TAXING HUMAN CAPITAL EFFICIENTLY: THE DOUBLE DIVIDEND OF TAXING NON-QUALIFIED LABOUR MORE HEAVILY THAN QUALIFIED LABOUR

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Abstract

Assuming decreasing returns to education and the endogenous supply of qualified and non-qualified labour it is shown to be efficient to supplement a consumption tax with positive incentives for education. If the return from education is isoelastic and if the choice is between (i) subsidizing the monetary cost of education and (ii) taxing nonqualified labour income more heavily than qualified labour income while keeping the effective cost of education constant, the latter policy is shown to be second-best efficient. In particular, any tax distortions should be constrained to labour choices while the choice of education should remain undistorted. The result holds for arbitrary utility functions.

JEL Code: H2, I2, J24.

Keywords: endogenous choice of labour and education, efficient taxation, human capital investment, double dividend hypothesis.

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1. Introduction

Human capital accumulation is expected to be the driving engine of economic growth and development in the new century. Hence human capital policy should be highly ranked on the agenda. Unfortunately, the economic understanding of optimal human capital policy is still in its infancy. In particular, an integrated approach is still lacking which allows one to cope with the various sources of tax distortions and potential market failure. Economic analysis is rather eclectic in this field. The list of issues researched is long. It covers reasons of potential market failure such as positive external effects of education, incomplete markets for educational loans and missing private opportunities to insure against educational risks. It extends to issues raised by distortionary taxation and includes key words such as income uncertainty (Eaton and Rosen, 1980; Varian, 1980), informational asymmetry (Mirrlees, 1971), credibility of government policy (Andersson and Konrad, 2003), and asymmetric income taxation of human and physical capital (Heckman, 1976; Nerlove et al, 1993; Nielsen and Sörensen, 1997), to mention just a few prominent ones.

One of the areas where systematic analysis has only begun refers to the imperfect taxation of rent income generated by the endogenous choice of education. The analysis has been triggered off by some numerical simulations carried through by Trostel (1993) on the basis of a representative agent general equilibrium model. This study finds a significant negative effect of proportional income taxation on human capital. By means of further simulation experiments Trostel (1996) shows that it is second-best efficient to supplement an income tax with a subsidy to higher education. In theoretic independent studies Wigger (2003 and 2004) and Bovenberg and Jacobs (2005) look more closely at the question of when educational subsidies are efficiency enhancing. These studies differ from Trostel (1996) and the present one in the attempt to integrate two sources of imperfections in one single model: the imperfect taxation of rent income generated by education and the imperfect taxation of rent income generated by informational asymmetry in the Mirrlees tradition. Although similar in design the studies suggest strikingly different conclusions. Whereas Bovenberg and Jacobs (2005) find strong theoretical evidence for subsidising human capital investment,

Wigger (2004) proves that social welfare can never be increased by supplementing a non-linear income tax with a subsidy to higher education. The conclusions less raise the question of who is right or wrong but more of which modelling features are able to explain such contradicting results. This is where the present paper ties in. It offers a simple framework of analysis which allows one to give structure to a strand of literature which threatens to become more and more confusing. It does so by going one step back in the literature and by returning to the isolated analysis of the effects that the imperfect taxation of rent income of education has on efficient human capital policy. It is the author's strong belief that these effects have not been well understood till now and that they are of key importance for the design of optimal human capital policy.

The paper is structured as follows. Section 2 introduces a simple model of a representative household with the only endogenous choices concerning education and labour supply. Returns to education are decreasing and the source of rent income which cannot be fully skimmed off by a proportional tax on consumption. As a result, the Production Efficiency Theorem of Diamond and Mirrlees (1971) is not applicable. In Section 3 it is shown that it is efficiency enhancing to supplement the consumption tax with positive incentives for education. Two instruments are contrasted. One gives positive incentives directly by subsidising the monetary cost of education. The other gives incentives indirectly by taxing non-qualified labour income more heavily than qualified labour income while keeping the effective cost of education constant. In Section 4 the latter is shown to be the more efficient instrument. More precisely, it turns out to be second best to tax labour income regressively with respect to qualification. In particular, the choice of education should remain undistorted and any tax distortions should be restricted to labour choices. The result is surprisingly strong. It basically holds for arbitrary utility functions and only requires human capital to be an isoelastic function of education. Section 5 provides an example and Section 6 reinterprets various related results of the literature in the light of the present analysis. Section 7 summarizes. Major proofs are relegated to an technical Appendix.

2. A representative household model

Consider a representative household which has to choose between supplying non-qualified and qualified labour, L_l and L_h, respectively. The household derives utility $U(C, L_l, L_h)$ from consumption C and the two differentiated forms of labour. Non-qualified labour has to be divided between time spent in the market, $L_l - E$, and time spent on education, E. It earns a constant wage rate ω_l if supplied to the market. The productivity of qualified labour depends on the amount of education. The choice of E is part of the household's optimization problem. Qualified labour is paid $\omega_h H(E)$ where ω_h is constant while the *earnings function* $H(E)$ displays positive but diminishing returns, $H'>0>H''$. It is well-known that the aggregate empirical earnings function tends to be log-linear with increasing returns in E. The focus of the present analysis is however on the individual choice of education and thus diminishing returns make more sense.

