must be kept constant in all periods following the tax reform, the public budget constraint for each of these periods is given by:

$$\begin{aligned} t_l W (2 - E) + t_h W [g (E (1 - h)) - 1] + \tau r [(1 - t_l) W (1 - E) - \omega E] \\ - G - rD - (\theta - \omega) E = 0 \end{aligned} \quad (11)$$

since the steady state is reached already in the period following the reform. Consolidating the constraints in (10) and (11) by eliminating D yields:

$$\begin{aligned} rR + (1 + r) t_l W (1 - E) + t_l W + t_h W [g (E (1 - h)) - 1] \\ + \tau r [(1 - t_l) W (1 - E) - \omega E] - (1 + r) G - (1 + r) (\theta - \omega) E = 0 \end{aligned} \quad (12)$$

where:

$$R = t_l^0 W + t_h^0 W \left[g^0 \left(E^0 \left(1 - h^0 \right) \right) - 1 \right] + \tau r S^0 \quad (13)$$

is an exogenous constant.

[4] A similar approach is used by Nielsen and Sørensen (1997) and Alstadsæter (2003a).

[5] Note that the government debt at the beginning of the reform period is assumed to be zero.

3 Taxes, Tuition Fees, and Educational Choice

The representative agent maximises the utility function in (1) with respect to C, E, and h, subject to the budget constraint in (5). Defining non-productive education as $E_1 = hE$ and productive education as $E_2 = (1-h)E$, such that $E = E_1 + E_2$, the household optimisation problem can be rewritten as:

$$\begin{aligned} \max_{C,E_1,E_2} \quad & U(C, E_1) \\ s.t. \quad & C = \frac{(1-t_l)W(1+p-E_1-E_2) - \omega(E_1+E_2)}{p} + \\ & (1-t_h)W[g(E_2)-1] \end{aligned} \tag{14}$$

with the following first-order conditions for E_1 and E_2:[6]

$$U_1' \cdot \frac{1}{p}\{-(1-t_l)W - \omega\} + U_2' = 0 \tag{15}$$

$$U_1' \cdot \left\{\frac{1}{p}[-(1-t_l)W-\omega] + (1-t_h)Wg'\right\} = 0 \tag{16}$$

The condition in (16) directly determines the optimal value of E_2:

$$p(1-t_h)Wg'(E_2) = (1-t_l)W + \omega \tag{17}$$

The optimal amount of productive education, E_2, is found where the marginal cost of E_2, given by the tuition fee and the opportunity cost of the time invested (the right-hand side), equals the marginal return, given by the present value of higher period-2 income (the left-hand side).

The condition for E_1 in (15) can be rewritten as:

$$\frac{U_1'}{U_2'} = \frac{p}{(1-t_l)W + \omega} \tag{18}$$

This is a standard optimality condition saying that the marginal rate of substitution between two consumption goods, C and E_1 (the left-hand side), must be equal to the relative price of these goods (the right-hand side).

3.1 Comparative Statics

In this section, we consider the effects of changing the labour income tax rates, t_l and t_h, and the tuition fees, ω. The comparative statics results are

[6] Throughout the paper, we assume that the parameter values ensure an interior solution, *i.e.* $E_1, E_2 > 0$ and $E_1 + E_2 < 1$.

derived formally in the Appendix. The analytical results indicate that it is in general ambiguous how the type of education, h, is affected by isolated changes in t_l, t_h, and ω. Below, we give an intuitive presentation of the results.

An increase in the marginal tax rate, t_h, lowers E_2 since the return to productive education decreases as t_h increases. Furthermore, the negative income effect of an increase in t_h causes the "consumption" of E_1 to fall, while the relative prices of E_1 and C are unaffected by a change in t_h, see (18). Thus, total education, $E = E_1 + E_2$, drops, and as a consequence, the effect on the consumption share in education, h, becomes ambiguous, depending on whether the consumption of E_2 drops more or less than investments in E_1.

Increasing the basic tax rate, t_l, causes productive education, E_2, to increase due to a lower opportunity cost of the time invested in education. The effect on non-productive education, E_1, on the other hand, is unclear. The increase in t_l makes E_1 relatively cheaper as a consumption good compared to C, but at the same time, there is a negative income effect working in the opposite direction. Hence, the aggregate effect on E_1, and therefore E, becomes ambiguous. So does the effect on h, although it will be negative provided that E_1 does not grow more than E_2.

