The private and fiscal returns to schooling: A general framework and some results for EU countries

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Abstract

We develop a comprehensive framework for the quantitative analysis of the private and fiscal returns to schooling. This framework is applied to 14 member states of the European Union. For each of these countries, we construct estimates of the private return to an additional year of schooling for an individual of average attainment, taking into account the effects of education on wages and employment probabilities, and after allowing for academic failure rates, the direct and opportunity costs of schooling, and the impact of personal taxes, social security contributions and unemployment and pension benefits on lifetime earnings. Within the same framework, we also provide an approximation to the fiscal returns to schooling that captures the long-term effects of a marginal increase in attainment on public finances under conditions that approximate general equilibrium.

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1. Introduction

This paper builds on the extensive literature that has sought to quantify the economic returns to schooling and brings together several of its strands. A large number of studies have explored the effects of education on wages and employment using individual-level data.[1] Wage effect estimates obtained in this manner can be interpreted as approximations to the rate of return to schooling, only under very stringent assumptions that include the absence of both direct educational costs and taxes, perfect certainty, and infinite working lives. Another set of papers has estimated rates of return to schooling by discounting the lifetime earnings profiles associated with different educational levels under a less stringent set of assumptions (see, for instance, Heckman et al., 2005). While this "full discounting" approach is conceptually well suited for the joint analysis of wage and employment effects, for quantifying the impact of educational finance and tax and benefit policies on the returns to schooling, and for estimating the fiscal returns from investment in education, systematic attempts to bring all or most of these factors into the analysis and to isolate their respective effects seem to be rather scarce in the literature.[2]

We derive almost closed-form expressions for the private and fiscal returns to schooling that can be seen as a compromise between the two approaches outlined above and that take into account a number of factors that have not generally been considered jointly in the literature. Our estimates of private returns to schooling consider the effects of education on wages and employment probabilities, allow for academic failure rates, the direct and opportunity costs of schooling, and include the impact of personal taxes, social security contributions and unemployment and pension benefits on lifetime earnings. By considering taxes and benefits, a simple by-product of this framework is that it easily provides estimates of fiscal returns to schooling, approximated by the long-term effects of a marginal increase in educational attainments on public finances. While our procedure can only be regarded as an approximation to the full discounting method, as it imposes some simplifying assumptions, it does have the important advantage that it is much less data and computation intensive, and is therefore better

[1]Wage equation studies have generally adopted the specification proposed by Mincer (1974). Psacharopoulos and Patrinos (2002) collect the results of such studies for a large number of countries and Card (1999) surveys the relevant literature focusing on estimation issues. On the impact of education on unemployment, see among others Ashenfelter and Ham (1979), Nickell (1979) and Mincer (1991).

[2]As for employment effects, Barceinas et al (2000a) and Blöndal, Field and Girouard (2002) allow explicitly for unemployment when calculating the rate of return to education. As for the impact of taxes and benefits, Barceinas et al take into account unemployment benefits, while Blöndal et al allow for taxes and isolate the contribution of educational subsidies to private returns. As for studies that introduce explicit corrections for unemployment and taxes when calculating rates of return by the full discounting method, see Psacharopoulos (1995). There are also some studies that implicitly allow for taxes and/or unemployment in the estimation of Mincerian rates of return by using data on net-of-tax wages or on total earnings rather than on gross hourly wage rates (see for instance Nickell, 1979). As for estimation of the fiscal returns from investment in education, see O'Donoghue (1999), who combines wage equation estimates with a micro-simulation model to explore the effects of taxes and social benefits on the returns, and a second study by Barceinas et al (2000b).

suited for broad cross country comparisons. As an illustration, and in spite of data limitations, we apply this framework to 14 member states of the European Union.

The structure of the paper is as follows. Section 2 presents the formulae used to compute private and fiscal returns to schooling. Section 3 describes the data and parameter values used in our calculations, and Section 4 collects the results. Section 5 discusses the main limitations imposed by our framework and possible further refinements of our estimates of the private and fiscal returns to schooling. Finally, Section 6 concludes with a summary of the main findings and a discussion of their policy implications.

2. Almost closed-form formulae for the private and fiscal returns to schooling

As in the case of more standard investment projects, the financial payoff to an additional year of schooling can be quantified by computing its internal rate of return, formally defined as the discount rate that equates the present value of the relevant streams of incremental pecuniary costs and benefits. This calculation involves the explicit costs of schooling born by a representative agent, her opportunity cost in the form of foregone labor income and lost work experience, and the expected increase in future net-of-tax labor earnings and unemployment and pension benefits arising both from higher wages and from higher employment probabilities. As for the fiscal returns from investment in education, they are closely related to the expected increase in net tax payments. Hence, some parameters affect simultaneously both private and fiscal returns to schooling, as shown below.

2.1. The private return to schooling

Let us consider an individual who attends school for X years, successfully completes $S(X)$ grades, retires at time U, and is expected to live until time Z. Wages and the probability of employment will be assumed to be an increasing (and time-invariant) function of schooling, respectively $f(S(X))$ and $p(S(X))$. Wages also increase as a result of exogenous technical progress and the accumulation of physical capital and experience. The experience premium on wages is denoted by ν while the rate of growth of the efficiency of labor is g. If the worker is unemployed, she is entitled to a benefit, given by a function of previous wages, $B(W)$. Similarly, taxes are also a function of earnings, $T(W)$, while employed, and $T(B(W))$ while unemployed. While studying, individuals are not entitled to unemployment benefits (which is true in most countries, as a minimum period of previous employment is generally required for contributory benefits) while unemployed, but can work part-time, with probability $p_s(S(X))=\eta p(S(X))$, and, if so, their wages, W_S, that do not rise with experience, are a fraction $(1-\phi)$ of the wages of an adult full-time worker of average experience with the same qualifications.[3] Finally, pensions are

[3] Hence, we can think of ϕ as the fraction of the work year devoted to full-time school attendance but it should be kept in mind that this parameter will also implicitly capture other factors (such as the lack of experience and the nature of the jobs available to young people who seek part-time or summer employment) that will influence the wages of students relative to those of adult workers.

initially set as a fixed fraction, κ, of gross wages at the time of retirement, U, and their real value grows over time at a constant rate, ω.

The present value of this agent's expected lifetime net earnings can be written as a function of years of schooling as follows:

$$(1)\ V(X) = \int_0^X A_o e^{\nu H_o/2} F_s(t) e^{-(R+\nu)t} dt + \int_X^U A_o F(X) e^{-Rt} dt + \\ + \int_U^Z A_o e^{(g+\nu-\omega)U} F_p(X) e^{-(R+g+\nu-\omega)t} dt - \int_0^X \mu_S A_o e^{\nu H_o/2} f(S_o) e^{-(R+\nu)t} dt$$

being r the discount rate, and $R \equiv r - g - \nu$. A_0 denotes the initial level of the efficiency of labor, and H_0=U-X_0 and S_0 are, respectively, the experience of the "average" worker (at the mid-point in its career) and her years of schooling.

The first term on the right-hand side of (1) denotes the present value of expected labor earnings while attending school and (potentially) working part-time between times 0 and X. $F_s(t) = p_s(S(t))\left[(1-\phi)\ f(S(t)) - T((1-\phi)\ f(S(t)))\right]$ gives the expected earnings of students with years of schooling t, measured in efficiency units of the adult full-time worker of average experience $(A_0 e^{\nu H_0/2})$.

The second term represents the present value of expected labor income and unemployment benefits over the individual's post-school working life (between times X and U). Normalizing by the initial level of the efficiency of labor, earnings are a weighted average of net expected earnings while employed, $F_e(X) = e^{-\nu x} f(S(X)) - T(e^{-\nu X} f(S(X)))$, and unemployed, $F_U(X) = B(e^{-\nu X} f(s(X))) - T(B(e^{-\nu X} f(s(X))))$, after leaving school, so that $F(X) = p(S(X))\ F_e(X) + [1-p(S(X))]\ F_u$.

The third term gives the discounted value of pension benefits between retirement and the expected time of death, Z, with $F_p(x) = ke^{-\nu x} f(S(X)) - T[ke^{-\nu x} f(S(X))]$ being expected pensions in retirement, also in the corresponding efficiency units.

Finally, the last term corresponds to the present value of the direct costs of schooling born by the agent (i.e. net of public subsidies), being μ_s the direct cost of each year of schooling as a constant fraction of the earnings of the average worker ($A_0 e^{\nu H_0/2} f(S_0)$).

To calculate the rate of return to schooling, we compute the derivative of the net lifetime earnings function, $V'(X)$, and solve for the value of the discount rate, r, that makes this derivative equal to zero when $X = X_O$ (i.e. for an individual of average attainment), which yields:[4]

$$(2)\ \frac{R}{1-e^{-RH_o}} = \frac{F'(X_o) + \gamma(R) F_p'(X_o)}{\left[F(X_o) - F_s(X_o) e^{-\nu X_o} e^{\nu H_o/2}\right] + \mu_s f(S_o) e^{-\nu X_o} e^{\nu H_o/2}}; \qquad \gamma(R) \equiv \frac{R}{R+g+\nu-\omega} \frac{1-e^{-(R+g+\nu-\omega)(Z-U)}}{e^{RH_o}-1}$$

This expression shows that the return to schooling is an increasing function of the ratio between the gain in expected net income induced by a marginal increase in school attendance and the cost of schooling. The numerator of this ratio can be written as the sum of two terms

[4]For a detailed derivation of equation (2) , see de la Fuente and Jimeno (2005).

that capture the benefits that accrue respectively during the agent's working life and after retirement; the denominator, as the sum of an opportunity (F - F_S) and a direct cost component. Notice that, before being added to the wage component of the payoff to schooling (F'), retirement benefits (F_p') are weighted by a factor $\gamma(R)$ that discounts for their later accrual and takes into account their potentially different growth rate (ω rather than $g+\nu$) and expected duration (Z - U rather than H).

For computation purposes, it is convenient to express this rate of return as function of the Mincerian returns, $\theta \equiv \frac{f'(S_o)}{f(S_o)}$, very often estimated by microeconometric wage equations, the rise in the probability of employment as a function of educational attainment, and average and marginal tax and benefit rates under different states (studying, employed, unemployed, and retired). It is easy to check that the private rate of return to schooling is also given by $r_p = R_p + g + \nu$ where R_p is the value of R that solves the following equation

$$(3)\quad \frac{R}{1-e^{-RH_0}} = \frac{p(1-T')[\theta S'(X_0)-\nu]+\Delta p' S'(X_0)+\gamma(R)(1-T_p')\kappa[\theta S'(X_0)-\nu]}{[p(1-\tau)-\eta p(1-\phi)(1-\tau_s)e^{\nu H_0/2}]+\mu_s e^{\nu H_0/2}} \equiv$$

$$\equiv \frac{\theta_{net}+p'_{net}+PENS}{OPPC+DIRC} \equiv R'$$

being $p(1\text{-}T')$ and $p(1\text{-}\tau)$, respectively, the expected marginal and average net-of-tax factors for adult workers, and where Δ captures the difference in net earnings between employed and unemployed adult workers, as defined in Table 1.[5]

To interpret equation (3), notice that its left-hand side is an increasing function of R where the term $1\text{-}e^{-RH_0}$ that appears in the denominator serves to adjust for the fact that the "useful life" of the asset (the working life of the individual, H_0) is finite. The right-hand side, R', is simply the ratio of the marginal benefits derived from an additional year of schooling (which we can interpret as the "dividend" paid by human capital) to its cost, with all the terms expressed as fractions of the initial gross earnings of an adult employed worker with average education, namely, $Ae^{-\nu X_0}f(S_0)$. The first term in the numerator (θ_{net}) captures the expected increase in after-tax earnings and unemployment benefits holding the probability of employment constant and taking into account the opportunity cost of losing a year of experience to remain in school. The second term (p'_{net}) measures the increase in expected net

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5 This calculation assumes that unemployment benefits are set as a function of gross income in employment. This is so in most countries, but there are some exceptions. For instance, Germany and Austria set benefits as a fixed fraction (β) of net-of-tax income in employment and do not tax them. As shown in de la Fuente and Jimeno (2005), equation (3) continues to hold in this case provided we redefine T', τ and Δ as follows:

$$1-T' \equiv \left[1+\frac{1-p}{p}\beta\right](1-T'_e)\ ;\ (1\text{-}\tau) \equiv \left[1+\frac{1-p}{p}\beta\right](1-\tau_e),\ \text{ and }\quad \Delta \equiv (1-\tau_e)(1-\beta)$$

earnings that comes from an increase in the probability of employment, holding wages constant, and the third one gives the discounted value of the increase in expected retirement benefits. Notice that, except for the experience offsets, all these terms are directly proportional to the marginal productivity of time spent at school, $S'(X_o)$. The denominator measures the total cost of an additional year of schooling as the sum of two terms: i) the opportunity cost of school attendance or net foregone wages *(OPPC)*, and ii) the direct costs of schooling born by the student or his family *(DIRC)*.

Table 1: Tax and benefit parameters used in the rate of return formula

$$\tau_e \equiv \frac{T\left(e^{-\nu X_o} f(S_o)\right)}{e^{-\nu X_o} f(S_o)}, \quad \tau_u \equiv \frac{T\left(B\left(e^{-\nu X_o} f(S_o)\right)\right)}{B\left(e^{-\nu X_o} f(S_o)\right)}, \quad \tau_s \equiv \frac{T\left((1-\phi) f(S_o)\right)}{(1-\phi) f(S_o)}, \quad \tau_p \equiv \frac{T\left(\kappa e^{-\nu X_o} f(S_o)\right)}{\kappa e^{-\nu X_o} f(S_o)}$$

$$T'_e \equiv T'\left(e^{-\nu X_o} f(S_o)\right), \quad T'_u \equiv T'\left(B\left(e^{-\nu X_o} f(S_o)\right)\right), \quad T'_p \equiv T'\left(\kappa e^{-\nu X_o} f(S_o)\right)$$

$$b \equiv \frac{B\left(e^{-\nu X_o} f(S_o)\right)}{e^{-\nu X_o} f(S_o)}, \quad B' \equiv B'\left(e^{-\nu X_o} f(S_o)\right)$$

$$T' \equiv T'_e - \frac{1-p}{p}(1-T'_u)B, \quad \tau \equiv \tau_e - \frac{1-p}{p}(1-\tau_u)B, \quad \Delta \equiv (1-\tau_e) - (1-\tau_u)b \text{ where } p \equiv p(S_o).$$

Note: The symbols τ_e, τ_u, τ_s and τ_p denote the average income tax rates faced by the representative employed and unemployed adult workers, student part-time workers and pensioners, respectively. T'_e, T'_u and T'_p are the corresponding marginal tax rates, and b and B' are the average and marginal *gross replacement rates* for unemployed workers.

2.2. The impact of public policies on the return to schooling

As seen in equation (3), public policies influence the private return to schooling in many ways. Educational subsidies and the direct public provision of educational services at no charge raise the return to schooling by lowering its direct cost to the individual *(DIRC)*. Pension benefits will also raise r_p, provided of course they are linked to wages. There are also effects from varying net tax rates under different employment status and from their interaction with the direct cost term, *DIRC*. One main advantage of our specification of the impact of schooling on earnings is that all these different effects of public policies can be separately identified under a simple decomposition.