The representative household is assumed to maximize utility in C, L_l, L_h, E subject to the budget constraint

$$qC = \omega_l (L_l - E) + \omega_h H(E) L_h - \varphi E = \omega_l L_l + \omega_h H(E) L_h - (\omega_l + \varphi) E .$$

Education has a cost in *foregone earnings* which is captured by $\omega_l E$. *Monetary costs of education* like college fees come on top of these and are modelled by φE. The *effective (unit) cost of education* is given by $\pi \equiv \omega_l + \varphi$. Finally, q is the consumer price of consumption. All prices are after tax and subsidy. In what follows, two policies will be compared in terms of efficiency. One is characterized by subsidizing the monetary cost of education, i.e. by targeting φ, while keeping wage rates constant. The other policy is characterized by taxing non-qualified labour, i.e. by targeting ω_l, while keeping π constant. This policy is effectively realized by varying ω_l and respecting $d\omega_l = -d\varphi$ as a constraint.

It must be stressed that the model assumes two separate time constraints, one for non-qualified labour and one for qualified labour. It is as if lifetime would fall into two separate periods which are not made explicit. A true one-period model would suggest a

joint time constraint for leisure time, E, L_l, and L_h. The present model is flexible enough to cover this case if $\omega_l < \omega_h H(E)$ is assumed to hold in equilibrium. By arbitrage, the household maximizing $U(C, L_l + L_h)$ will then choose to increase E only at the cost of L_l and not at the cost of L_h.

The analysis relies on the dual approach to optimal taxation. This means that the focus is shifted from the household's (indirect) utility function to its (net) expenditure function. The task of minimizing (net) expenditures subject to an exogenous utility constraint is best solved in a two-step approach. At the first step rent income derived from education is maximized while keeping the level of qualified labour supply, L_h, fixed. Let rent income be denoted by $Y(\omega_h, \pi, L_h) \equiv \max_E [\omega_h H(E) L_h - \pi E]$ and the optimal amount of education by $E(\omega_h, \pi, L_h)$. Note that the primary source of rent income is education and its diminishing return. Qualified labour supply increases rent income only indirectly via increased incentives for education. Assume that w_h is labour cost and p the effective social cost of education. Clearly, $E(\omega_h, \pi, L_h) = E(w_h, p, L_h)$ holds if $\pi / \omega_h = p / w_h$. In what follows $\pi / \omega_h = p / w_h$ is interpreted as a condition guaranteeing an efficient choice of education relative to the given value of L_h. For the sake of brevity, speech will just be of *efficiency in education* whenever $\pi / \omega_h = p / w_h$ holds.

The expenditure function is defined as

$$e(q, \omega_l, \omega_h, \varphi; u) \equiv \min[qC - \omega_l L_l - Y(\omega_h, \omega_l + \varphi, L_h)] \text{ in } C, L_l, L_h \text{ such that } U(C, L_l, L_h) \geq u.$$

Hotelling's Lemma yields $e_q = C$ where $C = C(q, \omega_l, \omega_h, \varphi; u)$ solves the optimization and where the subscript q denotes a partial derivative. One equally derives the identities $e_\varphi = E$ and $e_l \equiv \frac{\partial e}{\partial \omega_l} - (L_l - E)$. Just like C, functions L_l and L_h are Hicksian ones to be evaluated at $q, \omega_l, \omega_h, \varphi$ and u. Similarly, $E = E(\omega_h, \omega_l + \varphi, L_h(q, \omega_l, \omega_h, \varphi; u))$.

Propositions 1 and 2 make use of two assumptions (A1) and (A2) ranking the elasticities of various demand and supply functions with respect to variations in q. In order to state these assumptions in convenient form let $\varepsilon_{C/q} \equiv \frac{q}{C}\frac{\partial C}{\partial q}$ denote the elasticity of consumption and $\varepsilon_{L_l/q} \equiv \frac{q}{L_l}\frac{\partial L_l}{\partial q}$ the elasticity of non-qualified labour, both with respect to variations in q. The elasticities $\varepsilon_{E/q}$, $\varepsilon_{Y/q}$ are defined accordingly. Assume first that consumption reacts more elastically than non-qualified labour,

$$\varepsilon_{L_l/q} > \varepsilon_{C/q} \ . \qquad \text{(A1)}$$

Assumption (A1) holds if the demand for consumption and for qualified leisure are not too complementary. (A1) fails to hold if non-qualified labour reacts strongly and negatively to an increase in q, i.e. if non-qualified *leisure* reacts strongly and positively to an increase in q. For constant utility the latter is conceivable only if both, consumption and qualified leisure, decrease in q. If the demand for consumption is complementary to non-qualified leisure, instead, then the LHS is positive while the RHS is negative and (A1) holds trivially. Assuming zero net expenditures, inequality (A1) is easily seen to be equivalent to the inequality

$$\varepsilon_{C/q} > \varepsilon_{Y/q}. \qquad \text{(A1')}$$

This equivalence is proved by differentiating the expenditure function $e = qC - \omega_l L_l - Y$ with respect to q and by making use of $e_q = C$. The differentiation yields

$$qC_q = \omega_l L_{lq} + Y_{L_h} \cdot L_{hq} \ . \qquad (1)$$

As before, subscripts indicate derivatives except for the case of labour supply functions. By some slight misuse of notation, L_{iq} stands for $\partial L_i / \partial q$ with i=l, h. The equivalence between (A1) and (A1') follows by some simple algebraic manipulation relying on (1) and e=0.