A higher tuition fee, ω, lowers productive education, E_2, by raising the cost of investment. This also applies to non-productive education, E_1, which is further reduced through a negative income effect. As above, the effect on h will therefore depend on the relative changes in E_1 and E_2.

3.2 A Financing Experiment

A number of studies compare estimated social rates of return to education across countries. Although the existing studies have limited and different coverage of countries, rely on a number of different computation methods, see Cohn and Addison (1998), and focus on returns to different levels of education, most studies find that the Scandinavian countries tend to have lower average returns, see, *e.g.*, Asplund et al. (1994), Cohn and Addison (1998), Trostel, Walker, and Woolley (2002), and Harmon, Oosterbeek, and Walker (2003). A possible explanation for this finding could be a higher consumption content in the educations chosen by Scandinavian students, as the estimated rates of return only take the productive returns into account. Would this be consistent with the implications of the present model?

To answer this question, consider a financing reform involving an increase in tuition fees, ω, while reducing the marginal tax rate, t_h. That is, the government replaces the indirect cost of education with a direct cost of education.

This can be interpreted as a transition from a Scandinavian-type system to a US-type system.

In terms of our model, there are several ways to implement the details of such a reform. A relevant experiment would be to increase ω while decreasing t_h so as to keep the total level of education, E, constant.

The effect on h of such a reform can be found from the f.o.c.'s for E_1 and E_2 in (18) and (17) by replacing E_1 and E_2 with hE and $(1-h)\,E$, and then differentiating with respect to ω, t_h, and h. It turns out that h will decrease if and only if:

$$\frac{1}{p}\left(E-\frac{g-1}{g'}\right)\left[U''_{11}\left((1-t_l)\,W+\omega\right)-pU''_{21}\right]<U'_1 \tag{19}$$

The right hand side of this condition is always positive, and a sufficient condition for the left hand side to be negative is that:[7]

$$E-\frac{g-1}{g'}>0 \tag{20}$$

If (20) holds, a reform replacing marginal taxes with tuition fees to keep the total amount of education constant will always induce an increase in the productive share of education, $1-h$. The intuition for this result is that the reform decreases the relative price of C and E_1, see (18). This price effect will tend to decrease the consumption of E_1. Thus, for the reform to yield an increase in E_1 (and hence a decrease in E_2), the income effect of this reform should be sufficiently positive. However, with an associated decrease in E_2, this requires at least: i) an increase in the government deficit; or ii) an initial suboptimal high level of E_2.

As a consequence, under the additional assumptions that E_2 is initially below its social optimum and that the reform does not worsen the public budget – which can be achieved through additional lump-sum taxation[8] – the effect on $1-h$ becomes unambiguously positive. Alternatively, assumptions about the functional form of g can ensure an unambiguous effect. If, for example, $g=\ln(1+E_2)+1$, the condition in (20) always holds, in which case the suggested reform gives rise to an increase in the productive share of education.

In sum, the model is fully consistent with the observed lower rates of return in the Scandinavian countries. According to the model, they simply

[7] Since we assume normality of both goods, it can be shown that $U''_{11}\left((1-t_l)\,W+\omega\right)-pU''_{21}<0$.

[8] Of course, if lump sum taxes were possible, there would be no reason to use distortionary taxes, and we only use lump sum taxation to explain what are the roots of the ambiguity.

reflect a higher consumption content in the educations chosen, caused by a tax system where tuition fees have been replaced by high marginal income taxes.

4 Optimal Financing of Education

Having considered how the representative household responds to changes in labour income taxes, t_l and t_h, and tuition fees, ω, the aim is now to consider how to optimally design the financing system – given that government expenditures, G, as well as the social costs of education, θ, must be financed through taxes and tuition fees. As mentioned above, we will assume that a non-negative capital tax, τ, is exogenously given. We will then for a given level of τ derive the optimal combination of labour income taxes and tuition fees.