We perform this decomposition by computing the rate of return under a set of different counterfactual assumptions or *scenarios* (listed in Table 2). We start from a hypothetical situation in which there is no government intervention. Then we add various policies one by one. First, we assume that private agents pay the full costs of education and there are no taxes or social benefits (scenario [1], *NO GOV'T)*. Then, we introduce *subsidies* to education and the public provision of schooling free of charge, maintaining the remaining assumptions (scenario [2]). We then add personal *taxes* (scenario [3]), unemployment benefits (scenario [4]) and pensions (scenario [5]). For this last scenario, we will use a gross replacement rate of 67% (of wages at retirement) and assume that pension benefits grow at the same rate as wages ($\omega = g$).[6] In what follows, we will refer to estimates of r_p obtained under the assumptions of the *NO GOV'T* and *OBS* scenarios as *raw* and *all-in* returns respectively. We calculate the tax or subsidy wedge ($wedge_{gov't} = r_{no\ gov't} - r_{obs}$) generated by public policies as the difference between the raw and all-in rates of return, and define the effective tax rate on schooling ($etr_{gov't} = \frac{wedge_{gov't}}{r_{no\ gov't}}$) as the ratio between the tax wedge and the raw return. Notice that $wedge_{gov't}$ and $etr_{gov't}$ capture the joint effect of all the public policies we are considering except for pensions.[7]

Table 2: Definition of alternative scenarios for the computation of private return to schooling

	raw return NO GOV'T [1]	*educational subsidies [2]*	*personal taxes [3]*	*all-in return OBS [4]*	*Pensions [5]*
direct costs	Total	Private	Private	Private	Private
taxes	None	None	Observed	Observed	Observed
unempl. benefits	None	None	None	Observed	Observed
pensions	None	None	None	None	$\kappa = 0.67$ and $\omega = g$

To isolate the impact of each individual policy, it will be useful to write $wedge_{gov't}$ and $etr_{gov't}$ as the sum of three factors that capture the separate effects of educational subsidies, personal taxes and unemployment benefits. The effective subsidy to schooling implied by retirement benefits can be computed in a similar way.[8] Thus,

$$wedge_{gov't} = r_{no\ gov't} - r_{obs} = (r_{no\ gov't} - r_{subsidies}) + (r_{subsidies} - r_{taxes}) + (r_{taxes} - r_{obs})$$
$$\equiv -wedge_{subs} + wedge_{tax} + wedge_{ben}$$
$$etr_{gov't} = \frac{wedge_{gov't}}{r_{no\ gov't}} = \frac{-wedge_{subs} + wedge_{tax} + wedge_{ben}}{r_{no\ gov't}}$$
$$\equiv -subs_{edu} + etr_{tax} + etr_{ben}$$
$$subs_{pens} = \frac{wedge_{pens}}{r_{no\ gov't}} = \frac{r_{pens} - r_{obs}}{r_{no\ gov't}}$$

[6] Since our assumptions on pension determination are only meant to be illustrative and do not reflect the true features of national retirement systems, we will focus on the before-pension rates of return obtained under the assumptions of scenario [4] *(OBS)* as our baseline measure of the observed private returns to education.

[7] The progressivity of the tax and benefit system is a crucial determinant of the private return to schooling. In Appendix 1 we provide an alternative version of equation (3) which relates this return to some indexes of progressivity of tax and benefits, and discuss the effects of alternative tax and benefit schemes on the former.

[8] Wedges and effective tax rates are defined so that their signs are positive under normal circumstances, that is, whenever taxes and unemployment benefits reduce the private return to schooling and educational subsidies and pensions increase it.

2.3. The fiscal return to schooling

Public expenditure on education, through its effects on wages and employment probabilities, increases future tax revenues and pension liabilities and is likely to reduce expenditure on unemployment benefits. Proceeding as in Section 2.1 and in order to summarizing the long-term impact of educational spending on government finances, it is straightforward to compute a *fiscal rate of return to schooling* (r_f). It is defined as the discount rate that equates the present value of public schooling expenditures with the present value of the induced incremental flows of tax revenues and savings on social protection payments.[9] It can also be interpreted as the maximum real rate of interest at which the government can borrow to finance educational expenditure without increasing the present value of current and future deficits. For computation purposes, we consider, as in Section 2.1, the net tax revenue streams associated with adult and student workers and with pensioners. In addition to the personal taxes considered in the previous section, we also take into account social security contributions by employers and consumption taxes.[10]

The present value of the expected stream of net tax revenues associated with a worker of schooling X can be written as follows

$$(4)\ V_g(X) = \int_0^X A_o e^{vH_o/2} G_s(t) e^{-(R+v)t} dt + \int_X^U A_o G(X) e^{-Rt} dt - \int_0^X \mu_g A_o e^{vH_o/2} f(S_o) e^{-(R+v)t} dt$$
$$+ \int_U^Z q[S(X)] G_p(X) A_o e^{(g+v-\omega)U} e^{-(R+g+v-\omega)t} dt$$

where $\mu_g A_t e^{vH_o/2} f(S_o)$ is annual government expenditure per student.

The first term in equation (4) gives the net tax revenues from students working part-time, where

$$G_s(X) = q_s(S(X))\, p_s(S(X)) A_0 e^{gt} e^{v^{H_0}\!/_2} *$$
$$\{T((1-\phi) f(S(X)) + E((1-\phi) f(S(X))) + \tau_C C[(1-\phi) f(S(X)) - T((1-\phi) f(S(X)))]\}$$

being $q_s() = \eta_q q()$ gives the probability of participation of a student of attainment $S(X)$, that is, the probability that she will be seeking a part-time job while attending school. In these and the following expressions, the function $T()$ captures personal taxes on workers, including employee's social security contributions, as a function of their gross income, $E()$ denotes social contributions paid by employers, $C()$ gives consumption as a function of after-tax income, and τ_C is the tax rate on consumption.[11]

The second term in equation (4) gives the net tax revenues from adult workers, where $G_e(X) \equiv T\left(e^{-vX} f[S(X)]\right) + \tau_c C\left\lfloor e^{-vX} f[S(X)] - T\left(e^{-vX} f[S(X)]\right)\right\rfloor + E\left(e^{-vX} f[S(X)]\right)$ is, in labor efficiency units, the difference between the benefits that accrue to an employed workers and the direct and indirect taxes paid by her directly or by her employer on her behalf, and

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9 Public schooling expenditures include an opportunity cost component, as school attendance reduces wage income and hence current tax payments.

10 There are other plausible beneficial effects of education on the public budget, through its incidence on health, crime rates or externalities on labor productivity. These will be discussed in Section 5.

11 *T(), E()* and *C()* all give amounts per efficiency unit of labor.

$$G_u(X) \equiv -B\left(e^{-\nu X} f\left[S(X)\right]\right) + T\left[B\left(e^{-\nu X} f\left[S(X)\right]\right)\right] + \tau_c C\left[B\left(e^{-\nu X} f\left[S(X)\right]\right) - T\left[B\left(e^{-\nu X} f\left[S(X)\right]\right)\right]\right]$$

is the corresponding expression for the unemployed. Since the wages of adult workers grow at a rate $g+\nu$, the expected net tax revenue generated by an adult agent at time t will be given by

$$A_o e^{(g+\nu)t} G(X) \equiv q\left[S(X)\right]\left\{p\left[S(X)\right]G_e(X) + \left(1 - p\left[S(X)\right]\right)G_u(X)\right\}A_o e^{(g+\nu)t}$$

where $q()$ gives the probability that the agent will be active as a function of his attainment level and $p()$ the probability that she is employed, conditional on her being active. The participation rate is relevant for our calculations here because only those students that become active pay taxes or are entitled to unemployment benefits or (in most countries) to pensions.

Finally, the third term gives the total net tax revenue generated by a pensioner of schooling X where[12]

$$G_p(X) = \left\{-\kappa e^{-\nu X} f(S(X)) + T(\kappa e^{-\nu X} f(S(X))) + \tau_C C[\kappa e^{-\nu X} f(S(X)) - T(\kappa e^{-\nu X} f(S(X)))]\right\}$$

Differentiating $V_g()$, and setting the result equal to zero when $X = X_o$ it is easily shown that the fiscal rate of return on schooling is given by $r_f = R_f + g + \nu$ where R_f is the value of R that solves the following equation

$$(5)\ \frac{R}{1-e^{-RH_o}} = \frac{G'(X_o) + \gamma(R)\left[q S'(X_o)G_p(X_o) + qG_p'(X_o)\right]}{\left[G(X_o) - G_s(X_o)e^{-\nu X_o}e^{\nu H_o/2}\right] + \mu_g f(S_o)e^{-\nu X_o}e^{\nu H_o/2}}$$

We now rewrite equation (5) in terms of a more convenient set of parameters. The relevant ones are defined in Table 3, including the average and marginal propensities to consume out of after-tax income of students, pensioners and adult employed and unemployed workers (c_i and C'_i with $i = s, p, e, u$), and the average and marginal rates of employers' social security contributions for employed adult and student workers (e_e, e_s and E'_e) and a set of marginal (Δ'_i) and average (T_i) total tax rates for the different types of agents that capture the combined effect of the different types of taxes and of unemployment and retirement benefits.[13]

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[12] The pension term, $G_p()$, enters the equation multiplied by $q()$, since we assume that only active workers are entitled to (contributory) retirement benefits.

[13] In the case of Germany and Austria, the average and marginal total tax rates for unemployed workers will be given by

$$T_u \equiv -(1-\tau_c c_u)(1-\tau_e)\beta \quad \text{and} \quad \Delta'_u \equiv -\left(1-\tau_c C_u'\right)\left(1-T_e'\right)\beta$$

Table 3: Parameters used in the fiscal returns formula

$$c_s \equiv \frac{C\left[(1-\tau_s)(1-\phi)f(S_o)\right]}{(1-\tau_s)(1-\phi)f(S_o)} \quad c_e \equiv \frac{C\left[(1-\tau_e)e^{-\nu X_o}f(S_o)\right]}{(1-\tau_e)e^{-\nu X_o}f(S_o)} \quad c_u \equiv \frac{C\left[(1-\tau_u)be^{-\nu X_o}f(S_o)\right]}{(1-\tau_u)be^{-\nu X_o}f(S_o)}$$

$$C'_e \equiv C'\left[(1-\tau_e)e^{-\nu X_o}f(S_o)\right] \quad C'_u \equiv C'\left[(1-\tau_u)be^{-\nu X_o}f(S_o)\right] \quad C'_p \equiv C'\left[(1-\tau_p)\kappa e^{-\nu X_o}f(S_o)\right],$$

$$e_s \equiv \frac{E\left[(1-\phi)f(S_o)\right]}{(1-\phi)f(S_o)} \quad e_e \equiv \frac{E\left[e^{-\nu X_o}f(S_o)\right]}{e^{-\nu X_o}f(S_o)} \quad \text{and} \quad E'_e \equiv E'\left(e^{-\nu X_o}f(S_o)\right).$$

$$T_s \equiv \tau_s + \tau_c c_s(1-\tau_s) + e_s$$

$$T_p \equiv -(1-\tau_p)(1-\tau_c c_p)\kappa \qquad \Delta'_p \equiv -(1-\tau_c C'_p)(1-T_p')\kappa$$

$$T_e \equiv \tau_e + \tau_c c_e(1-\tau_e) + e_e \qquad \Delta'_e \equiv T'_e + (1-T'_e)\tau_c C'_e + E'_e$$

$$T_u \equiv -(1-\tau_c c_u)(1-\tau_u)b \qquad \Delta'_u \equiv -(1-\tau_c C'_u)(1-T'_u)B$$

$$T_a = pT_e + (1-p)T_u \qquad \Delta'_a \equiv p\Delta'_e + (1-p)\Delta'_u$$

Using these parameters, equation (5) can also be written as follows:

$$(6) \quad \frac{R}{1-e^{-RH_o}} = R_f' \equiv \frac{\left[T_a \frac{q'}{q}S' + \Delta'_a\,\theta' + (T_e - T_u)p'S'\right] + \gamma(R)\left[T_p \frac{q'}{q}S' + \Delta'_p\,\theta'\right]}{\left[T_a - \eta_q p_s T_s(1-\phi)e^{\nu H_o/2}\right] + \frac{\mu_g}{q}e^{\nu H_o/2}} \equiv \frac{N_1 + \gamma(R)N_2}{D}$$

where $q()$, $q'()$ and $p'()$ are all evaluated at S_o, $\eta_q = q_s/q$ and $\theta' = \theta S' - \nu$. The remaining variables have the same meaning as in Sections 2.1 and 2.2 (although some adjustments will have to be made in their values to approximate general equilibrium effects, as will be discussed below).[14]

Equation (6) has essentially the same interpretation as the private returns formula given in Section 2.1. That is, r_f is an increasing function of the growth rate of wages over the lifecycle and of the ratio of the marginal (fiscal) benefits of an additional year of schooling to its (budgetary) costs, adjusted for the finiteness of working lives. We have written R_f' so that all its cost and benefit components are measured as fractions of an adult worker's gross wages.

The numerator of R_f' in equation (6) measures the expected net annual contribution to the public budget of an additional year of schooling. Its first term captures the impact of an increase in the labor force participation rate. Since inactive workers pay no taxes on labor

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[14] It is also easy to show that the net present fiscal value of a year of an additional year of schooling, defined as the difference in present value terms between incremental net fiscal revenues and public educational expenditures and calculated as of time X_0 (i.e. when the representative individual leaves school), can be approximated by

$$NPFV(r_0) = V_g'(X_o)e^{r_o X_o} =$$

$$= \left\{N_1 \frac{1-e^{-(r_o-g-\nu)H_o}}{r_o-g-\nu} + N_2 e^{-(r_o-g-\nu)H_o}\frac{1-e^{-(r_o-\omega)(Z-U)}}{r_o-\omega} - D\right\}qe^{-\nu H_o/2}W_o$$

where r_0 is the discount rate, W_0 the average gross salary of a full-time worker with average schooling and N_1, N_2 and Δ have been defined in (6).

income and are not entitled to unemployment benefits, increasing the labor force participation rate will increase net tax revenues provided tax payments by newly active workers exceed the social benefits paid to them. The second term, $\Delta_a'\theta'$, captures the net revenue effects of higher salaries, which increase tax payments by employed workers but also the insurance entitlements of the unemployed. The third term, $(T_e\text{-}T_u)p'S'$, reflects the impact of the increase in the probability of employment and is unambiguously positive since greater employment implies both higher tax revenues and lower unemployment payments (recall that T_u is always negative). Finally, the pension-related terms that appear in the numerator are weighted by the same discount factor as in the private returns calculation and are both negative, as pension liabilities will increase both with the rate of labor force participation and with wages.

The denominator of R_f' is the sum of the opportunity and direct budget costs of schooling. The opportunity cost term is the difference between expected net tax receipts from a full-time worker and net receipts from a part-time student worker. The direct cost component, finally, is equal to government expenditure per student divided by the labor force participation rate. This correction is required because expenditure is incurred for all students, but only those that enter the labor force pay taxes on labor income or are entitled to unemployment benefits.