The second assumption (A2) needed in the sequel requires that the rent income earned from education does not react more elastically than education itself,

$$\varepsilon_{Y/q} \geq \varepsilon_{E/q} \ . \qquad \text{(A2)}$$

(A2) holds with equality in the important special case when human capital is an isoelastic function of education, $H(E) \equiv hE^{\eta}$. Isoelasticity has further strong implications for key elasticities and the following analysis will make heavy use of them:

Remark: Assuming $H(E) = hE^{\eta}$, $\eta < 1$, one obtains $\varepsilon_{Y/q} = \varepsilon_{E/q}$ and

$$\varepsilon_{Y/x} = \varepsilon_{E/x} + \frac{x}{\omega_1 + \varphi} \quad \text{for} \quad x = \varphi, \omega_1 . \qquad (2)$$

The proof is given in the Appendix. Inequalities (A1), (A1'), and (A2) will help to sign the efficiency effects of the tax reforms to be considered next.

3. Marginal tax reforms

The analysis assumes the availability of three tax instruments. The first one is a tax *t* on consumption. As it turns out it is convenient to define the rate in "inclusive" form. Treating consumption as numéraire good with a producer price of one, this means that *t* satisfies the condition $q(1\text{-}t) = 1$. In other words, the base of the consumption tax includes the tax payment. The second instrument is a tax τ_l on non-qualified labour. It is convenient to define this tax in "exclusive" form. This requires $w_l = (1+\tau_l)\omega_l$ where w_l is the exogenous wage rate before tax. Qualified labour is assumed to remain untaxed, $\omega_h = w_h$. Hence a positive τ_l can be interpreted as implying regressive taxation of labour income. The third and final instrument is a subsidy to education *s*. This is again defined in exclusive form requiring $f = (1+s)\varphi$ where *f* is the monetary social cost of education. As a result tax revenue amounts to T

$\equiv \frac{t}{1-t}C + \frac{\tau_l}{1+\tau_l} w_l (L_l - E) - \frac{s}{1+s} fE$. By invoking Hotelling's Lemma, tax revenue can be written in the form of

$$T = (q-1)e_q + (\omega_l - w_l)e_l + (\varphi - f)e_\varphi . \qquad (3)$$

The social planner is assumed to maximize tax revenue *T* subject to the condition that private net expenditures remain constant at zero level, *e*=0. A set of instruments *t*, τ_l and *s* is said to be second-best efficient if it solves the planner's maximization. Section 4 studies the characteristics of a second-best efficient choice of instruments. Before turning to this exercise tax reforms are analysed that are both, partial and marginal. They are partial in the sense that the choice of instruments is constrained. One reform studied in some detail is characterized by varying *s* while keeping τ_l constant. The other reform is characterized by varying τ_l while keeping the *effective* subsidy to the cost of education constant. The effective subsidy σ is defined by $w_1 + f = p = (1+\sigma)\pi$. It remains constant if any variation in τ_l is compensated by one in *s* and if $\frac{w_l}{1+\tau_l} + \frac{f}{1+s} = \omega_l + \varphi = \pi$ =constant is respected as a constraint. The reforms are marginal in the sense that the consumption tax is marginally varied at some positive level *t*>0. The marginal variation is compensated in both cases by varying the second instrument at zero level. The compensation is such that the household's net expenditures remain constant. The reform can be interpreted as one adding either τ_l or σ to a tax regime relying on the broad based consumption tax. The efficiency of the reform is measured by the resulting increase in government's net tax revenue.

3.1 Taxing non-qualified labour more heavily than qualified labour

Consider a marginal change in *t* which is compensated in τ_l and which leaves the choice of education undistorted, σ=0. It is easier to study the reform in terms of prices. Hence *q* is varied, compensation holds in terms of ω_l, and the cost of education is kept constant at the social level, $\omega_l + \varphi = \pi = p$. The latter requires $d\varphi = -d\omega_l$. Private net expenditures remain constant if $0 = de = e_q dq + e_l d\omega_l + e_\varphi d\varphi =$

$e_q dq + (e_l - e_\varphi) d\omega_l \Leftrightarrow \frac{d\omega_l}{dq} = -\frac{e_q}{e_l - e_\varphi}$ which equals $\frac{C}{L_l}$ and thus is positive. An increase in q has to be compensated by an increase in ω_l if private net expenditures are to remain constant. The effect that such a tax reform has on tax revenue is measured by

$$\left.\frac{dT}{dq}\right|_{\omega_l = w_l} = \left[\frac{\partial T}{\partial q} + \frac{\partial T}{\partial \omega_l}\frac{d\omega_l}{dq} + \frac{\partial T}{\partial \varphi}\frac{d\varphi}{dq}\right]\Bigg|_{\omega_l = w_l} = \left[\frac{\partial T}{\partial q} - \frac{e_q}{e_l - e_\varphi}\left(\frac{\partial T}{\partial \omega_l} - \frac{\partial T}{\partial q}\right)\right]\Bigg|_{\omega_l = w_l}.$$

The subscript $\omega_l = w_l$ indicates that ω_l is marginally increased at level w_l. Note that $\omega_l = w_l$ implies $\varphi = f$ if π is to equal p. Taking partial derivatives of (3) and evaluating the resulting expressions at $\omega_l = w_l$, $\varphi = f$ yields

$$\left.\frac{dT}{dq}\right|_{\omega_l = w_l} = (q-1)\left[e_{qq} - \frac{e_q}{e_l - e_\varphi}(e_{ql} - e_{q\varphi})\right] = \frac{q-1}{q} e_q \left[\varepsilon_{C/q} - \varepsilon_{L_l/q}\right] \qquad (4)$$

which is negative given that conditions q>1 and (A1) are assumed to hold.