We consider two scenarios, one where h is exogenous, and one where h is chosen optimally by the representative agent as in the previous section. The first scenario encompasses that of Alstadsæter (2003a), who considers the special case without tuition fees, while it also serves as a benchmark for the second scenario. In the first scenario, only two tax instruments are needed to achieve the first-best allocation. We therefore analyse how this allocation can be achieved through different combinations of taxes and tuition fees.

In the second scenario, three instruments are needed to achieve the first-best allocation. We start by considering the case where t_l, t_h and ω can all be optimally chosen by the government. Afterwards, we consider the case where only t_l and t_h can be adjusted and therefore only a second-best allocation can be reached. The latter exercise is motivated by existing cross-country differences in tuition fees.

4.1 First Scenario: Exogenous Consumption Share

In this scenario, the government problem is to choose t_h, t_l, and ω so as to maximise the individual indirect utility function of the current young and all future generations, $V(t_l, t_h, \omega, p)$, subject to the consolidated public budget constraint. This ensures that the utility of the current old generation remains unaffected. Formally, the problem is:

$$\max_{t_l,t_h,\omega} \quad V(t_l, t_h, \omega, p) \tag{21}$$

$$\begin{aligned} s.t. \quad & (1+r)\, t_l W (1-E) + t_l W + t_h W \left[g\left(E(1-h)\right) - 1\right] + \\ & \tau r \left[(1-t_l) W (1-E) - \omega E\right] - (1+r) G - (1+r)(\theta - \omega) E \\ & + rR = 0 \end{aligned} \tag{22}$$

It can be shown that this implies that optimal taxes and tuition fees must satisfy the following condition together with the budget constraint in (22):[9]

$$\frac{pU_2' \cdot \bar{h}}{U_1' W}\left(-\frac{t_h}{1-t_h}\right)+\left(\frac{1-t_l}{1-t_h}-\frac{(1+r)}{(1+r-r\tau)}\right)+ \frac{1}{W}\left(\frac{1}{1-t_h}\omega-\frac{(1+r)}{1+r-r\tau}\theta\right)=0 \quad (23)$$

To reveal the implications of this condition, it is instructive to consider a few special cases.

First, assume that tuition fees are absent, $\omega = 0$. It then immediately follows that the first and last terms in (23) are negative. Hence, the optimal tax system becomes progressive, $t_h > t_l$, as it has to satisfy the following condition:

$$\frac{1-t_l}{1-t_h} \geq \frac{(1+r)}{(1+r-r\tau)} \geq 1 \quad (24)$$

To explain this result, it may be instructive to consider under which circumstances the optimal tax system would be proportional. It follows from (23) that if there is no consumption value of education, $U_2' = 0$, no social costs of education, $\theta = 0$, and no capital taxes, $\tau = 0$, the optimal tax system is proportional, $t_h = t_l$. With no social costs of education, $\theta = 0$, optimal taxes should ensure a symmetric taxation of returns to financial and human capital investments. In the present case, at the rate of zero since $\tau = 0$. When there is no direct consumption return to education, $U_2' = 0$, this is achieved with a proportional labour income tax, $t_h = t_l$, since it taxes the returns at the same rate, t_h, as the one at which expenditures (the opportunity cost of time invested) can be deducted, t_l.

On the other hand, if either $U_2' > 0$, $\theta > 0$, or $\tau > 0$, the optimal tax system becomes progressive. In case of a capital tax, $\tau > 0$, a progressive labour income tax is needed to ensure an equivalent taxation of human-capital investments, see also Nielsen and Sørensen (1997). If $U_2' > 0$, a proportional tax acts like a net subsidy to human-capital investments, since only the productive return is taxed, while all expenditures are deductible. As a consequence, the productive return must be taxed at a higher rate, since this is an indirect way of taxing the consumptive return, see also Alstadsæter (2003a). Finally, if $\theta > 0$, taxes must be progressive because without tuition fees, students do not take the social costs of education into account when investing in education.

Second, consider the case where $t_h = 0$, which means that there is no taxation of the returns to education. In this situation, it follows that optimal

[9]Proofs of the results in this section are available upon request.

tuition fees, ω, must satisfy the following condition:

$$\omega = \frac{(1+r)}{(1+r-r\tau)}(\theta + W) - (1-t_l)W \tag{25}$$

It is easily seen that $\omega > \theta$ whenever the basic tax rate, t_l, and/or the tax on capital income, τ, are strictly positive – assuming that t_l is non-negative. Hence, provided that there is a need for taxation, students must pay tuition fees in excess of the social costs of education.