3. Cross-country data and parameter values

We compute the private and fiscal returns to post-compulsory schooling in 14 countries of the European Union.[15] They refer to each country's representative individual endowed with average school attainment. We will assume that this representative agent's income, when employed, is equal to the gross earnings of the average production worker (APW) as estimated by the OECD.[16] When computing the private rate of return, it is also assumed that the agent is active throughout his working life -- that is, that she is active while attending school at post-compulsory levels and remains a member of the labor force until the average retirement age. Hence, the employment probabilities and related parameters used in this calculation are conditional on labor force participation. For the estimation of the fiscal returns, we will also take into account the probability of participation in the labor force of the representative individual. Our estimates of private returns will be obtained under partial equilibrium assumptions, that is, taking as given the aggregate level of schooling and factor prices. To calculate fiscal returns, on the other hand, we will try to approximate general equilibrium conditions. This will require adjustments that will reduce the values of some of the key parameters (in particular, θ, $p'$and q'), as will be discussed below.

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[15] They are the members of the EU before the last extension, with the exception of Luxembourg, for which some of the required data are not available.

[16] This assumption is made for convenience, as it allows us to make use of the estimates of APW earnings and of the relevant tax rates that are provided by the OECD for all countries in the sample. It should be noted, however, that this is not necessarily a good approximation, for average wages and skill levels in manufacturing may differ from those in the overall economy.

This Section gathers together the data required for the calculations. Raw measures of the effects of schooling on wages, employment probabilities and participation rates come, respectively, from Mincerian wage equations, and from employment and participation probit regressions, estimated separately for each country with individual-level data and corrected, to the extent possible, for endogeneity bias. Average and marginal tax and social benefit rates, measures of the direct cost of education and academic failure indicators come mainly from various OECD publications. Fiscal parameters are those applicable to a single and childless individual of average attainment in each country in 2000, and also come from OECD statistics. Table 4 summarizes the data sources, and below we give further details.

Table 4: Variables used in the calculation of the returns to schooling

μ_S and μ_g = private and government expenditure per student and year, measured as a fraction of APW gross earnings. Source: *Education at a Glance*. See Appendix 4.

μ and μ_g' = total expenditure per student and year, net and gross of government grants for non-tuition purposes, measured as a fraction of APW gross earnings. Source: *Education at a Glance*. See section 1 of Appendix 1.

W_0 = gross wage of the average production worker (APW) in 2000. Measured in US dollars, using current exchange rates. Source: OECD (2001).

θ = Mincerian returns to schooling parameter. Source: constructed using estimates for 1995 taken from Harmon, Walker and Westergaard-Nielsen (2001) and other authors.

p, p' = probability of employment after leaving school, conditional on participation in the labor force, and derivative of p with respect to school attainment. Source: estimated using individual data from ECHP.

p_S = probability of employment while attending school, conditional on participation in the labor force. We estimate it as $p_S = \eta p$, where η is defined below.

η = correction factor capturing the greater difficulty of finding part-time employment while attending school. Source: calculated as the ratio between the probability of employment of those enrolled in education and those not enrolled in education among active workers aged 20 to 24, using data for 1998 from *Education at a Glance 2000*.

q, q_S, q' and η_q = probability of labor force participation of adult workers and students, derivative of the first variable with respect to school attainment and adjustment factor for students. Constructed using the same sources and procedure as p, p_S, p' and η .

τ_e and T_e' = average and marginal tax rates on labor income (including national and regional income taxes and employee social security contributions) applicable in 2000 to a single employed worker earning APW wages. Source: OECD Tax database.

τ_S = average tax rate on student earnings from part-time work, estimated as the tax rate on labor income applicable in 2000 to a single worker earning 20% of the APW salary. Source: estimated using OECD (2001).

τ_u and T_u' = average and marginal tax rates on unemployment and housing benefits applicable to a single worker earning APW wages prior to the loss of employment. Source: estimated using OECD (2000).

Table 4: Variables used in the calculation of the returns to schooling --continued

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τ_p and T_p' = average and marginal tax rates on pensioners, estimated as the personal tax rates (excluding employee social security contributions) applicable to a single worker earning 67% of APW wages. Source: OECD Tax database

τ_c = Consumption tax rate. Source: Carey and Tchilinguirian (2000).

e_e and E'_e = average and marginal rates of employer social security contributions (expressed as a fraction of gross wages rather than total labor costs) applicable to a single employed worker earning APW wages. Source: OECD Tax database.

e_s = average rate of employer social security contributions for part-time student work. Estimated using the OECD Tax database.

b and B' = average and marginal gross replacement ratio. The average gross replacement ratio is defined as the ratio of gross unemployment and housing benefits to gross income in employment. Source: OECD (2000).

β = net replacement ratio (ratio of unemployment benefits to net after-tax earnings while employed). This is calculated for countries where benefits are linked to after-tax earnings in employment (and are not taxed). Source: OECD (2000).

$S'(X_0)$ = expected increase in schooling (measured in completed grades) per additional year spent in school. Estimated using OECD data on school survival probabilities as discussed in Appendix 3.

S_0 = average years of school attainment of the adult (over 25) population in 1990. Source: de la Fuente and Doménech (2001).

X_0 = years required to complete average attainment. See section 4 of Appendix 1.

U = Average retirement age in 1995. Source: Blöndal and Scarpetta (1999).

$H = U - Max(6+X_0, 14)$ = estimated length of the (post-school) working life of the representative individual.

Z = Life expectancy at birth in 2000, calculated as a weighted average of male and female life expectancies with weights given by each sex's share in total employment. Source: Eurostat.

3.1. Mincerian returns

A key input in our calculation is the Mincerian returns to schooling parameter (θ), measuring the percentage increase in gross wages resulting from an additional year of schooling. Seeking a balance between the reliability of individual estimates and cross-country comparability, we have constructed a set of estimates for this parameter using the results of microeconometric wage regressions reported in several studies.[17]

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[17] One alternative we have explored is to estimate the Mincerian parameter using data from the European Community Household Panel Survey (ECHP). However, this source has some serious disadvantages relative to the national data sets used in the studies cited above that in our view more than outweight the potential advantages of using a common data source. In particular, the breakdown of the population by

The first of these sources is the introduction to a collective volume summarizing the results of a large research project on the returns to education in Europe, known as PURE *(Public funding and private returns to education)* that was recently sponsored by the European Commission. In this paper Harmon, Walker and Westergaard-Nielsen (HWW, 2001) use relatively homogeneous data on hourly wages provided by the project's national teams to estimate the Mincerian returns parameter (θ) using a common econometric specification. For each country, they estimate separate wage equations for men and women controlling for potential experience (i.e. time since the completion of education) and the square of this variable. For the eight countries in our EU sample for which HWW provide estimates based on data on gross wages, our estimate of θ is obtained by averaging their male and female estimates, weighting them by the share of each sex in total employment (using data from the 2000 Labor Force Survey provided by Eurostat).

The remaining countries are Belgium, for which HWW provide no results, and a set of five countries (Austria, Greece, Italy, the Netherlands and Spain) for which the data used by HWW refer to net rather than gross wages. For Spain, Belgium and Italy, our estimates of θ are taken, respectively, from de la Fuente, Doménech and Jimeno (2003), de la Croix and Vandenberghe (2003) and Ciccone (2004)). The first two of these studies use data on gross wages and a specification that is identical to the one in HWW except in that a single equation is estimated for men and women jointly, including a sex dummy variable to allow for differences in wage levels. Using the same specification, Ciccone (2004) works with data on net wages but then adjusts his results to approximate gross returns using previous estimates of gross and net returns in Italy to construct a correction factor.

For the remaining countries, we have constructed estimates of the gross (before-tax) return to schooling as follows. In the case of the Netherlands, we have found in the chapter for this country of the PURE volume (Smits et al, 2001) an estimate of male and female returns to schooling based on gross wages in 1996 that is obtained with a specification almost identical to the one used by HWW (p. 183, Table 10.3).[18] Since similar estimates could not be found in the country chapters for Austria and Greece, we have adjusted HWW's results using the theoretical relationship between net and gross returns.[19]

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educational attainment is generally much coarser than in national sources, sample sizes are considerably smaller in many cases, and hourly wages cannot be recovered for all countries.

[18] The only difference is that, unlike HWW, Smits et al. (2001) include a dummy for part-time workers in the female equation, but its estimated coefficient is zero.

[19] The procedure is as follows. In the notation of section 2, the gross return to schooling is given by $\theta = f'(S)/f(S)$ and the net return by $\theta_n = F_e'(S)/F_e(S)$, where $F_e(S) = f(S) - T[f(S)]$. Working with this last expression, it is easy to show that

$$\theta_n = \frac{F_e'(S_o)}{F_e(S_o)} = \frac{(1-T_e')f'(S_e)}{(1-\tau_e)f(S_e)} = \frac{(1-T_e')}{(1-\tau_e)}\theta$$

We have used this formula to estimate the gross return to schooling given HWW's estimate of the net return.

All these estimates of θ were obtained by OLS (or WLS) and are therefore potentially subject to conflicting biases arising from measurement error and from omitted variable bias. The consensus view in the literature seems to be that the net effect is likely to be a small upward bias. On the basis of a review of the results of twin studies, Card (1999) argues that the net bias in OLS estimates of the returns to schooling is likely to be around 10%. We have used this figure to correct the estimates discussed above. The values of θ for the "*No government*" and "*All-in*" scenarios shown in Table 5 already incorporate this correction.

Table 5. Mincerian returns

	Before taxes	*After taxes*
Ireland	0.071	0.047
UK	0.069	0.034
Finland	0.054	0.046
Spain	0.045	0.031
Germany	0.058	0.037
Greece	0.049	0.025
Italy	0.038	0.033
France	0.048	0.032
Belgium	0.041	0.024
Portugal	0.060	0.017
Austria	0.054	0.032
Netherlands	0.043	0.018
Denmark	0.034	0.021
Sweden	0.016	0.010
avge. EU14	*0.048*	*0.029*

Notes: The values of θ shown in the table are the original estimates multiplied by an adjustment coefficient (0.9) that attempts to correct for the likely net endogeneity bias.

3.2. Employment and participation effects

We estimate the effect of schooling on labor force participation rates and employment probabilities by a two-stage procedure. First, we estimate a probit regression that relates the probability that a given individual will be active *(q)* to his or her level of education, measured by years of schooling, and a series of personal characteristics and other variables. Then, we estimate a second probit regression relating the probability of employment *(p)* to schooling and to a subset of the same explanatory variables, including as an additional regressor a variable that measures the propensity of the individual to participate in the labor market.[20] The covariates included in these regressions are listed in Table 6.

[20] In order to avoid identification problems, the explanatory variables used in the second equation should be a subset of the set of regressors of the first-stage equation (see Wooldridge, 2002). In our case, we assume that marital status and the number of children under twelve years of age affect the participation decision but not the probability of employment conditional on participation.

Table 6: Non-schooling variables used in the participation and employment equations

	participation	*employment*
sex (male)	X	X
potential experience	X	X
potential experience squared	X	X
married (*)	X	
married*male	X	
children below twelve	X	
children below twelve* male	X	

(*) In addition to those that declare this status, we count as married those persons that are living in a "consensual union" with another person (question PD007).

The data are taken from the 1996 wave of the European Community Household Panel survey (ECHP), except in the case of Sweden, where the data correspond to 1997. The years of schooling variable used in the participation and employment probits is constructed by combining information from two different questions in the ECHP survey with the theoretical durations of the different school cycles reported in de la Fuente and Doménech (2002, Table 4). The first question classifies respondents into three educational levels (low, medium and high, with high corresponding to tertiary studies and medium to upper secondary). The second question gives the age at which the individual left the highest schooling cycle she completed. This last question can in principle be used to construct a direct estimate of years of schooling, but the percentage of responses is low in four countries. An additional problem is that an estimate of years of schooling based on this question will be biased upward if the agent had to repeat a course or temporarily interrupted his studies at some point. Hence, we base our attainment estimates on the response to the first question. On the other hand, we use the second question to try to refine the initial breakdown into three educational levels by distinguishing between primary and lower secondary education on the one hand, and between the first and second cycles of university on the other. For instance, a person who classifies herself as having a low education will be assumed to have completed lower secondary schooling except if the number of years of schooling implied by the answer to the second question is lower than the theoretical cumulative duration of this cycle, in which case we assume the individual has only completed primary schooling. [21]

[21] We have been unable to use the ECHP data to estimate the employment and participation probabilities of students. The survey includes two questions that may in principle be used to identify students, but neither of them suits our purposes. The first one asks whether the individual is or has been enrolled in formal schooling during the current or preceding year, and the second one asks the person to identify his or her main activity, giving "student" as an option. The problem with the first question is that, because it mixes currently enrolled students with those who have recently completed their training, its use as a control variable will underestimate the effects of school enrollment on the variables of interest. For the second question, the problem is the opposite one, as it is likely that many employed students will fail to report education as their main occupation. In some countries, for instance, the intersection between self-reported students and the labor force or the employed population is empty. To get around this problem, we have used aggregate data from the 2003 edition of *Education at a Glance* to calculate rough correction factors for the employment and participation probabilities of students (η_π and η_θ). This source reports the employment and participation rates of the 20 to 24 age group in 2001, distinguishing between those enrolled in educational institutions and those who have already completed their formal schooling. A

The detailed results of the estimation are in Tables 7a and 7b. The probabilities of employment *(p)* and of labor force participation *(q)* of adult workers are estimated as the prediction of the relevant equation for the average values of the regressors. Our preliminary estimates of p' and q' are the estimated marginal effects of the schooling variable, calculated at the sample means of all the regressors. Since these estimates potentially suffer from the same biases as the Mincerian coefficients discussed above, our final estimates of p' and q' are obtained by multiplying the preliminary estimates by 0.9 and 0.8 respectively.[22]

Table 7a: Marginal effects in the employment probit regression and employment probabilities

	S	*potexp*	*potexp*^{2} *(x 100)*	*male*	*no. of observ.*	*predicted prob. (p)*	
Austria	0.004	0.001	0.000	0.032	5,883	0.9566	0.34%
	(2.74)	(0.52)	(0.01)	(3.82)			
Belgium	0.017	0.004	-0.004	0.044	4,201	0.9282	1.50%
	(7.51)	(1.48)	(0.65)	(3.52)			
Denmark	0.005	0.000	0.001	0.015	4,001	0.9486	0.48%
	(3.54)	(0.02)	(0.27)	(2.05)			
Finland	0.017	0.006	-0.006	0.020	7,201	0.8816	1.56%
	(9.32)	(2.43)	(1.19)	(2.26)			
France	0.018	0.008	-0.008	0.040	9,184	0.9267	1.58%
	(10.99)	(4.55)	(2.03)	(4.91)			
Germany	0.007	-0.001	0.003	0.017	10,314	0.9413	0.60%
	(5.10)	(0.82)	(0.89)	(2.87)			
Greece	0.013	0.018	-0.023	0.116	8,801	0.8859	1.20%
	(8.62)	(9.99)	(5.96)	(8.32)			
Ireland	0.024	0.002	0.002	-0.020	5,746	0.9174	2.14%
	(10.70)	(1.46)	(0.52)	(1.36)			
Italy	0.021	0.023	-0.028	0.090	14,125	0.8581	1.88%
	(15.62)	(12.88)	(7.22)	(9.08)			
Netherlands	0.006	-0.001	0.003	0.021	7,472	0.9614	0.53%
	(4.39)	(0.69)	(1.38)	(4.42)			
Portugal	0.004	0.005	-0.006	0.027	8,903	0.9579	0.38%
	(4.51)	(4.21)	(2.58)	(4.20)			
Spain	0.025	0.015	-0.016	0.106	12,438	0.8005	2.21%
	(14.74)	(7.64)	(3.71)	(8.39)			
Sweden	0.016	0.010	-0.015	0.005	7,625	0.8989	1.40%
	(9.66)	(8.20)	(5.88)	(0.75)			
UK	0.008	0.001	0.001	-0.0234	5528	0.9462	0.70%
	(5.69)	(1.49)	(0.29)	(3.61)			

- *Explanatory variables: S* = years of schooling: *potexp* = potential experience; *male* = dummy variable, it is equal to 1 for males and to 0 for females.
-*Note: t* statistics in parentheses below each coefficient. *Predicted prob.* is the model's prediction for the probability of employment at the mean values of all regressors. *Notes:* The values p' and q' shown in the table are the original OLS estimates multiplied by an adjustment coefficient (0.9 in the first case and 0.8 in the second one) that attempts to correct for the likely endogeneity bias.

preliminary estimate of the correction factors is obtained by dividing the first of these figures by the second one. To obtain the values of η_π and η_θ we assign a value of one to countries where the preliminary estimate exceeds that value (that is, we assume that, other things equal, it is never easier to find part-time employment as a student than a full-time job). See Appendix 2 for details.