Proposition 1: A reform by which a marginal decrease in the consumption tax is compensated by the introduction of a tax on non-qualified labour while keeping the effective cost of education constant enhances efficiency.

The intuition for this result is obvious. Education generates rent income which accrues to the household only in part. The household fails to internalize the positive effect education has on the revenue of the consumption tax. Hence efficiency calls for more education at the margin. This objective can be achieved indirectly by leaving the education decision undistorted and setting incentives to substitute qualified for non-qualified labour. As a result labour income is taxed regressively.

3.2 Subsidizing the cost of education

It is suggestive to encourage education more directly by subsidizing its cost. In order to study the effect of such a subsidy in pure form, assume that labour income is not

taxed, $\omega_l = w_l$. A subsidy to the effective cost of education then amounts to a subsidy to the monetary cost of education. In technical terms consider a marginal change in q which is compensated by a marginal change in φ and evaluated at the level $\varphi = f$. Private net expenditures remain constant if $\frac{d\varphi}{dq} = -\frac{e_q}{e_\varphi} < 0$. The total variation of tax revenue is given by

$$\left.\frac{dT}{dq}\right|_{\varphi=f} = (q-1)[e_{qq} - \frac{e_q}{e_\varphi} e_{q\varphi}] = \frac{q-1}{q} e_q [\varepsilon_{C/q} - \varepsilon_{E/q}] . \qquad (5)$$

Assuming (A1') and (A2) the bracketed expression on the RHS is positive. As (A1') is equivalent to (A1) one can conclude that the tax reform is marginally efficiency enhancing if q>1, (A1), and (A2) hold.

Proposition 2: A reform by which a marginal increase in the consumption tax is compensated by introducing a marginal subsidy to the monetary cost of education is efficiency enhancing.

The reform implies that the education decision will be distorted and that labour income will be effectively taxed proportionally through the consumption tax. The policy is intuitive and can be rationalized by the same kind of arguments used before when interpreting Proposition 1. Although Proposition 2 should not come as a surprise it is however not totally obvious. There are results in the literature which convey the intuition that it may well be efficient to tax factors more heavily when these factors produce pure profit and if pure profit cannot be taxed away. See e.g. Huizinga and Nielsen (1997). In the present context, this might have given support to the expectation that tax efficiency calls for *taxing* the cost of education (Richter, 2005). This is so as education generates non-taxable rent income and this effect conflicts with tax efficiency in a framework with distortionary taxation. Proposition 2 invalidates this kind of reasoning.

In the present framework a consumption tax is clearly equivalent to a tax on labour income which does not differentiate according to qualification, $\tau_l = \tau_h \equiv \tau$. If such a tax regime is taken for comparison, Proposition 2 implies that an effective subsidy to education, σ, which marginally exceeds τ enhances efficiency. This result confirms simulations of Trostel (1996) and deserves to be looked at from a different perspective. Remember that the effective cost of education, $\pi = p/(1+\sigma)$, equals the sum of the opportunity cost of attending school, $\omega_l = w_l/(1+\tau_l)$, and the monetary cost of education, $\varphi = f/(1+s)$. Then $\sigma = \dfrac{\tau_l \omega_l + s\varphi}{\omega_l + \varphi}$ follows by noting $\sigma(\omega_l + \varphi) = \sigma\pi = p - \pi = (w_l + f) - (\omega_l + \varphi) = (w_l - \omega_l) + (f - \varphi) = \tau_l \omega_l + s\varphi$. Hence $\sigma > \tau = \tau_l$ implies $s > \tau$. The latter means that the monetary cost of education should be subsidized at a rate which exceeds the tax rate on labour income. One way of subsidizing the monetary cost of education is to grant deduction under the labour income tax.

Corollary 1: If labour income is taxed at a rate which does not differentiate according to qualification, the monetary cost of education should be granted tax deduction at a rate which exceeds the tax rate on labour income.

4. Characterizing efficient taxation

There are obviously two possible ways of increasing tax efficiency. One is characterized by $0 > d\omega_l = -d\varphi, d\pi = 0$ and requires to tax non-qualified labour more heavily than qualified labour while keeping the effective cost of education constant. The competing one is characterized by $0 > d\pi = d\varphi,\ d\omega_l = 0$ and relies on subsidizing the monetary cost of education. The two feasible policies differ with respect to the following key features:

- Taxing non-qualified labour more heavily than qualified labour increases education indirectly whereas subsidizing education does so directly.

- Taxing non-qualified labour more heavily than qualified labour and respecting $\pi = p$ as a constraint leaves the choice of education undistorted while the choice is distorted when the effective cost of education is subsidized.
- Taxing non-qualified labour more heavily than qualified labour generates tax revenue while subsidizing education relies on spending tax revenue.