The above results reflect that it is possible to tax the returns to education in two ways: Either by a tax on the higher salary achieved as a result of the education or by tuition fees in excess of the social costs of education. In this model, the two ways of taxing the returns to education are close substitutes.

In the following Proposition, we summarise the main findings from above:

Proposition 1 *When the consumption share of education, h, is exogenous, the first-best allocation can be reached by use of only two of the tax instruments, t_l, t_h, and ω. The optimal values of these are characterised by the following:*

- *Without tuition fees, $\omega = 0$, optimal labour income taxes are progressive, $t_h > t_l$ if $U_2' > 0$, $\tau > 0$, or $\theta > 0$.*
- *With no taxation of the productive return to education, $t_h = 0$, optimal tuition fees exceed the social costs of education, $\omega > \theta$, if $\tau > 0$ or $t_l > 0$, and $t_l \geq 0$.*
- *Optimal taxation implies that tuition fees and marginal income taxes are substitutes, i.e. $\frac{dt_h}{d\omega} < 0$.*

4.2 Second Scenario: Endogenous Consumption Share

In this set-up, we first consider the case where the government can freely determine the size of all three tax instruments, t_l, t_h, and ω. Second, we consider the case where ω is exogenous, and only t_h and t_l can be adjusted by the government. If tuition fees are not considered to be a part of the tax system, but are determined by other political motives or set by private schools to partly cover their costs, this would be the relevant real-world situation.

4.2.1 Adjustable Tuition Fees

When the government can optimally set all three tax instruments, the first-best outcome is achieved. It can be shown that the optimal taxes and tuition fees are in this case given by:

$$t_h = 0 \tag{26}$$

$$t_l = \frac{(1+r)\,G - rR - \tau r W}{(2+r-\tau r)\,W} \tag{27}$$

$$\omega = \frac{(1+r)}{(1+r-r\tau)}\,(\theta + W) - (1-t_l)\,W \tag{28}$$

The optimal marginal tax rate, t_h, equals zero. The reason is that a tax on the wage return to education, $t_h > 0$, distorts the educational choice as this is a tax on productive education, E_2, only, whereas it leaves non-productive education, E_1, untaxed.

Furthermore, provided that either the basic tax rate, t_l, or the tax on capital income, τ, is positive, optimal tuition fees are higher than the social cost of education, $\omega > \theta$, provided that t_l is non-negative. However, as long as public expenditures are not too small, $G > r\,(R + \tau W)\,/\,(1+r)$, the basic tax rate, t_l, will always be positive. In this case, optimal income taxes become regressive, $t_l > t_h = 0$, and ω must exceed θ. With regressive taxes on labour income and/or a tax on capital income, education must be taxed by other means to prevent overeducation. As opposed to t_h, tuition fees is a symmetric "tax" on the two types of education. Thus, optimal tuition fees, ω, exceed the social costs of education, θ, in this situation. With an endogenous consumption share in education, t_h and ω are therefore no longer perfect substitutes.

We summarise the above results in Proposition 2:

Proposition 2 *When the consumption share of education, h, is endogenous, and tuition fees, ω, are adjustable, the first-best allocation requires $t_h = 0$. Furthermore, if government expenditures are not too small, $G > r\,(R + \tau W)\,/\,(1+r)$, optimal labour income taxes will be regressive, and tuition fees will exceed the social costs of education:*

$$t_l > t_h = 0 \quad \textit{and} \quad \omega > \theta$$

4.2.2 Fixed Tuition Fees

Assuming that ω is exogenous, the government no longer has sufficient instruments to ensure that the first-best allocation is achieved. Instead, it solves the following maximisation problem:

$$\begin{aligned}
\max_{t_l, t_h} \quad & V(t_l, t_h, \omega, p) && (29) \\
s.t. \quad & (1+r) t_l W (1-E) + t_l W + t_h W [g(E(1-h)) - 1] + \\
& \tau r [(1-t_l) W (1-E) - \omega E] - (1+r) G - (1+r)(\theta - \omega) E - \\
& rR = 0
\end{aligned}$$