[22] This correction is entirely ad-hoc since we lack an outside estimate of the size of the relevant net bias, but it seems plausible that the bias on p' will be of the same order of magnitude as that in wage equations, and that the bias on q' may be larger as agents who know early on that it is unlikely that they will be seeking a job in the future for reasons that we cannot control for will choose to leave school early.

Table 7b: Marginal effects in the participation probit regression

	S	*potexp*	*potexp2 (x 100)*	*male*	*married*	*married*male*	*children*	*children*male*	*q'*
Austria	0.014	0.032	-0.090	0.047	0.003	0.105	-0.129	0.220	1.13%
	(5.76)	(16.12)	(20.63)	(2.29)	(0.19)	(3.99)	(6.44)	(8.14)	
Belgium	0.028	0.038	-0.099	0.063	0.009	0.178	-0.047	0.078	2.21%
	(11.58)	(16.12)	(18.66)	(2.55)	(0.47)	(5.69)	(2.20)	(2.22)	
Denmark	0.011	0.022	-0.056	0.017	0.020	0.093	-0.063	0.063	0.86%
	(5.00)	(11.92)	(14.27)	(0.81)	(1.19)	(4.17)	(3.62)	(2.44)	
Finland	0.016	0.044	-0.095	0.036	0.086	-0.012	-0.088	0.124	1.28%
	(7.82)	(29.52)	(29.88)	(2.31)	(5.34)	(0.48)	(5.16)	(6.12)	
France	0.027	0.044	-0.107	0.027	-0.059	0.189	-0.111	0.176	2.18%
	(13.44)	(29.66)	(33.63)	(1.56)	(4.00)	(9.59)	(7.61)	(8.21)	
Germany	0.016	0.027	-0.078	0.016	-0.027	0.097	-0.205	0.160	1.29%
	(8.69)	(19.57)	(25.68)	(1.01)	(2.07)	(5.47)	(15.00)	(10.22)	
Greece	0.015	0.035	-0.083	0.012	-0.125	0.380	-0.105	0.201	1.16%
	(8.10)	(20.40)	(24.37)	(0.65)	(6.66)	(17.86)	(5.66)	(6.25)	
Ireland	0.037	0.026	-0.068	0.169	-0.082	0.280	-0.165	0.143	2.94%
	(12.87)	(11.69)	(15.24)	(8.53)	(3.61)	(10.39)	(8.17)	(4.22)	
Italy	0.022	0.051	-0.115	0.047	-0.163	0.314	-0.096	0.180	1.77%
	(16.13)	(32.94)	(37.27)	(3.54)	(10.46)	(19.25)	(6.60)	(7.30)	
Netherl.	0.019	0.030	-0.089	0.001	-0.019	0.188	-0.235	0.181	1.53%
	(7.14)	(16.28)	(22.84)	(0.25)	(0.90)	(8.87)	(14.94)	(8.99)	
Portugal	0.014	0.034	-0.073	0.087	0.010	0.201	-0.037	0.103	1.12%
	(6.47)	(21.06)	(23.96)	(5.68)	(0.63)	(10.25)	(2.25)	(3.81)	
Spain	0.026	0.052	-0.115	0.048	-0.190	0.370	-0.102	0.164	2.05%
	(15.07)	(32.29)	(35.51)	(3.32)	(11.65)	(20.41)	(6.74)	(6.22)	
Sweden	0.010	0.024	-0.0488	0.027	0.056	-0.003	-0.024	0.052	0.77%
	(6.53)	(23.90)	(22.51)	(3.11)	(6.07)	(0.22)	(2.21)	(3.72)	
UK	0.007	0.017	-0.053	0.033	0.047	0.115	-0.249	0.104	0.54%
	(2.68)	(9.44)	(14.65)	(1.28)	(3.39)	(5.28)	(14.24)	(4.80)	

- *Explanatory variables: S* = years of schooling: *potexp* = potential experience; *male* = dummy variable, it is equal to 1 for males and to 0 for females; married = dummy variable, equal to 1 for married individuals or those living in consensual unions with other persons; *children* = dummy variable for individuals with children under the age of twelve.

-*Note: t* statistics in parentheses below each coefficient.

3.3. Tax rates and unemployment benefits

To calculate taxes rats and unemployment benefits, we assume that i) the representative individual is single and has no children (so as to abstract from cross-country differences in family support policies), and ii) any unemployment spells are relatively short-lived and do not exhaust contributive benefits. We will not try to construct realistic estimates of the pension benefits that would accrue to our representative individual in each country. Instead, we will make uniform and rather generous assumptions about pension determination in order to obtain an upper bound on the effects of retirement systems on private and fiscal returns. Table 8 reports the values of the tax and benefits parameter and below we describe in more detail how they were computed.

Table 8: Tax and benefits data used in the calculations

	τ_u	T'_u	τ_p	T'_p	e_e	E'_e	e_s	τ_c
Austria			3.50%	18.90%	23.50%	23.50%	23.50%	20.0%
Belgium	0.00%		21.10%	41.00%	32.70%	34.70%	31.70%	18.7%
Denmark	33.84%		27.80%	41.70%	0.50%	0.00%	0.70%	25.7%
Finland	20.89%	34.63%	20.60%	35.20%	26.00%	26.00%	26.00%	22.7%
France	11.15%	40.56%	8.90%	32.60%	41.20%	41.20%	29.10%	18.0%
Germany			15.00%	31.50%	20.50%	20.50%	20.50%	15.8%
Greece	4.22%	15.90%	0.00%	0.00%	28.00%	28.00%	28.00%	18.6%
Ireland	0.00%		11.10%	22.00%	12.00%	12.00%	8.50%	22.8%
Italy	0.67%	19.00%	14.80%	24.00%	34.10%	34.10%	34.10%	16.0%
Netherlands	27.55%	37.05%	4.90%	8.60%	16.20%	12.30%	15.90%	18.7%
Portugal	0.00%	0.00%	2.90%	14.00%	23.75%	23.75%	23.75%	20.5%
Spain	10.68%		6.00%	20.10%	30.60%	30.60%	30.60%	13.7%
Sweden	31.97%		23.60%	31.30%	32.90%	32.90%	32.90%	18.7%
UK	0.00%		12.60%	22.00%	9.30%	12.20%	7.80%	16.9%
average EU14			*12.34%*	*24.49%*	*23.66%*	*23.70%*	*22.36%*	*19.06%*

Table 8: Tax and benefits data used in the calculations—continued

	β	B'	b	S'	τ_s	τ_e	T_e'
Austria	60%			91.14%	18.20%	0.279	0.429
Belgium		0.0%	37.47%	91.59%	13.07%	0.419	0.555
Denmark		0.0%	52.89%	96.70%	20.04%	0.441	0.507
Finland		58.9%	54.41%	96.07%	23.20%	0.336	0.480
France		57.4%	57.40%	93.23%	18.01%	0.268	0.335
Germany	60%			95.77%	20.50%	0.420	0.579
Greece		40.0%	40.00%	***94.18%***	15.90%	0.181	0.285
Ireland		0.0%	23.59%	93.47%	0.00%	0.203	0.525
Italy		30.0%	30.00%	93.57%	9.19%	0.285	0.404
Netherlands		70.0%	73.05%	96.26%	10.52%	0.362	0.531
Portugal		65.0%	65.00%	87.10%	11.00%	0.177	0.260
Spain		0.0%	68.19%	92.89%	6.35%	0.185	0.288
Sweden		0.0%	68.35%	87.83%	24.21%	0.329	0.352
UK		0.0%	35.03%	***93.28%***	0.00%	0.236	0.320
average EU14				*93.08%*	*13.73%*	*0.294*	*0.418*

- *Note:* blank entries indicate that a parameter is not defined or not relevant for the calculations.

Data on marginal and average tax rates are directly taken from the OECD Tax Database and come originally from *Taxing Wages* (OECD, 2001). They refer to the year 2000 and are those applicable to a single person with no children and APW gross earnings. All the personal tax rates used to calculate private returns incorporate (local and national) income taxes and, when appropriate, employee (but not employer) social security contributions, so as to be consistent with the definition of gross wages that seems to have been used in the wage equation estimates we are using. For the calculation of fiscal returns, employer social insurance contributions and consumption taxes are taken into account as well.

The average and marginal tax rates on adult employed workers and pensioners (τ_e, T_e', τ_p and T_p') and employer social security contribution rates for full-time workers (e_e and E_e') are also taken directly from the OECD's on-line Tax Database (and originally from *Taxing Wages*). The tax rates on employed adult workers are those applicable to an individual earning the same salary as the average production worker (APW), i.e. with average earnings for full-time workers in the manufacturing sector, while those for pensioners correspond to 67% of APW wages[23] and do not include social security contributions, from which we assume pensioners are exempt. Employer social contribution rates on part-time student earnings *(e_S)* have been approximated, for lack of better information, by those applicable to workers earning 67% of APW wages. For most countries this is actually correct, as contributions are levied at a flat rate on gross wages, but in a handful of them this is not the case.

The average tax rate on student income *(τ_S)* has been constructed using the description of the 2000 tax systems of European countries given in *Taxing Wages 2000-2001*. This rate has been calculated under the assumption that the gross income of an employed student is 20% of before-tax APW earnings. The consumption tax rate *(τ_C)* is taken from Carey and Tchilinguirian (2000). These authors construct τ_C as the ratio between consumption tax revenue (including excise and general consumption taxes) and total final consumption measured in gross terms (i.e. including indirect taxes) using data for the period 1991-97 taken from the OECD's *National Acccounts* and *Revenue Statistics*.

All benefit parameters (B', b and β) and the average and marginal tax rates on unemployed workers (τ_u and T_u') have been calculated using the information contained in the country chapters of the OECD's *Benefit Systems and Work Incentives 1999* (OECD, 2000) assuming again that we are dealing with a single individual with no children whose wage prior to the loss of employment was equal to APW earnings.[24] We have used this source rather than OECD (2001) because it contains a more detailed description of the tax treatment of unemployment benefits. Replacement rates have been constructed taking into account benefit ceilings (the marginal rate, B', is set to zero when the ceiling is binding for our reference individual) and incorporate housing benefits for the unemployed but treating them as lump-sum payments. While this is incorrect in many cases, the description of these benefits provided by OECD (2000) is too sketchy to allow a more careful treatment, and the resulting error is unlikely to be important because housing benefits are generally a small fraction of income out of employment. The one exception to this is the UK, but the amount of the benefit appears to be fixed in this case.

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[23] Notice that this is not exactly in accordance with our assumption about replacement rates. We have assumed that initial pensions are set at 67% of wages at the time of retirement, which will be higher than those of the average worker. Hence the tax rates we use will be initially too low, but the situation may be gradually reversed over time if pensions grow less than average wages, as seems to be the case in most countries.

[24] While the tax parameters for employed workers and students correspond to 2000, the tax and benefit parameters for unemployed workers will reflect the regulations in force one year earlier. This is unlikely to be an important problem, as legislative changes between the two years appear to be infrequent and minor.

3.4. Academic failure rates, school durations and length of working lives

The number of successfully completed grades, S, and the number of years spent in formal schooling, X, can differ because students may take several years to complete a single grade or may drop out of the system without passing a grade. To construct the function $S(X)$ that relates these two variables, we would need comparable data on repetition and drop out rates for the countries in the sample. Since we have not been able to find such information, we have constructed a rough approximation to $S(X)$ using OECD data on survival rates in tertiary studies and on other indicators that can be used to approximate the school survival rate at the upper secondary level. In particular, we approximate the marginal contribution of time in school to academic progress, $S'(X_0)$, by an estimate of the yearly probability of survival in school (σ). This probability is estimated separately for upper secondary (σ_{usec}) and tertiary studies (σ_{univ}) using the procedure discussed in Appendix 3. The results are then averaged across levels in the usual way, so that the single value of $S'(X_0)$ that is used in the rate of return calculations is given by $S'(X_0) = (2*\sigma_{usec}+\sigma_{univ})/3$.

The estimates of σ are also used to correct upward the theoretical duration of these two school cycles so as to approximate the actual time spent in school by the average individual in each country. The corrected duration of each cycle will be given by $D_i = d_i/\sigma_i$, where d_i is its theoretical duration in years and $1/\sigma_i$ the average time required to complete each grade. The time spent in school by an individual of average attainment, X_0, is then computed in the usual way but using the corrected rather than the theoretical durations of the upper secondary and tertiary school cycles (ignoring therefore any potential delays carried over from compulsory schooling). The calculation makes use of the breakdown of the adult population by attainment level given in de la Fuente and Doménech (2001) and refers to 1990.[25]

The expected length of the working life of the representative individual (H_0) is calculated as the difference between the estimated average age of retirement and the age at which average attainment has been completed (provided this last figure is at least fourteen years). Retirement ages refer to 1995 and are calculated by averaging the estimates for males and females reported by Blöndal and Scarpetta (1999), weighting them by the share of each sex in total employment (using Eurostat data for 2000 referring to the age group 25-64). Average life expectancy (Z) is calculated in a similar way using separate estimates for males and females taken from Economic Policy Committee (2001) and ultimately from Eurostat. Table 9 lists these parameter values.

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[25] See Appendix 2 for further details.