Given these features it is not self-evident which way of encouraging education is the more efficient one. One might conjecture that efficient policy should rely more on direct instruments and less on indirect ones. This would mean that the use of σ or *s*, respectively, is more efficient than the use of τ_l. As a matter of fact, Proposition 4 states just the opposite. As it turns out, encouraging education indirectly via the use of τ_l while keeping the effective cost of education constant is more efficient than doing so directly via the use of *s*. Obviously, directness provides no efficiency advantage in the present context. The third bullet provides a more convincing basis for understanding the relevant efficiency trade off. The parallel to the double dividend hypothesis (in weak form) known from environmental taxation is obvious (Goulder, 1995; Bovenberg and de Mooij, 1994). According to this hypothesis it is more efficient to encourage socially desirable behaviour by taxing non-compliance instead of subsidizing compliance. By taxing non-compliance the distorting consumption tax *t* can be reduced while *t* has to be increased if compliance is subsidized.

In order to prove that indirect encouragement of education is more efficient than direct encouragement, tax revenue *T* is jointly maximized in *t*, τ_l and *s*, assuming that net household expenditures are kept constant at zero level, *e*=0. This is a standard Lagrangean optimization. After taking partial derivatives with respect to q, ω_l, φ and after eliminating the Lagrangean factor one ends up with a system of two first-order conditions:

$$(q-1)\left[\frac{e_{ql}}{e_l}-\frac{e_{q\varphi}}{e_\varphi}\right] = (\omega_l - w_l)\left[\frac{e_{l\varphi}}{e_\varphi}-\frac{e_{ll}}{e_l}\right] + (\varphi - f)\left[\frac{e_{\varphi\varphi}}{e_\varphi}-\frac{e_{\varphi l}}{e_l}\right] \qquad (6)$$

$$(q-1)\left[\frac{e_{qq}}{e_q}-\frac{e_{q\varphi}}{e_\varphi}\right] = (\omega_l - w_l)\left[\frac{e_{l\varphi}}{e_\varphi}-\frac{e_{lq}}{e_q}\right] + (\varphi - f)\left[\frac{e_{\varphi\varphi}}{e_\varphi}-\frac{e_{\varphi q}}{e_q}\right]. \qquad (7)$$

This system is best restated in a form that admits to be interpreted in the spirit of Ramsey. For this purpose define the derivation operator Δ to be applied to functions $X = X(q, \omega_l, \varphi; u)$ as follows:

$$\Delta X \equiv (q-1)X_q + (\omega_l - w_l)X_l + (\varphi - f)X_\varphi . \qquad (8)$$

Making use of the Δ-notation it is shown in the Appendix that the system of equations (6) and (7) can be transformed and restated in equivalent form:

$$\frac{\Delta L_l}{L_l} = \frac{\Delta E}{E} \qquad (9)$$

$$\frac{\Delta C}{C} = \frac{\Delta E}{E} . \qquad (10)$$

This shows that efficiency is achieved if the policy induces equi-proportionate reductions in consumption *C*, education *E* and non-qualified labour L_l when all these behavioural functions are interpreted in the Hicksian sense.

Proposition 3: Efficiency in the taxation of human capital requires equi-proportionate reductions in consumption, education, and non-qualified labour.

It is informative to restate (9) and (10) in still another form by making use of elasticities:

$$t(\varepsilon_{L_l/q} - \varepsilon_{E/q}) = \tau_l(\varepsilon_{L_l/\omega_l} - \varepsilon_{E/\omega_l}) + s(\varepsilon_{L_l/\varphi} - \varepsilon_{E/\varphi}) \qquad (9')$$

$$t(\varepsilon_{C/q} - \varepsilon_{E/q}) = \tau_l(\varepsilon_{C/\omega_l} - \varepsilon_{E/\omega_l}) + s(\varepsilon_{C/\varphi} - \varepsilon_{E/\varphi}) \qquad (10')$$

This form draws attention to the question of which values the policy instruments *t*, τ_l, *s*, or σ respectively, should take on in the optimum.

Proposition 4: Assuming $H(E) = hE^{\eta}$, $\eta < 1$, it is efficient not to distort the choice of education, $\sigma = 0 \Leftrightarrow \frac{s}{1+s} f = -\frac{\tau_l}{1+\tau_l} w_l$, and to encourage education solely indirectly by taxing labour income according to qualification.

The proof is given in the Appendix. It only relies on isoelasticity of the human capital function. No special assumptions have to be met with respect to the taxpayer's utility function. If (A1) holds, the statement can be sharpened. Proposition 4 then takes the form that allows one to speak of a double dividend to be reaped by taxing non-qualified labour income more heavily than qualified labour income. Given (A1) it is efficient to tax labour income regressively with respect to qualification and not only vaguely according to qualification.

Consider the case in which tax revenue is not generated by a consumption tax but by a tax on labour income which differentiates rates according to qualification. Note that $\tau_l > \tau_h = \sigma = \frac{\tau_l \omega_l + s\varphi}{\omega_l + \varphi}$ implies $s < \sigma$.

Corollary 2: Assuming (A1) and $H(E) = hE^{\eta}$, $\eta < 1$, it is efficient to tax labour income regressively with respect to qualification and not to grant full tax deductibility to the monetary cost of education. In other words, efficiency requires $s < \tau_h < \tau_l$.

The intuition is that regressive taxation works like a subsidy for education. Hence the monetary cost of education should be subsidized less if the choice of education is not to be distorted.