which, after some manipulations, results in the following condition for optimal t_l and t_h:

$$\begin{aligned}
& [-(1+r) t_l W + t_h W g' - \tau r [(1-t_l) W + \omega] - (1+r)(\theta - \omega)] \cdot \\
& \left\{ W (1+p-E) \frac{\partial E}{dt_h} - pW [g(E_2) - 1] \frac{\partial E}{dt_l} \right\} + \\
& [-t_h W g'] \cdot \\
& \left\{ W (1+p-E) \frac{\partial E_1}{dt_h} - pW [g(E_2) - 1] \frac{\partial E_1}{dt_l} \right\} = 0 \qquad (30)
\end{aligned}$$

From (30), it follows that it is, in general, ambiguous whether the optimal tax system is progressive or regressive.

However, it can be shown that, if:

$$\omega < \theta \frac{(1+r)(1-t_h)}{1+r-rt} \qquad (31)$$

i.e. if ω is sufficiently small compared to θ, then:

$$\left(\frac{t_h - t_l}{1 - t_h} - \frac{\tau r}{1+r-rt} \right) > 0 \qquad (32)$$

i.e. $t_h > t_l$. Hence, if students pay low tuition fees, the optimal tax system is progressive. Proposition 3 summarises the findings:

Proposition 3 *When the consumption share of education, h, is endogenous, and tuition fees, ω, are fixed, only a second-best solution can be achieved. In this case, a sufficient condition for optimal labour income taxes to be progressive is that tuition fees, ω, satisfy (31).*

5 Conclusion

While existing studies of education and optimal taxation concentrate on the *level* of education as the variable of interest, we argue that the *type* of education is (equally) relevant to consider, as different types of education come with different productive returns. We model the type of education as the "consumption share" in education, *i.e.* as the non-productive share of total education. Hence, different degree subjects are characterised by different relative amounts of consumptive and productive returns.

As long as the type of education is exogenous, we find that tuition fees and high marginal taxes are close substitutes. However, if the type of education is endogenous, this result changes. We show that a regressive income tax system with high tuition fees is the optimal choice in this situation. A low (zero) marginal labour income tax is needed to avoid a distortion between productive and non-productive education. Furthermore, since the basic labour income tax tends to induce overinvestment in education, tuition fees in excess of the social pecuniary costs of education are required. As opposed to marginal labour income taxes, tuition fees do not distort the choice of type of education as they tax the two types of education symmetrically. Hence, with an endogenous choice of educational type, education should be taxed on the input side rather than the output side.

To further illustrate the asymmetric taxation of educational returns caused by income taxes, we showed that a financing reform which replaces high marginal income taxes by tuition fees will most likely increase the productive share in education. This may in turn explain why we observe differences in educational returns across countries with comparable levels of education.

However, a high marginal income tax might be the second-best choice if tuition fees for some (political) reason are fixed at a low level. In this case, the high marginal income tax constitutes the only feasible taxation of education, although it distorts the choice of educational type.

A Appendix

In this Appendix, we present a formal derivation of the comparative statics results from Section 3.

From the first-order condition for E_2 in (17), we can easily obtain the derivatives of the demand function, $E_2(t_l, t_h, \omega)$:

$$\begin{aligned}
\frac{\partial E_2(t_l, t_h, \omega)}{\partial t_l} &= \frac{-1}{p(1-t_h)\, g''(E_2)} > 0 \\
\frac{\partial E_2(t_l, t_h, \omega)}{\partial t_h} &= \frac{pg'(E_2)}{p(1-t_h)\, g''(E_2)} < 0 \\
\frac{\partial E_2(t_l, t_h, \omega)}{\partial \omega} &= \frac{1}{p(1-t_h)\, W g''(E_2)} < 0
\end{aligned}$$