Table 9. Academic failure rates, school durations and length of working lives

	S'	X_0	U	H	Z
Austria	91.14%	11.52	57.68	40.17	77.71
Belgium	91.59%	10.24	56.12	39.89	77.87
Denmark	96.70%	11.81	61.17	43.36	77.24
Finland	96.07%	11.05	58.95	41.90	77.32
France	93.23%	10.61	58.79	42.18	78.40
Germany	95.77%	13.06	59.59	40.53	77.35
Greece	***94.18%***	7.98	61.55	47.55	77.82
Ireland	93.47%	9.51	62.07	46.56	76.18
Italy	93.57%	8.11	59.36	45.25	77.87
Netherlands	96.26%	11.02	57.33	40.31	77.76
Portugal	87.10%	6.50	62.32	48.32	75.29
Spain	92.89%	7.17	60.50	46.50	77.50
Sweden	87.83%	10.92	62.72	45.80	79.56
UK	***93.28%***	10.66	61.36	44.70	77.34
average EU14	*93.08%*	*10.01*	*59.97*	*43.79*	*77.52*

- *Note:* blank entries indicate that a parameter is not defined or not relevant for the calculations.

3.5. Direct costs of schooling

Our estimates of the direct costs of schooling (μ, μ_s and μ_g) are based on data on expenditure on secondary and higher education taken from recent issues of the OECD's *Education at a Glance*. These variables try to approximate the (total, private and public) cost per student of a marginal increase in enrollments, which would have to come at the upper secondary and university levels since attendance at lower levels is already compulsory in the EU. Public expenditure (μ_g) includes the operating costs of public educational institutions (net of research expenditure by universities), subsidies to private centers and two types of subsidies to households: tuition-related grants and cash subsidies that help defray living expenses and other costs. The private (household) expenditure indicator (μ_s) captures the net costs paid by families and is shown net of government transfers (which makes them negative in quite a few European countries). Hence, we do not take into account expenditure on books, school materials, lodging or transportation. Total expenditure *(μ)* is calculated as the sum of public and private expenditure (plus expenditure by enterprises on apprenticeship programs in the case of Germany)[26] and is shown net of non-tuition grants, which we consider a transfer of income to the private sector rather than a real resource cost of education. We also calculate total expenditure inclusive of non-tuition grants. This variable will be denoted by μ_g' because we will use it in our calculation of fiscal returns as an estimate of the budgetary cost per student of an increase in attainment financed entirely by the government, holding constant the observed level of non-tuition subsidies.

[26]Educational expenditure by enterprises only appears to be significant in Germany, where the bulk of non-public spending on secondary education corresponds to contributions by business firms to apprenticeship programmes.

All our indicators of the direct costs of schooling are weighted averages of expenditure per student at the secondary and tertiary levels and are measured as a fraction of the gross earnings of the average production worker *(W_0)*. We use weights of 2/3 and 1/3 for secondary and tertiary schooling respectively to try to capture the impact of a marginal change in upper secondary attainment under the assumption that half of the new graduates will go on to university. The resulting values are in Table 10 and further details are given in Appendix 4.

Table 10: Parameter values determining the Direct Costs of Schooling

	μ	μ_S	μ_g	μ_g'	W_0
Austria	***35.33%***	-1.40%	36.73%	***37.70%***	21,364
Belgium	21.46%	0.32%	21.14%	22.99%	26,721
Denmark	21.38%	-4.44%	25.82%	26.21%	34,975
Finland	22.91%	-1.84%	24.74%	25.13%	29,587
France	32.76%	1.94%	30.82%	33.42%	19,171
Germany	21.29%	0.00%	18.26%	22.49%	29,423
Greece	21.56%	***0.98%***	20.58%	21.92%	9,734
Ireland	27.20%	0.73%	26.48%	30.07%	20,392
Italy	***25.28%***	0.74%	24.54%	***26.15%***	18,951
Netherlands	21.40%	-1.34%	22.74%	23.68%	26,062
Portugal	**39.51%**	***-0.33%***	**39.84%**	**40.14%**	**7,041**
Spain	25.64%	4.05%	21.59%	26.12%	13,816
Sweden	29.84%	-5.80%	35.64%	37.61%	25,118
UK	20.34%	0.94%	19.40%	22.31%	27,864
average EU14	*26.14%*	*-0.39%*	*26.31%*	*28.28%*	*22,159*

3.6. Other parameters

Table 11 lists definitions and data sources for the rest of the parameters. We set the growth rate of average wages in the economy *(g)* to 1%. This is the observed average annual growth rate of real compensation per employee in the EU15 between 1981 and 2000. The experience component of the growth rate of individual wages over the lifecycle *(ν)* has been set at 1.38% per annum. This figure has been obtained as the constant growth rate that better approximates the quadratic experience-earnings profile estimated for a typical EU country.[27] We also assume that student earnings from part-time work are 20% of the wages of an adult worker of average attainment and experience, and that pensions are initially set at 67% of gross wages at the time of retirement and are indexed either to prices ($\omega = 0$) or to wages ($\omega = g$). Finally, we assign

[27] We estimate ν by fitting a linear trend to the wage-experience profile predicted by a set of Mincerian regressions. Since HWW do not report the coefficients of potential experience and its square we proceed as follows. First, we estimate a Mincerian wage regression with 1996 ECHP data for those countries for which hourly wages can be recovered. We use the estimated coefficients of potential experience and its square to construct the time profile of the experience premium (in log terms) and regress it on a linear trend for each country. The slope coefficient of this regression provides a preliminary estimate of ν for each country. We calculate the ratio of this quantity to the estimate of θ from the same regression (which is different from the one used in our calculations), and average these ratios across countries, obtaining a value of 0.1927. We then multiply this value by the average value of θ in our sample (after correcting it for the likely net bias). This gives a value of 1.38%, which is our final estimate for ν.

what we consider conservative values to the average and marginal propensities to consume of different types of workers (c_i and C'_i with $i = e, u, s, p$ for employed and unemployed adult workers, students and pensioners, respectively).

Table 11: Other parameter values used in the calculation of the private and fiscal returns to schooling

g = 1%, growth rate of average real wages. Source: AMECO Database, European Commission, DG for Economic and Financial Affairs.

ν = 1.38%, percentage increase in real wages with each year of experience. See footnote no. 12.

$1-\phi$ = 0.2, part-time student earnings as a fraction of APW wages.

κ = 0.67, gross pension replacement rate (= initial pension before tax/gross wage at retirement).

ω = 0 or g, rate at which a worker's pension grows over time in real terms.

$c_e = C'_e$ = 0.8, average and marginal propensities to consume out of after-tax income for employed adult workers.

c_s = 1, average propensity to consume of employed students.

$c_u = C'_u = c_p = C'_p$ = 0.9, average and marginal propensities to consume of unemployed adult workers and pensioners.

4. Results for some EU countries

Table 12 reports net private and fiscal returns to schooling, breaking them down in several components related to subsidies to education and tax and benefit policies. This estimation is performed in relation to the average worker in each country. Unless otherwise noted, the rates of return for the average EU country are obtained by entering the average values of the relevant parameters into the rate of return formula, and not by averaging the rates of return across countries.[28]

4.1. The private rate of return to schooling

The raw private rate of return, computed under the assumption of no government intervention and displayed in column [1], ranges between 3.21% and 10.98%, with a value of 7,56% for the hypothetical average EU country. The all-in rate of return, r_{obs}, which includes the effects of taxes, benefits and subsidies to education and displayed in column [4], lies between 7.5% and 10%, with a value of 8.78% for a hypothetical average EU country. In both cases, Sweden is a clear outlier in the low side. The rates of return estimated for this country (4.28% and 3.21%) is almost three points lower than that of the Netherlands, which is the second country at the bottom of the distribution. The low returns in Sweden are due to an atypically

[28] In particular, we use the average values of T', Δ and τ, which are computed in a slightly different manner in Austria and Germany but enter the final formula in the same way.

low Mincerian return to schooling parameter that reflects the country's compressed wage structure. At the other side, the estimated value of r_{obs} exceeds 10% in the UK, Ireland and Portugal, while the raw return exceeds 10% only in Ireland. Adding pensions (see column [5]), under our admittedly simplifying assumptions (κ = 0.67 and $\omega = g$), will add between 0.07 and 0.70 percentage points to the all-in rate of return, 0.23 percentage points for the average EU country.[29]

Figures 1a and 1b plot our estimates of raw and all-in returns against the Mincerian returns parameter (θ) that is often interpreted as a direct estimate of the returns to schooling. The correlation between θ and both $r_{nogov't}$, on the one hand, and between θ and r_{obs} is high (0.87 and 0.90, respectively), but for many countries there are significant differences that reflect, among other factors, the size of employment effects and the impact of taxes, subsidies and other public policies on all-in returns. In Denmark, for instance, the all-in return to schooling exceeds the value of θ by 56%.

To better illustrating the determinants of the net private returns, Figure 2 shows the relative contribution of the wage-related benefits of education, its opportunity cost, employment-related effect, and direct costs on our two measures of returns to schooling. Almost 20% of the raw benefits of schooling in the average EU country come from its impact on employment rates, and over one third of its costs are direct resource costs. When considering government intervention, however, the picture changes significantly: the share of employment effects on the total benefits of schooling drops by almost one half, indicating that this component of returns is taxed more heavily than the wage component, and direct (private) costs become negative as a result of government subsidies in excess of household expenditure on schooling.[30] Subsidies are particularly generous in the Scandinavian countries, while net private costs are highest in Spain, mainly as a result of the existence of a large private sector at the secondary level which is only partially subsidized by the state. Employment effects account for over 30% of the raw benefits of schooling in Spain, Italy and Sweden and for less than 5% in Germany, Portugal, Austria and the UK.

[29] In most cases, these estimates overestimate the contribution of retirement benefits to private returns because pension determination and actualization rules are generally less generous than we have assumed. This will be particularly so in countries such as Ireland and the UK where pensions are paid at fixed rates or have an important fixed rate component. Hence, the contribution of pension benefits to the private return to schooling is not significant and can be safely ignored in what follows.

[30] This may be somewhat misleading as our cost estimates do not take into account the purchase of books and other classroom materials or other school-related expenses such as transport. Psychic costs, that Heckman et al. (2005) estimate to be rather large, are another component of direct costs of education that we do not consider here.

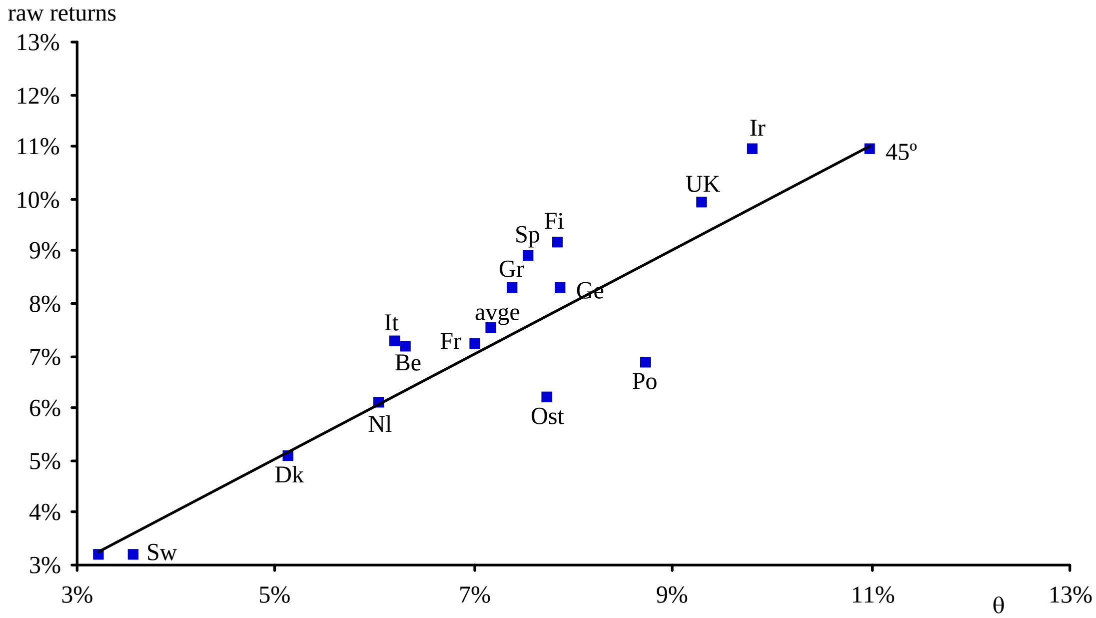
Table 12: Private and fiscal rates of return to schooling

	Private return under different scenarios				
	NO GOV'T	*+subsidies*	*+ taxes*	*OBS + benefits*	*Pensions (w=g)*
	[1]	*[2]*	*[3]*	*[4]*	*[5]*
Austria	6.22%	10.35%	8.96%	8.52%	8.90%
Belgium	7.20%	9.91%	9.88%	7.47%	7.93%
Denmark	5.08%	7.87%	9.16%	7.99%	8.27%
Finland	9.19%	13.31%	12.15%	9.98%	10.17%
France	7.25%	11.00%	10.59%	8.63%	8.85%
Germany	8.32%	11.32%	9.97%	9.13%	9.47%
Greece	8.28%	11.16%	10.22%	9.18%	9.34%
Ireland	10.98%	15.82%	12.40%	11.03%	11.13%
Italy	7.31%	10.46%	10.08%	8.44%	8.65%
Netherlands	6.11%	8.73%	7.98%	6.95%	7.65%
Portugal	6.87%	11.44%	10.82%	10.30%	10.38%
Spain	8.91%	12.24%	11.59%	7.50%	7.77%
Sweden	3.21%	6.48%	7.18%	4.28%	4.76%
UK	9.94%	13.07%	13.16%	12.25%	12.32%
avge. EU14	*7.56%*	*11.05%*	*10.43%*	*8.78%*	*9.01%*

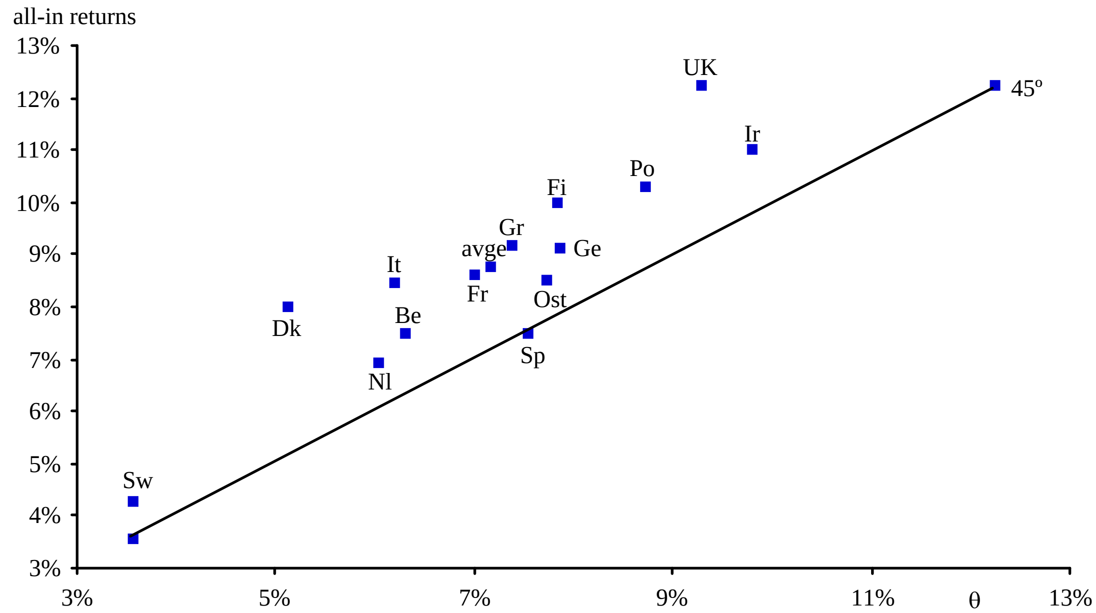
	Fiscal return arising from different sources				
	personal taxes	*+ consumption . taxes*	*+ employer s. sec. contr.*	*+ pensions 1 ($\omega = g$)*	*+ pensions 2 ($\omega = 0$)*
	[6]	*[7]*	*[8]*	*[9]*	*[10]*
Austria	0.68%	1.17%	2.11%		
Belgium	3.03%	3.15%	3.91%	3.10%	3.20%
Denmark	0.82%	1.19%	1.18%	-1.01%	-0.53%
Finland	3.77%	4.10%	4.92%	4.37%	4.42%
France	1.52%	2.11%	3.66%	2.69%	2.81%
Germany	3.97%	4.13%	4.70%	3.93%	4.01%
Greece	1.79%	2.54%	3.70%	2.22%	2.44%
Ireland	5.34%	5.67%	6.17%	5.82%	5.85%
Italy	1.81%	2.21%	3.39%	-2.31%	2.47%
Netherlands	2.25%	2.52%	2.82%		
Portugal	0.09%	1.18%	2.42%	1.04%	1.20%
Spain	2.98%	3.37%	4.74%	3.92%	4.01%
Sweden	-1.42%	-1.25%	-0.52%	-2.58%	-2.11%
UK	3.19%	3.80%	4.53%	3.43%	3.55%
avge. EU14	*2.35%*	*2.74%*	*3.58%*	*2.48%*	*2.62%*