5. An Example

Assume quasi-linear utility, $U \equiv C - V(L_l) - V(L_h)$, equally elastic disutility of labour, $V(L) \equiv L^{\frac{\nu}{\nu-1}}, \nu > 1$, and isoelastic returns from education, $H(E) = E^{\eta}$, η<1. It turns out that the problem is only well behaved in the sense that conditions of second order are fulfilled if $\eta\nu <$ 1. The specific appeal of this example comes from vanishing income effects. Maximizing household's utility yields the following conditions of first order: $\frac{\omega_l}{q} = V'(L_l)$, $\frac{\omega_h}{q} H(E) = V'(L_h)$ and $\omega_h H'(E) L_h = \pi$. Solving these equations for L_l, L_h, E yields $E = [a\eta \frac{q}{\pi}\left(\frac{\omega_h}{q}\right)^{\nu}]^{\frac{1}{1-\nu\eta}}$, $L_l = a\left(\frac{\omega_l}{q}\right)^{\nu-1}$ and $L_h = a\left(\frac{\omega_h}{q} E^{\eta}\right)^{\nu-1}$ with $a \equiv (\frac{\nu-1}{\nu})^{\nu-1}$. This implies the following elasticities:

$\varepsilon_{L_l/q} = -(\nu-1)$, $\varepsilon_{L_l/\omega_l} = \nu - 1$, $\varepsilon_{E/q} = -\frac{\nu-1}{1-\eta\nu}$, $\varepsilon_{E/x} = -\frac{x}{\omega_l + \varphi}\frac{1}{1-\eta\nu}$ for $x = \omega_l, \varphi$.

Plugging these values into (9') and setting σ =0 yields

$$\tau_l = \frac{\eta\nu}{1-\eta\nu} t .$$

The efficient tax rate on non-qualified labour increases in the consumption tax rate, in the elasticity of the disutility of labour and in the elasticity of the education function.

6. Connections to the literature

The analysis allows one to structure and to generalize various earlier results of the literature. A first group of results relates to the efficiency enhancing role of subsidies to education. Another earlier result refers to the optimality of the Nordic system of dual income taxation. Both topics deserve to be discussed in some detail.

6.1 To what extent are education subsidies efficiency enhancing?

As mentioned before, the literature discusses the role of subsidies paid to education and the effect such subsidies have on the equity-efficiency trade off in the taxation of labour income. The conclusions derived are irritatingly opposing. According to Bovenberg and Jacobs (2005) “redistribution and education subsidies are Siamese twins”. Subsidies on education are shown to alleviate the tax distortions on learning induced by redistributive policies. The more eager the distributive objectives are, the stronger must policy rely on educational subsidies. Quite to the contrary, Wigger (2003, 2004) proves that social welfare can never be increased by supplementing a non-linear income tax with a subsidy to the cost of education. The present paper helps to understand these seemingly conflicting conclusions. In order to do so the various frameworks of analysis first have to be described however.

The papers of Bovenberg et al. and Wigger and the present analysis differ in one important respect. The former ones are written in the Mirrlees tradition. They connect the problem of taxing human capital accumulation efficiently with the problem of trading off equity and efficiency subject to informational constraints. The resulting analysis is much more complex than the present one which deals with pure efficiency issues. Still a comparison is possible and insightful.

From the Mirrlees literature it is well-known that highly productive labour income should not be taxed at the margin if the tax planner wants to redistribute income between two productivity types of individuals and if low and high types cannot be identified on an individual basis. In present notation this means $\tau_h = 0$. Relying on this famous result and on quasi-linear utility functions, Wigger is able to prove that a subsidy to the monetary cost of education effectively lowers social welfare, $s < \tau_h = 0$. This comes close to Corollary 2 above. In fact, Corollary 2 is much stronger than Wigger’s result in the following sense. It assumes (A1) only and does not require utility functions to be quasi-linear. Furthermore it makes clear that $s < \tau_h$ follows from pure efficiency considerations while $\tau_h = 0$ follows from the government’s need to respect an informational participation constraint when redistributing income from high to low productivity types of individuals.

Bovenberg and Jacob's (2005) results are less easy to summarize. The reason is that these authors study education subsidies in varying frameworks. The most general one allows for costs of foregone leisure. With certain respect such as the feasibility of utility functions it is even more general than Wigger's analysis. The price Bovenberg and Jacobs however pay is a loss in the simplicity and clarity of results. They are only able to prove that non-pecuniary educational costs may have an increasing effect on optimal education subsidies, especially if they are complementary to work effort. In the less ambitious part of their paper, Bovenberg and Jacobs ignore non-pecuniary educational costs. They demonstrate that optimal subsidies on education ensure efficiency in human capital accumulation even if the government values equity and pursues a redistributive policy. If tax rates on labour increase, optimal subsidies on education should do so as well in order to alleviate the tax distortions on learning.

At first sight it may seem as if such a result goes beyond Proposition 4 of the present analysis. It seems to do so as the Bovenberg and Jacobs reuslt allows for a distributive objective which the present analysis does not. Closer inspection however reveals that the efficiency result of Bovenberg and Jacobs is not comparable with the one derived here. The key difference is that Bovenberg and Jacobs model education as an intermediate good so that the Production Efficiency Theorem of Diamond and Mirrlees (1971) applies. By way of contrast, education is no intermediate good in the present framework and hence Proposition 4 is unrelated to the Production Efficiency Theorem. Just note that education, as modelled here, is a leisure-time consuming activity generating rent income that cannot be fully taxed away. Hence important assumptions of the Production Efficiency Theorem are violated and still efficiency in education is obtained. The price that has to be paid is that Proposition 4 may not be expected to extend to a regime in which the government trades off efficiency against equity.