To find the derivatives of the demand function $E_1(t_l, t_h, \omega)$, define p_{E_1} and Y as:

$$p_{E_1}(\omega, t_l) \equiv \omega + (1-t_l)\, W$$

and:

$$\begin{aligned}
Y(\omega, t_1, t_h, E_2(t_l, t_h, \omega)) &\equiv (1-t_l)\, W(1+p-E_2(t_l, t_h, \omega)) - \\
&\quad \omega E_2(t_l, t_h, \omega) + p(1-t_h)\, W\left[g(E_2(t_l, t_h, \omega)) - 1\right]
\end{aligned}$$

and rewrite the budget constraint in (5) as:

$$pC + p_{E_1} E_1 = Y$$

where Y is interpreted as "full income" and p_{E_1} as the price of E_1. Hence, the demand for E_1 can equivalently be expressed as $E_1(p_{E_1}, Y)$, and the effect of a change in t_h is then given by:

$$\begin{aligned}
\frac{\partial E_1(t_l, t_h, \omega)}{\partial t_h} &= \frac{dE_1(p_{E_1}, Y)}{dt_h} = \frac{\partial E_1(p_{E_1}, Y)}{\partial p_{E_1}} \cdot \frac{\partial p_{E_1}}{\partial t_h} + \frac{\partial E_1(p_{E_1}, Y)}{\partial Y} \cdot \frac{dY}{dt_h} \\
&= \left(\frac{\partial H_{E_1}}{\partial p_{E_1}} - \frac{\partial E_1(p_{E_1}, Y)}{\partial Y} E_1\right) \frac{\partial p_{E_1}}{\partial t_h} + \frac{\partial E_1(p_{E_1}, Y)}{\partial Y} \frac{dY}{dt_h}
\end{aligned}$$

using the Slutsky decomposition, where H_{E_1} is the Hicksian demand function. Note the presence of two income effects in the above expression. First, a change in t_h may affect the price of E_1 as a consumption good, p_{E_1} – an effect which contains a standard substitution and income effect (the first term). Secondly, t_h directly affects full income (the last term) – an additional income effect. It is the latter effect that is referred to as the income effect in the paper.

Now, since $\partial p_{E_1}/\partial t_h = 0$ and $\partial E_1 (p_{E_1}, Y)/\partial Y > 0$, because E_1 is a normal good, it follows that:

$$\frac{\partial E_1 (t_l, t_h, \omega)}{\partial t_h} = \frac{\partial E_1 (p_{E_1}, Y)}{\partial Y} \frac{dY}{dt_h} < 0$$

where it has been used that:

$$\begin{aligned} \frac{dY}{dt_h} &= -pW [g (E_2) - 1] \\ &\quad + \frac{\partial E_2 (t_l, t_h, \omega)}{\partial t_h} \{-(1 - t_l) W - \omega + p (1 - t_h) W [g' (E_2) - 1]\} \\ &= -pW [g (E_2) - 1] < 0 \end{aligned}$$

since the first-order condition for E_2 in (17) implies that the expression in curly brackets is zero. In other words, the effect on Y via E_2 is only of second order.

Similarly, we find that:

$$\frac{\partial E_1 (t_l, t_h, \omega)}{\partial t_l} = \left(\frac{\partial H_{E_1}}{\partial p_{E_1}} - \frac{\partial E_1 (p_{E_1}, Y)}{\partial Y} E_1 \right) \frac{\partial p_{E_1}}{\partial t_l} + \frac{\partial E_1 (p_{E_1}, Y)}{\partial Y} \frac{dY}{dt_l} \lesseqgtr 0$$

where the first term is positive since $\partial H_{E_1}/\partial p_{E_1} < 0$ and $\partial E_1 (p_{E_1}, Y)/\partial Y > 0$ by assumption, and $\partial p_{E_1}/\partial t_l = -W < 0$. The second term is negative since $dY/dt_l = -W (1 + p - E_2) < 0$.

Finally:

$$\frac{\partial E_1 (t_l, t_h, \omega)}{\partial \omega} = \left(\frac{\partial H_{E_1}}{\partial p_{E_1}} - \frac{\partial E_1 (p_{E_1}, Y)}{\partial Y} E_1 \right) \frac{\partial p_{E_1}}{\partial \omega} + \frac{\partial E_1 (p_{E_1}, Y)}{\partial Y} \frac{dY}{d\omega} < 0$$

since $\partial p_{E_1}/\partial \omega = 1$. Hence, the first term is negative, whereas $dY/d\omega = -E_2 < 0$, which also makes the second term negative.

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