Figure 1: Rate of return to schooling vs. Mincerian returns parameter

a. Raw return

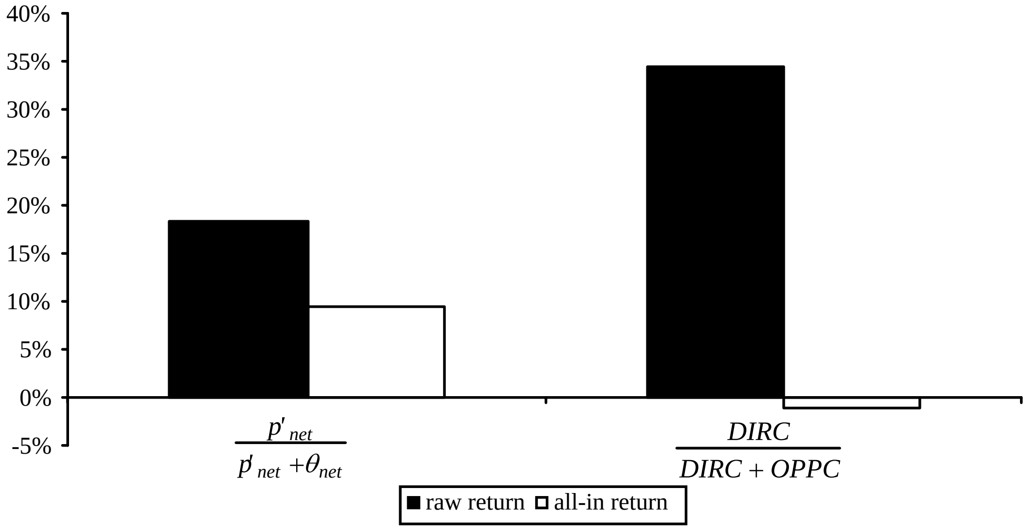


b. All-in return



Legend: UK = United Kingdom; *Ir* = Ireland; *Po* = Portugal; *Fi* = Finland; *Gr* = Greece; *Ge* = Germany; *avge.* = average; *It* = Italy; *Ost* = Austria; *Dk* = Denmark; *Sp* = Spain; *Be* = Belgium; *Nl* = Netherlands; *Sw* = Sweden.

Figure 2: Relative weight of different cost and benefit components of the return to schooling in the average EU country



The comparison between columns [1] and [4] of Table 12 also shows that, taken together, public policies (excluding pensions) imply a net *subsidy* to human capital at a rate of 16.15% in the average European country. Hence, educational subsidies more than offset the disincentive effects generated by personal taxes and unemployment benefits. The average subsidy rate *(subs)* stands at a very respectable 46% when we consider only the effects of public educational finance, but both personal taxes and social benefits reduce the net return to schooling and partially offset direct subsidies to education. The effective tax rates induced by these factors in the average EU country are 8.2% and 21.9% respectively. Somewhat surprisingly, unemployment protection seems to be a significantly more important source of distortions than taxes per se.

There are, nevertheless, very important differences across countries in terms of both the total effective tax burden on human capital and the sources of this burden. Spain is the only country where the overall effective tax rate on schooling is significantly positive. It is followed by Ireland and Belgium, where the net subsidy is below 4%. At the other end of the scale, the effective subsidy rate on schooling exceeds 30% in Sweden, Austria, Portugal and Denmark. Figure 3 helps to understand the sources of differences in effective tax rates across countries. In the case of Ireland, the main disincentive has to do with the very high progressivity of personal taxes at APW income levels (π_e). In Spain and Belgium employment effects account for a large share of the total returns to schooling and are subject to high taxes (i.e. to large replacement ratios). In addition, benefit ceilings are binding in both countries at APW income levels making the marginal tax rate on the wage benefits of schooling equal to 100% for the unemployed. This, in turn, raises average progressivity ($\pi - \pi_e$ is positive and large) and therefore the tax rate on the wage component of the returns to schooling.[31] Educational subsidies are very large in four countries, Sweden, Portugal, Austria and Denmark (although this result is somewhat suspect in the case of Portugal for reasons already discussed). In addition, the disincentive effects of personal taxes are low in all the countries, but Ireland and Austria. In both Denmark and Sweden, the tax system actually raises the return to schooling. This surprising result arises from a combination of factors that includes low tax progressivity ratios at average income levels and the interaction between a negative private cost ($\mu_S < 0$) and a high average tax rate on adult workers. In Portugal and Austria, finally, the tax rate implied by unemployment benefits is very low because the probability of employment is rather insensitive to school attainment and the contribution of the tax-benefit schedule facing the unemployed to overall progressivity is either zero or negative.

Despite the distortions, the estimated returns suggest that schooling is a rather attractive investment from an individual point of view.[32] Table 13 compares the private *after-tax* return to education (under the all-in scenario, *OBS*) to the *before-tax* real return on debt and equity. The real returns on bonds and stocks are averages for the period 1950-1989 and are taken from Dimson, Marsh and Staunton (2002).[33] Since these authors provide no data for Austria, Greece, Finland and Portugal, we have imputed to these countries the average returns in the remainder

[31] The unemployment benefits component of the tax rate (etr_{ben}) is dominated by two factors: the weight of employment effects on the total benefits of schooling ($\varepsilon'/(\varepsilon'+\theta')$), and the contribution of social benefits to overall progressivity ($\pi - \pi_\varepsilon$). The tax component (etr_{tax}) is mainly determined by the degree of pure tax progressivity (π_ε) and the subsidy rate (*subs*) reflects government's contribution to the direct costs of schooling. The overall subsidy rate and the overall degree of progressivity are the main determinants of the total effective tax rate, $etr_{gov't}$.

[32] In order to draw unequivocal conclusions about the relative attractiveness of education as an investment, we would need to control for the riskiness of its returns. While the variation of earnings across workers with similar attainment levels is very high, much of this variation is not the result of random luck but of differences in individual abilities and career choices. We are not aware of any refined measures of earnings risk that can be used to make valid comparisons with other assets.

For an attempt in this line, see Palacios-Huerta (2003). This author, however, considers only the time-series component of wage risk for highly aggregated sex-race-experience groups. With these data, Sharpe ratios (which measure the expected return per unit of risk) clearly favour educational investment over shares in the US. Surprisingly, however, formal tests for mean-variance spanning suggest that the risk-adjusted returns of schooling dominate those of equities only for university education, but not for secondary schooling. Christiansen et al (2004) construct what are probably better measures of wage risk using the average residuals in Mincer equations for specific types of education. They find that the risk-return trade-off involved varies a lot with the type of studies but do not compare their results with the returns on financial assets.

On a somewhat different note, Padula and Pistaferri (2001) provide some evidence that introducing risk considerations may actually increase the attractiveness of investment in schooling. They find, in particular, that increases in attainment tend to lower wage risk and, as a result, increase the (risk-adjusted) rate of return on schooling.

Finally, Heckman et al. (2005) show that under uncertainty and sequential resolution of information the rate of return to schooling includes an option value of a sizeable amount.

[33] The same source provides average returns for the period 1950-2000. This last year, however, is probably not a good reference point, for it marks the peak of a long bull market associated with a "technological bubble." At the time the first version of this paper was written, many Western stock market indices had lost around 50% of their value relative to their 2000 peaks. The average return on the equal weights portfolio we use as a reference was one percentage point higher over 1950-2000 than over 1950-89 (5.02% rather than 4.03%). This is a significant difference, but it does not qualitatively change our conclusions.

of the sample. As usual, the corresponding entries are shown in bold type in Table 13. Column [5] of this table shows what we will call the (private) *premium on human capital*. This variable is defined as the difference between the all-in rate of return on schooling (column [1] of the same table) and the average return on a portfolio where bonds and shares have the same weight (column [4]).

For the average country, the real return to schooling exceeds the return on bonds by 7.66 points and that on equity by 1.85 points. When allowance is made for taxes on capital income (a complicated matter we will not address here), the premium on schooling will increase significantly. The return differential with bonds is positive in all countries and is always above 4.9 points (which is the value corresponding to France). The before-tax return to equity, however, is above the rate of return on schooling in three countries, and significantly so in Sweden due to a combination of outstanding stock market performance and the lowest returns to education in the sample. The premium on human capital, as defined above, is positive in all countries, and ranges from 0.33% in Sweden to 8.25% in the UK with a mean value of 4.75%.[34]

Table 13: *After-tax* rate of return on schooling vs. *before-tax* real return on financial assets, and premium on human capital

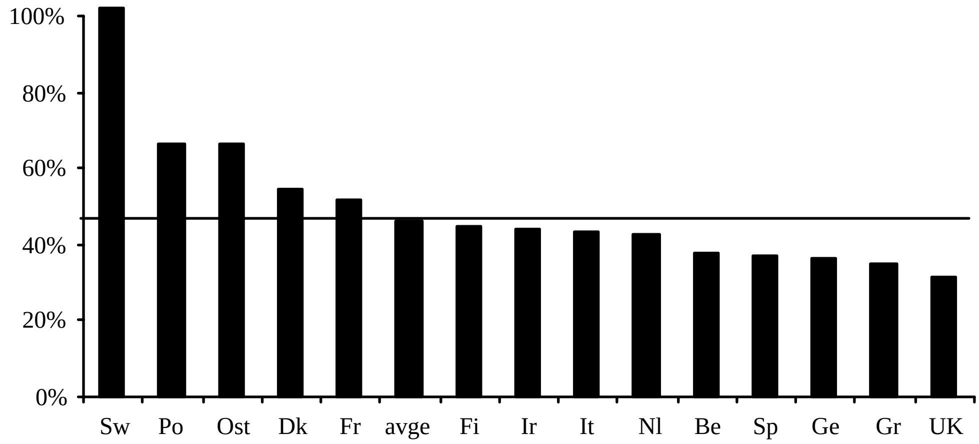
	[1]	*[2]*	*[3]*	*[4]*	*[5]*
	schooling r_{obs}	*Equity*	*bonds*	*avge. portfolio*	*premium on h. capital*
Austria	8.52%	**6.93%**	**1.12%**	**4.03%**	**4.49%**
Belgium	7.47%	6.50%	1.90%	4.20%	3.27%
Denmark	7.99%	6.20%	2.60%	4.40%	3.59%
Finland	9.98%	**6.93%**	**1.12%**	**4.03%**	**5.95%**
France	8.63%	7.70%	3.70%	5.70%	2.93%
Germany	9.13%	9.50%	3.40%	6.45%	2.68%
Greece	9.18%	**6.93%**	**1.12%**	**4.03%**	**5.15%**
Ireland	11.03%	6.90%	0.30%	3.60%	7.43%
Italy	8.44%	4.90%	0.20%	2.55%	5.89%
Netherlands	6.95%	7.50%	-0.30%	3.60%	3.35%
Portugal	10.30%	**6.93%**	**1.12%**	**4.03%**	**6.27%**
Spain	7.50%	4.50%	-0.90%	1.80%	5.70%
Sweden	4.28%	8.70%	-0.80%	3.95%	0.33%
UK	12.25%	8.30%	-0.30%	4.00%	8.25%
avge. EU14	*8.78%*	*6.93%*	*1.12%*	*4.03%*	*4.75%*

- *Note:* No data are available on the returns to bonds and shares in Austria, Finland, Greece and Portugal. We impute to these countries the average return in the rest of the sample.

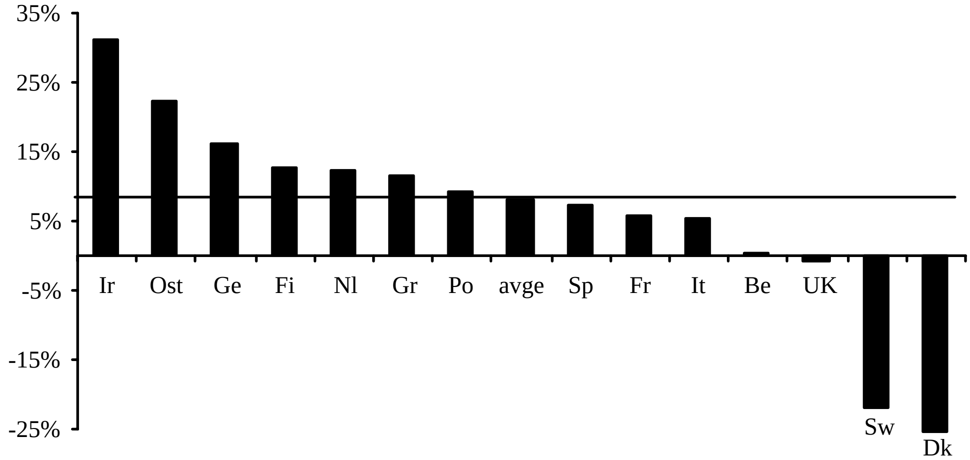
[34] The absence of data on financial returns makes our estimates of the private premium on schooling rather uncertain for four countries (Austria, Greece, Finland and Portugal). Notice, however, that the human capital premium in these countries would remain over 1.9 percentage points if we assigned to them the highest rate of return on financial assets observed in the sample.