In Bovenberg and Jacobs (2005) the argument runs as follows. Because of distributive concerns it is efficient to rely on a distortional tax on labour income. As a poll tax allows to skim off pure ability rents, the Production Efficiency Theorem is applicable and this requires to leave educational investment undistorted. In the present analysis distortions arise by taxing consumption. A poll tax is not available but labour income

can be taxed according to qualification which is not the case in Bovenberg et al. (2005). Pure profit accrues to the representative household and yet it is efficient to leave the educational choice undistorted.

One may well discuss whether tax rates should be allowed to depend on educational characteristics or not. From a positive point of view it is difficult to justify any dependence. No country is known to condition tax rates on educational characteristics explicitly. This common practice is however more and more questioned from a normative perspective. Most prominent is the idea to introduce graduate taxes. See e.g. Garcia-Penalos and Wälde (2000) or Poutvaara (2004). Such taxes are suggestive as school qualification and university degrees are certainly not difficult to verify by tax authorities. Even more, not to use this information is conceptually not really convincing given the framework of Bovenberg and Jacobs (2005). These authors assume that the government can subsidize individual monetary costs of education. Hence the government should be able to differentiate tax rates according to subsidies received. If not, the framework is not too far from the one assumed for Corollary 1 above. It relies on the assumption, that labour income tax rates cannot be differentiated according to qualification for some non-specified exogenous reason, $\tau_l = \tau_h \equiv \tau$. Corollary 1 states that, given non-differentiability, the monetary cost of education should be granted tax deduction at a rate s that exceeds τ. This result confirms simulation results of Trostel (1996). It however contradicts Bovenberg and Jacobs (2005) who prove $s=\tau$ in the less ambitious part of their paper. This is further evidence to the claim that the results of Bovenberg and Jacobs (2005) and the ones presented here are only similar in spirit but different in substance.

As has already been stressed, Proposition 4 is best interpreted with reference to the Double Dividend Hypothesis known from the literature on environmental taxation. If it is socially desirable to encourage education on the margin, one should do so by taxing non-compliant behaviour and not by subsidizing compliant behaviour. This is the so-called weak form of the Double Dividend Hypothesis. See Goulder (1995). The first dividend is the positive effect on education and the second dividend comes from the generated revenue which can be used to cut back distorting taxes. There have been other less convincing attempts in the literature to relate double dividends to optimal

education policy. Jacobs (2005) suggests to speak of a double dividend if education subsidies produce more equality in before-tax incomes and also generate efficiency gains in taxation. He refers to Dur and Teulings (2004). These authors argue in favour of educational subsidies. By promoting education and relying on general-equilibrium effects, the distortionary cost of progressive taxation may be reduced. According to Jacobs (2005) a "double dividend" of education subsidies generating more equality in before-tax wages through general equilibrium effects and lower distorting tax rates is however not likely to occur. Corollary 2 of the present paper is another blow against the thesis of Dur et al. The monetary cost of education should not even be granted full tax deductibility if labour income can be taxed according to qualification. In other words, for pure reasons of efficiency education should be taxed and not subsidized on a net basis. The conjecture is that this result perfectly extends to a general-equilibrium framework.

6.2 Dual income taxation

The Nordic system of dual income taxation is a highly topical reform option in various countries.[1] The system combines progressive taxation of labour income with proportional taxation of capital income. Nielsen and Sörensen (1997) argue that the progressive part serves to reduce the private return to human capital investment, thereby offsetting the tendency of a proportional comprehensive income tax to discriminate in favour of such investments. This sounds very much as if Nielsen and Sörensen were searching for a policy *dis*couraging human capital investment. In order to relate this irritating result to the present analysis the framework used by Nielsen and Sörensen has to be described in more detail.

The framework is one in which a representative agent works and consumes in two periods. The productivity of second-period labour increases with the amount of education acquired in first period. Time spent on education reduces leisure and non-qualified labour supplied to the market. The agent has two options to increase second-period consumption. She can invest in human capital and she can save out of first-

[1] Only recently, the Council of Economic Advisors (2006) to the German Government has proposed to follow the Nordic countries and replace comprehensive income taxation by dual the taxation of capital and labour.

period non-qualified labour income. In this simple framework the capital income tax affects two margins. First, it discriminates against saving by reducing its return. By doing so the capital income tax indirectly reduces the return to non-qualified labour. It thus gives an incentive to substitute non-qualified by qualified labour. Secondly it increases the discount factor and thus gives incentive to increase the amount of education. If for some exogenous reasons qualified labour income were taxed more heavily than non-qualified labour income, then Proposition 2 would suggest to supplement the labour income tax with a tax on capital income. In fact, the capital income tax would only correct for the negative effect that the progressive labour tax exerts on educational investment. See Jacobs and Bovenberg (2005) and Richter (2006). The thing only is that Nielsen and Sörensen (1997) completely reverse the logic. As already mentioned, they argue in favour of a policy that discourages human capital investment and they additionally reverse the reform perspective. They keep the capital income tax exogenous and prove optimality of progressivity in labour income taxation. The present analysis only allows one to confirm their analysis with the following qualification. If the exogenous rate of the capital income tax is positive, it may well set excessive incentives for human capital investment. In this case progressive labour taxation may well be an efficient means to correct for the excessive incentives. Clearly, whether or not incentives are excessive should depend on the model's parameterization. In fact, the efficiency condition (19) on which Nielsen and Sörensen base their policy recommendations is highly involved and extremely complicated. Without further research it is difficult to truly reconcile their own interpretation with the one given here.