Figure 3: Components of the effective tax rate on human capital

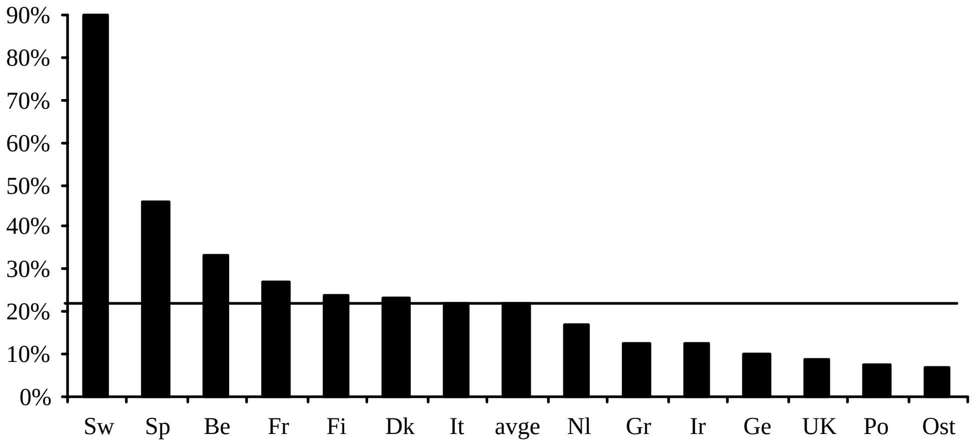
a. Educational subsidies (*subs*)



b. Taxes (etr_{tax})



c. Unemployment benefits (etr_{ben})



Legend: UK = United Kingdom; *Ir* = Ireland; *Po* = Portugal; *Fi* = Finland; *Gr* = Greece; *Ge* = Germany; *avge.* = average; *It* = Italy; *Ost* = Austria; *Dk* = Denmark; *Sp* = Spain; *Be* = Belgium; *Nl* = Netherlands; *Sw* = Sweden.

4.2. The fiscal return to schooling

For the computation of the fiscal return to schooling, data are the same as for the private return to schooling, with some deviations from our previous assumptions.

First, we assume that the increase in the direct costs of schooling, including non-tuition grants at the existing level, is born entirely by the government (that is, we will use μ_g' as our measure of government expenditure). Secondly, we take into account the effects of schooling on labor force participation rates. Hence, our calculations in this section will apply to a representative individual who may or may not be active with probabilities based on observed labor force participation rates, rather than to an individual who remains active throughout his student and adult life, as was the case in the computation of private returns. Thirdly, we try to approximate the general equilibrium effects of schooling on wages and employment probabilities. As has already been noted, the estimates of the wage (θ) and employment benefits (p' and q') of schooling typically reported are partial equilibrium estimates that capture expected return to a single individual of staying one more year in school holding constant the aggregate attainment level and factor prices. It should be expected, however, that the realized marginal returns to schooling will be smaller when the government undertakes policies that raise average attainment at the aggregate level. As discussed in de la Fuente (2003), the required correction to the wage benefits of schooling can be approximated by multiplying the estimated value of θ by one minus the share of capital in national income, which is around 1/3 in industrial countries. This adjustment, which holds the aggregate stock of capital constant and implicitly assumes that there is no capital mobility, can be regarded as rather conservative, especially for small countries. For the case of the employment and participation parameters we will introduce an ad-hoc correction that consists in reducing the original estimates of p' by two thirds and that of q' by one half. The correction factor for q' is smaller because the decision to join the labor force does not involve an element of competition with other workers for available jobs.[35]

The lower panel of Table 12 reports the results. Calculations are carried out under five alternative sets of assumptions: in column [6] we consider only personal taxes (including employee social security contributions) and unemployment benefits, in [7] we add consumption taxes, in [8] employer social security contributions and in [9] and [10] retirement benefits. Fiscal returns are between 2.5% and 3.5% for the average EU country, depending upon

35 A number of things should be noted about these estimates. The first is that the introduction of pension benefits does raise some problems for their calculation, for pensions represent a large negative cash flow at the "end of the project" and, as is well known, this can give rise to multiple solutions or to the absence of them in the calculation of internal rates of return. For two of the countries in the sample, indeed, the fiscal rate of return equation has no solution. In all other cases, the rate of return equation has two solutions, at least one of which is negative. In these cases we report the larger of the two solutions. When it is positive, this figure is not misleading as the net present value of schooling will be positive for any interest rate between zero and the reported rate of return and negative thereafter, so this is indeed the highest positive interest rate at which the government can borrow to finance educational expenditure without increasing the present value of its current and future deficits.

consideration of pensions. Not surprisingly, the cross-country variation of the fiscal return to schooling is similar to that of the private return to schooling: the coefficient of correlation between columns [4] and [8] in Table 12 is 68.0%. According to these results, countries in our sample can be classified into three groups. In the first one, comprised only by Sweden, the fiscal return is negative, indicating that the net cost of schooling exceeds its direct costs because the present value of induced current and future net tax revenues is negative, even without taking into account pension liabilities. This is possible, even though increased attainment does indeed raise incomes and therefore tax revenues in the future, because it does not do so by enough to compensate for the loss of the taxes that young people would pay in the current year, were they to join the labor market immediately. In the second group, the present value of induced tax and benefit flows is positive, but smaller than the direct costs of education, yielding low fiscal returns. Austria, Denmark, France, Greece, Italy, the Netherlands and Portugal fall in this group. Finally, in the third group, induced tax flows more than compensate for the direct costs of schooling, making the net present fiscal value of a year of schooling positive. This is the case in Belgium, Finland, Germany, Ireland, Spain and the UK.

Given our estimation of educational costs, we compute that in the average EU country, the net cost of an extra year of schooling is, under the least favorable set of assumptions, roughly 900 dollars. This figure is considerably smaller than the actual resource costs of education (which exceed $6,200), what suggests that the net tax revenues generated by an increase in attainment allow the government to recoup the bulk of its educational outlays. Table 14 makes the same point by providing for each country and scenario the *recovery rate* on educational expenditure, defined as the percentage of the direct cost of education (including transfers to households) that is recovered through increases in taxes and savings on social insurance payments. As seen in the Table, recovery rates on educational expenditure exceed 50% in all EU countries but four (Sweden, Denmark, Austria and the Netherlands), and lie above 100% in six of them. This suggests that an increase in public educational expenditure required to marginally raising current attainment levels would largely pay for itself over the long run through higher tax revenues and lower social insurance payments in the average EU country.

Table 14: Recovery rates on educational expenditure

	[1]	[2]	[3]	[4]	[5]
	personal taxes	*+ consump. taxes*	*+ employer s. sec. contr.*	*+ pensions 1 (w = g)*	*+ pensions 2 (w = 0)*
Austria	47.90%	52.55%	70.30%	34.35%	37.50%
Belgium	101.27%	106.01%	153.61%	103.90%	108.58%
Denmark	26.96%	31.61%	31.06%	11.52%	12.93%
Finland	125.04%	142.02%	197.66%	151.15%	154.93%
France	63.35%	74.24%	129.95%	90.56%	93.96%
Germany	138.96%	149.14%	192.51%	134.58%	139.15%
Greece	68.62%	84.67%	134.05%	80.75%	84.64%
Ireland	177.74%	205.72%	244.99%	198.31%	201.31%
Italy	67.01%	74.83%	118.50%	79.83%	82.99%
Netherlands	75.15%	82.35%	92.06%	32.68%	37.98%
Portugal	37.75%	51.18%	79.21%	55.68%	57.08%
Spain	99.44%	110.00%	170.87%	122.99%	126.63%
Sweden	4.77%	-2.99%	-18.55%	-26.69%	-26.07%
UK	106.43%	131.75%	170.36%	110.93%	115.21%
avge. EU14	*81.16%*	*91.37%*	*125.71%*	*85.65%*	*88.78%*

- *Note:* A real discount rate of 3% is used in the calculations. The fraction of direct expenditure recovered is calculated as *(NPFV+DCOST)/DCOST.*

5. Limitations and further refinements

Equations (3) and (6) provide a comprehensive account of all the factors affecting, respectively, the private rate of return to schooling and the rate of return to public investment in education. As shown in Section 4, they allow for the decomposition of the private and fiscal returns to schooling in several components depending upon the impact of some public policies (taxes, subsidies, social benefits). Nevertheless, taking into account all these factors in an operative way, that is, in a framework ready to be implemented with available data for several countries, we needed to impose some simplifying assumptions. Thus, we have achieved the operability needed to perform estimation of rates of return to schooling in a sample of 14 countries taking four types of shortcuts. Relaxing some of these assumptions is feasible within our framework, but only with more detailed data on the wage effects of schooling and on the distribution of social transfers across several population groups than those readily available for international comparisons.

First, we have referred our calculations to the "average worker", having defined the private return of schooling as the one that makes the net product of an additional year of schooling equal to zero for an individual at the *average educational level,* and the fiscal return to schooling as the one that makes the net marginal product of tax revenues accruing to the government equal to zero from increasing the *average educational level*. Thus, we have not considered that wage and employment effects of schooling, on the one hand, and the fiscal and benefit parameters, on the other, could noticeably change with some personal characteristics (like gender) and along the earnings distribution.[36] Indeed, the very extensive literature estimating

[36] Though, we have computed some of the parameters as weighted average of those of males and females using employment weights.

the effects of schooling on wages and employment rates, suggest that two key parameters in our calculation of the private and fiscal returns of schooling, the Mincerian coefficients in wage equations an the impact of schooling on employment rates, are different across gender and educational groups. It also suggests that the impact of years of schooling is non-linear, as there are significant "sheepskin effects", that is, the return of an additional year of schooling is larger when this additional year implies the completion of a grade. This differential effects across gender, years of schooling and educational levels are likely to be very much country-specific, as the relative labor market performance of several population groups and the curricula vary across countries. As for the impact of experience on wages, we have obtained private and fiscal returns to schooling under the assumption that it is constant across educational groups. Admittedly, wages increase with experience at a different rate depending on the years of schooling.[37] Although it would be rather informative to compute different returns of schooling for several groups, controlling for a differential impact of experience, this would have to be done at the cost of limiting the application to countries where microeconomic data on wages, employment status, and social transfer are readily available.

Secondly, we have used point estimates of the wage and employment effects of schooling, without consideration of the corresponding standard errors. Moreover, we have made use of some *ad hoc* adjustment factors to take into account endogeneity bias in the estimation of the wage and employment effects of schooling and general equilibrium effects. It is straightforward to provide alternative estimates of schooling just by using instead some confidence intervals around the estimated parameters. While this undoubtedly changes the level of the returns to schooling does not noticeably alter results from the comparison across countries and from the decomposition of the sources of the returns to schooling shown in Section 4.

Thirdly, we have imposed some assumptions about functional forms to keep tractability. For instance, we have assumed that tax rates depend only on the agent's status and do not change over time as his income rises with the efficiency of labor and experience. The first part of this assumption --that tax rates do not change over time as average incomes rise with technical progress and factor accumulation-- may not be a bad approximation in the medium or long run. While tax brackets are not explicitly indexed to average wages in any country in our sample, periodic reforms may work in this direction. Otherwise, fiscal drag would gradually raise income tax receipts as a fraction of GDP and this does not seem to have been the case in EU countries over the last two decades. The second half of the assumption --that tax rates remain constant over an individual's life cycle-- is harder to defend.

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[37] See Heckman et al. (2005) for a study of the returns to schooling in the US distinguishing different population groups and controlling for sheepskin effects, non-linearity of the impact of schooling on earnings and non-separability between schooling and experience in the earnings function. They notice that, for the US, wages rose with experience at similar rates for all educational groups during the 1960s and the 1970s, but not in more recent decades.

Finally, our definition of the private and fiscal returns of schooling focuses on earnings effects, and excludes others, such as the consumption-value of education and health effects in the case of the private return, and externalities and other social effects of education (such as, decreasing crime rates) in the case of fiscal returns. To measure the consumption-value of education will require to postulating some cardinal utility function. As for the health effects of education, there is a non-resolved debate about whether the observed correlation between health status and life expectancy, on the one hand, and educational levels, on the other, is the result of a causal effect of the latter. Less controversial is the existence of positive externalities in the accumulation of human capital and crime effects, which could give a boost to the fiscal return. However, cross-country empirical evidence on the externalities from education and on their reducing effects of crime is lacking. Obviously, by not considering these likely positive social effects of education, our measure of the fiscal return of schooling provides a lower bound of the *true social* rate of return to education.

6. Concluding remarks

In this paper we have constructed estimates of the private and fiscal returns to schooling in 14 European countries and analyzed the impact of various public policies on the first of these variables. The estimated private returns to a one-year increase in schooling, starting from currently observed average attainment levels, cluster between 7.5% and 10% in most member states of the EU. Sweden is a clear outlier at the bottom of the distribution, possibly as a result of severe wage compression, while the highest returns correspond to the UK and Ireland, followed by Portugal and Finland. In practically all European countries, the returns to schooling compare quite favorably with those available from standard financial assets. Taking as a reference a balanced portfolio of corporate shares and government bonds, the premium on education ranges from 0.3% in Sweden to 8.2% in the UK with a mean value of 4.7%.

Various public policies have a significant impact on the private return to schooling. On average, direct subsidies to education raise returns by 45% while personal taxes and unemployment benefits reduce them by 8% and 22% respectively. In most countries, the combined effect of all these policies is a net subsidy to education. This subsidy exceeds 30% in Denmark, Portugal, Austria and Sweden, and has an average value of 16% in the entire sample.

According to our calculations, public expenditure on post-compulsory education is at least partly self-financing over the long run in most EU countries. Leaving aside Sweden and Denmark, where educational subsidies are particularly generous, recovery ratios on public educational expenditure range between 37.5% in Austria and 201% in Ireland, with a mean value of 88.8%. This leaves the net budget cost in present value terms of an additional year of schooling in the average EU country at 700 US dollars, working under conservative assumptions that include full government funding of all educational costs and a rather generous provision for induced pension liabilities.

Our results indicate that in most countries the tax system generates only modest disincentives to invest in further education at observed average attainment levels. On the other hand, distortions arising from unemployment insurance can be very important in countries where unemployment rates are high and a significant fraction of the benefits of schooling come through an increase in the probability of employment. From the point of view of minimizing such distortions, it would be preferable to uncap unemployment benefits while reducing average replacement rates. Efficiency gains, however, must be balanced against the equity considerations that rightly influence the design of the social protection system.

Policy implications regarding educational finance should be drawn with some care, particularly in the absence of reliable estimates of social returns that may be used to gauge the potential misalignment between private incentives and social needs. We see our finding that government expenditure in education largely pays for itself over time in most countries as a good reason for governments not to subordinate educational policies to short-term budget concerns. In our view, however, the balance of our findings does not necessarily imply that additional educational subsidies are called for. For most countries, the premium on human capital relative to financial assets is large enough to suggest that the incentives to enroll in post-compulsory courses are already quite adequate. This is true in part because existing subsidy levels are quite high.