7. Summary

The policy conclusions derived from this paper's analysis are just as unambiguous as unpopular. They are unambiguous in the sense that it could be shown under fairly broad assumptions to be efficient to encourage education when education generates rent income. The policy that proved to be second best is not to distort the education choice itself but to tax non-qualified labour more heavily than qualified labour and by

doing so to set incentives for substituting non-qualified labour by qualified labour. This form of indirect encouragement of human capital investment has been shown to be more efficient than the direct subsidization of the monetary costs of education. The intuition behind this result reminds one of the Double Dividend Hypothesis well known from environmental taxation. According to this hypothesis it is more efficient to tax non-compliant behaviour than to subsidize compliant behaviour. The results derived in this paper allow one to give a consolidated interpretation of various other results that have been produced in the literature and that tend to be contradictory and confusing.

The policy conclusions derived from this paper's analysis are certainly not very popular. Not many people would be willing to tax non-qualified labour more heavily than qualified labour. This paper should however be less considered an appeal to move towards regressive income taxation. The primary value of the analysis is to stress the social efficiency cost of progressive taxation. Progressive taxation with respect to qualification is just the opposite of what is needed to encourage human capital investment. This negative incentive effect magnifies the negative disincentives for labour choice highlighted by Mirrlees (1971) and others.

A final remark concerns the simplicity of the model used in the present paper. The results derived are relatively strong and it is not clear how far they are owed to an overly simplistic model of human capital accumulation. There has been no explicit time structure and the accumulation of physical capital has not been modelled to mention just two obvious shortcomings. Part of these will be reconciled in the follow-up paper by Richter (2006). Still, much further research is needed to see how far the policy suggestions derived in this paper carry in more realistic settings.

8. Appendix

The *Remark* is only proved for the cases in which the equality of elasticities is claimed to hold with respect to *q*. The cases of φ and ω_l are proved along the same lines. See also Richter (2006). The definition $Y(\omega_h, \pi, L_h) = \omega_h H L_h - \pi E$ and the first-order

condition $\omega_h H' L_h = \pi$ imply $Y_q = \omega_h H L_{hq}$ and $E_q = -\frac{H' L_{hq}}{H'' L_h}$. Making use of $\eta \equiv EH'/H$ one obtains $Y = H\frac{\pi}{H'} - \pi E = \pi(\frac{1}{\eta} - 1)E$. Hence $\varepsilon_{Y/q} = \varepsilon_{E/q} \Leftrightarrow$

$$\frac{\omega_h H L_{hq}}{\pi(\frac{1}{\eta} - 1)E} = \frac{Y_q}{Y} = \frac{E_q}{E} = -\frac{H' L_{hq}}{H'' L_h E} \quad \Leftrightarrow \quad \frac{1}{1-\eta} = \frac{H}{(\frac{1}{\eta} - 1)EH'} = -\frac{H'}{H'' E}$$

which clearly holds if *H* is isoelastic.

The proof of Proposition 3 makes use of $e_q = C$, $e_l = -(L_l - E)$ and $e_\varphi = E$. Equation (10) is perfectly equivalent to (7). Equation (9) follows just by noting

$$\frac{\Delta E}{E} = \frac{\Delta e_\varphi}{e_\varphi} \underset{(6)}{=} \frac{\Delta e_l}{e_l} = \frac{\Delta(L_l - E)}{L_l - E} = \frac{\Delta L_l - \Delta E}{L_l - E}.$$

The proof of *Proposition* 4 requires some preparatory considerations. Note first that (1) holds in more general terms:

$$qC_x = \omega_l L_{lx} + Y_{L_h} \cdot L_{hx} \quad \text{for} \quad x = q, l, \varphi. \tag{11}$$

Making use of (8) and (11) one easily derives

$$q\Delta C = \omega_l \Delta L_l + Y_{L_h} \cdot \Delta L_h \ . \tag{12}$$

Assuming (6') and isoelasticity of *H*, (7') must be shown to hold if, and only if, $\pi = p$:

$$\frac{\Delta C}{C} \underset{(12)}{=} \frac{1}{qC}[\omega_l \Delta L_l + Y_{L_h} \cdot \Delta L_h]$$

$$\underset{(9)}{=} \frac{\omega_l L_l}{qC}\frac{\Delta E}{E} + \frac{1}{qC} Y_{L_h} \cdot \Delta L_h$$

$$\underset{(2)}{=} \frac{\omega_l L_l}{qC}\frac{\Delta E}{E} + \frac{1}{qC}\frac{Y}{E}\Delta E + \frac{Y}{qC}\frac{(\omega_l - w_l) + (\varphi - f)}{\omega_l + \varphi}$$

$$= \frac{\omega_l L_l + Y}{qC}\frac{\Delta E}{E} + \frac{Y}{qC}\frac{\pi - p}{\pi}$$

$$= \frac{\Delta E}{E} \quad \text{if, and only if, } \pi = p\,.$$

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