Appendix 1: Progressivity of the tax system and the private return to schooling

As commented in Section 2.2, the progressivity of the tax and benefit system is a crucial factor determining the private return to schooling. In fact, it is also possible to show an alternative decomposition of the effects of the tax and benefit systems on schooling, relating it to their progressivity. Taking R'_{obs} to be the right-hand side of the rate of return formula given in equation (3) after excluding the pension term in the numerator, equation (3) can be rewritten as follows,

$$R_{obs}' = \frac{(1-\pi)\theta' + (1-\rho)\varepsilon'}{\left[1-\eta(1-\phi)\frac{1-\tau_s}{1-\tau}e^{\nu H_o/2}\right] + \frac{\mu_s}{p(1-\tau)}e^{\nu H_o/2}} = \frac{(1-\pi)\theta' + (1-\rho)\varepsilon'}{OPPC' + DIRC'}$$

The parameters $\theta' \equiv \theta S'(X_o) - \nu$ and $\varepsilon' \equiv \frac{p'(S_o)}{p(S_o)} S'(X_o)$ measure the marginal contribution of schooling to expected income working respectively through the wage and the employment channels. The parameters $\pi \equiv 1 - \frac{1-T'}{1-\tau} = \frac{T'-\tau}{1-\tau}$ and $\rho \equiv \frac{(1-\tau_u)b}{p(1-\tau)}$, are, respectively, an index of the progressivity of the tax system and the net replacement rate measured as a fraction of the expected net earnings of an active adult worker (rather than as a fraction of income in employment as this variable is commonly defined).[38] Defining a new measure of the overall tax rate, t, as[39]

$$t \equiv \frac{R'_{no\,gov't} - R'_{obs}}{R'_{no\,gov't}} = 1 - \frac{R'_{obs}}{R'_{no\,gov't}}$$

it can be shown that

$$1-t = \frac{R'_{obs}}{R'_{no\,gov't}} = \frac{\frac{(1-\pi)\theta' + (1-\rho)\varepsilon'}{(1-s)C}}{\frac{\theta' + \varepsilon'}{C}} = \frac{1}{1-s}\left[(1-\pi)\frac{\theta'}{\theta'+\varepsilon'} + (1-\rho)\frac{\varepsilon'}{\theta'+\varepsilon'}\right]$$

Hence, the overall net-of-tax factor, $1-t$, is the product of an increasing function of the subsidy rate, s, and a weighted average of the net-of-tax factors on the wage and employment components of the return to schooling, with weights that are proportional to the shares of these components in the total return. Notice that the "tax rate" on the wage component of the returns to schooling is our measure of progressivity, π, and that on the employment component is the modified net replacement rate, ρ. The first of these terms, in turn, can be decomposed into two parts that reflect, respectively, the progressivity of the tax and benefit schedules faced by employed and by unemployed workers. Letting π_e and π_u denote the partial progressivity measures for employed and unemployed workers, which are defined by

$$1-\pi_e \equiv \frac{1-T'_e}{1-\tau_e} \quad \text{and} \quad 1-\pi_u \equiv \frac{(1-T'_u)B'}{(1-\tau_u)b},$$

it is easy to show that[40]

$$\pi = \pi_e + (1-p)\rho(\pi_u - \pi_e).$$

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[38] In the case of Germany and Austria, where (non-taxable) benefits are set as a fixed fraction, β, of net income in employment, the net replacement ratio is given by $\rho \equiv \frac{\beta}{p + (1-p)\beta}$

[39] It should be clear that t will not coincide with the effective tax rate defined above ($etr_{gov't}$) but the intuition will carry over since r is an increasing transformation of R'. (In our sample, the correlation between t and $etr_{gov't}$ is 0.983).

[40] See Appendix 2.

Hence, unemployment benefit parameters will affect π as well as ρ and their introduction may raise the overall tax rate, *t*, through an increase in average progressivity, especially if unemployment rates, approximated by *1-p*, are high. This effect will be particularly strong when unemployment compensation is paid at a fixed rate or benefit ceilings are binding, since that makes the marginal tax rate on additional schooling equal to 100% for the unemployed. Table A.1 below reports the values of these progressivity indexes and of effective tax rates on schooling in some EU countries.

Table A.1. Progressivity tax and benefit indexes and effective tax rates on schooling

	$etr_{gov\backslash t}$	$\frac{\varepsilon'}{\theta'+\varepsilon'}$	ρ	π	s	π_e	$\pi-\pi_e$	$\frac{\mu_g}{\mu}$
Spain	15.89%	0.313	0.787	0.264	0.303	0.126	0.137	0.842
Ireland	-0.54%	0.219	0.314	0.419	0.400	0.404	0.015	0.973
Belgium	-3.85%	0.253	0.662	0.270	0.393	0.234	0.036	0.985
Finland	-8.64%	0.217	0.676	0.208	0.371	0.217	-0.009	1.080
Germany	-9.68%	0.091	0.614	0.274	0.371	0.274	0.000	1.000
Greece	-10.80%	0.187	0.498	0.127	0.286	0.127	0.000	0.955
Netherlands	-13.74%	0.107	0.835	0.262	0.402	0.265	-0.003	1.063
Italy	-15.58%	0.317	0.454	0.168	0.368	0.166	0.001	0.971
France	-19.04%	0.237	0.713	0.104	0.376	0.092	0.013	0.941
UK	-23.23%	0.086	0.472	0.133	0.343	0.110	0.023	0.954
Sweden	-33.49%	0.440	0.715	0.104	0.497	0.034	0.070	1.194
Austria	-36.99%	0.054	0.611	0.208	0.439	0.208	0.000	1.040
Portugal	-49.97%	0.052	0.797	0.097	0.458	0.101	-0.003	1.008
Denmark	-57.27%	0.120	0.638	0.147	0.495	0.118	0.029	1.208
mean	*-19.07%*	*0.192*	*0.628*	*0.199*	*0.393*	*0.177*	*0.022*	*1.015*
	$etr_{gov\backslash t}$	$\frac{\varepsilon'}{\theta'+\varepsilon'}$	ρ	π	s	π_e	$\pi-\pi_e$	$\frac{\mu_g}{\mu}$
Spain	34.96%	**162.7**	**125.4**	132.5	**77.1**	71.4	**622.8**	**82.9**
Ireland	18.53%	113.7	**50.1**	**210.9**	101.8	**228.4**	70.3	95.9
Belgium	15.22%	131.4	105.4	136.0	100.0	132.3	165.3	97.0
Finland	10.42%	112.8	107.8	104.5	94.4	122.6	-40.5	106.4
Germany	9.39%	47.3	97.9	137.8	94.4	**155.0**	0.0	98.5
Greece	8.27%	97.2	79.3	63.7	72.8	71.8	-1.3	94.0
Netherlands	5.32%	55.6	**133.0**	131.6	102.3	149.7	-14.3	104.7
Italy	3.49%	**164.8**	**72.4**	84.3	93.7	94.1	5.3	95.6
France	0.03%	123.1	113.5	**52.3**	95.7	51.7	56.8	92.7
UK	-4.16%	45.0	**75.3**	66.6	87.4	62.2	102.7	94.0
Sweden	-14.43%	**228.7**	113.9	**52.3**	**126.4**	**19.4**	**317.0**	**117.6**
Austria	-17.93%	**28.3**	97.3	104.6	111.8	117.6	0.0	102.4
Portugal	-30.90%	**27.3**	**127.0**	**49.0**	**116.5**	57.0	-15.3	99.3
Denmark	-38.21%	62.2	101.7	73.9	**125.8**	66.7	131.4	**119.0**
mean	*0.00%*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
std. dev.	*19.02%*	*57.4*	*22.7*	*44.4*	*15.4*	*52.6*	*171.9*	*9.3*

- *Note:* In the upper part of the table, *mean* is the unweighted average of each column.

A proportional tax system (i.e. a tax system in which $T_e' = T_u' = T_p' = \tau_e = \tau_u = \tau_s$), would have absolutely no effect on the return to schooling whenever there are no direct costs (i.e. when *DIRC* = *0*) because taxes would then reduce both the costs and the benefits of education in the same proportion. However, it will reduce *R*' if *DIRC* > *0*, and increase it otherwise (that is, if students receive a net subsidy) because higher taxes will reduce the benefits of education in a greater proportion that its costs in the first case, and by a smaller one in the second. When we abandon the proportionality assumption, changes in marginal and average tax rates have different effects. An increase in either T_e' , T_u' or T_p' reduces the return to schooling by lowering the net wage gains term, θ_{net}, or the value of retirement benefits, *PENS*. An increase in student taxes, τ_s , also reduces R' by increasing the opportunity cost of schooling, *OPPC*. An increase in τ_u , however, raises the incentive to invest in education because it increases the earnings premium on being employed, p'_{net}, and lowers the opportunity cost of studying. Finally, an increase in the average tax rate on employed workers, τ_e , reduces both p'_{net} and *OPPC*. The net effect will be an increase in the rate of return whenever $R' > S'p'/p$, a condition which holds in all the countries in the sample we will consider below.

An important special case is the one where schooling has no employment benefits or direct costs (that is $p' = \mu_S = 0$), there are no retirement benefits ($\kappa = 0$) and students do not work part-time ($\phi = 1$). In this case, the tax system affects the returns to schooling only through its progressivity at the average wage level: as the tax system becomes more progressive (i.e. as the ratio $(1-T_e')/(1-\tau_e)$ declines), the incentive to invest in education falls. This is a useful benchmark because in practice it is not a bad approximation to the situation in many countries, where the employment-related effects of schooling and its direct costs are relatively unimportant, at least after government intervention.

The effects of the average and marginal gross unemployment replacement ratios are also different. Raising B' increases the return to schooling through θ_{net}, while raising b reduces the return both by lowering p'_{net} and by increasing *OPPC*. Under a flat-rate benefit system (with $B' = b$), an increase in benefits is likely to reduce the return to schooling for realistic parameter values.[41]

[41] The condition for this is $(1-p)(1-T_u')\theta' < (1-\tau_u)\left[p'S' + (1-p)R'\right]$, which again holds for all the countries in the sample.

Appendix 2: Correction for differential student employment probabilities and activity rates

Casual observation suggests that, at least in some countries, finding a part-time or summer job while attending school may be harder than finding a full-time job, and that the propensity of students to enter the labor market tends to be much lower than that of those who have completed their education. Since these factors can have an important effect on the opportunity cost of education and hence on its private return, they should be taken into account in our calculations.

To calculate the required correction factors (η *and* η_q) we have used data on the probability of employment of the 20 to 24 age group in 1998 taken from the 2003 edition of *Education at a Glance*. Columns [1] to [4] of Table A.2 show the probability of employment of this group conditional on participation in the labor force *(p)* and its labor force participation rate *(q)*, distinguishing between those enrolled in educational institutions and those who have already completed their formal schooling. Columns [5] and [6] show preliminary estimates of the correction factors, η and η_q. These variables are constructed by dividing the relevant employment probability or participation rate for those attending school by its counterpart for those out of school. We assign a value of 1 to countries where the preliminary estimate of η shown here exceeds that value --that is, we assume that, other things equal, it is never easier to find part-time employment as a student than a full-time job.

Table A.2: Probability of employment, population 20-24 in and out of school

	in education		*not in education*		*η = ratio in/not in edu.*	
	[1]	*[2]*	*[3]*	*[4]*	*[5]*	*[6]*
	p	*q*	*p*	*q*	η	η_q
Austria	92.45%	19.34%	94.62%	87.05%	0.977	0.222
Belgium	87.50%	16.33%	86.12%	89.07%	1.016	0.183
Denmark	90.91%	69.62%	92.93%	91.93%	0.978	0.757
Finland	82.40%	46.38%	83.86%	82.00%	0.983	0.566
France	95.12%	22.95%	79.57%	89.46%	1.195	0.257
Germany	98.37%	52.42%	89.69%	83.41%	1.097	0.628
Greece	65.79%	10.38%	74.17%	85.35%	0.887	0.122
Ireland	93.22%	20.85%	94.98%	91.63%	0.982	0.228
Italy	64.00%	12.95%	75.21%	77.52%	0.851	0.167
Netherlands	95.35%	62.50%	96.44%	89.94%	0.989	0.695
Portugal	91.55%	19.94%	91.33%	91.30%	1.002	0.218
Spain	74.26%	22.44%	82.39%	89.82%	0.901	0.250
Sweden	85.29%	32.69%	90.43%	91.27%	0.943	0.358
UK	93.41%	54.33%	91.18%	85.39%	1.024	0.636
average EU14	*85.94%*	*34.14%*	*86.79%*	*87.55%*	*0.988*	*0.390*

- *Source:* EAG 2003 (Table C4.1) with data for 2001.

Appendix 3: Approximating academic failure rates

As noted in the text, we distinguish between completed school grades, *S*, and time spent in school, *X* where $S = S(X)$ with $0 < S'(X) < 1$. To calculate the rate of return we need to estimate X_0 and $S'(X_0)$. To do this properly, we would need data on repetition and drop-out rates at different levels of schooling. Since these data are apparently not available, we have constructed a very rough approximation of year-by-year drop out probabilities using the data provided by the OECD (EAG 2002) on upper secondary and university survival rates.

We will assume that whenever a student starts one of these cycles but leaves school without completing it, the last year spent in school is wasted, and that this is the only type of academic failure that takes place. This is clearly incorrect for two reasons that will generate opposing biases in our estimates. First, we are ignoring repeaters, which will lead us to underestimate failure rates and effective completion times and, second, we are not taking into account that students may leave in mid-cycle after successfully completing a grade in order to take up a job or for other reasons. Since the first of these effects can be expected to be greater than the second one, it is likely that we are underestimating failure rates.

Under our assumptions, we can approximate S' by the one-year probability of survival in school, which we will denote by σ. The OECD provides estimates of survival rates in tertiary education that are calculated as the ratio between the number of graduates in a given year and the number of incoming students in the typical year of entrance into the programme.[42] These estimates, which are shown in column [1] of Table A.3, reflect the probabability of survival during the entire duration of the university cycle, that is, the probability that a student who enters university will eventually graduate. Calling the overall survival rate Σ, denoting by *d* the theoretical duration of university, and assuming that the probability of failure is the same for all years in the cycle, we have $\Sigma = \sigma^d$, which can be solved for the one-year survival probability, $\sigma = Exp(\ln \Sigma/d)$. Then, the expected (actual) duration of university can be approximated by $D = d/\sigma$, where $1/\sigma$ is the average time it takes to complete a grade. The original data and the results of the calculations are shown in Table A.7. The missing observation for Greece is filled by setting the value of σ for this country equal to the average value of those corresponding to Portugal and Spain.

Table A.3 : Estimates of university survival rates

	whole cycle	*duration*	*yearly survival*	*years per grade*	*adjusted duration*
	Σ	*d*	σ	$1/\sigma$	D
Austria	0.59	4	0.876	1.141	4.564
Belgium	0.60	4	0.880	1.136	4.545
Denmark	0.69	4	0.911	1.097	4.389
Finland	0.75	5	0.944	1.059	5.296
France	0.59	4	0.876	1.141	4.564
Germany	0.70	4	0.915	1.093	4.373
Greece		4	**0.893**	**1.120**	**4.480**
Ireland	0.85	4	0.960	1.041	4.166
Italy	0.42	5	0.841	1.189	5.947
Netherlands	0.69	5	0.928	1.077	5.385
Portugal	0.49	4	0.837	1.195	4.781
Spain	0.77	5	0.949	1.054	5.268
Sweden	0.48	4	0.832	1.201	4.806
UK	0.83	4	0.954	1.048	4.191
average EU14			*0.900*	*1.114*	*4.768*

- *Sources:* Theoretical durations are from de la Fuente and Doménech (2002, Table 4). Σ is taken from EAG (2002) (Table A2.2, survival rates for all tertiary type A programmes, with data for 2000). The only exceptions are Portugal and Greece. For Portugal, the data are taken from EAG (2000) and refer to 1993.

[42] The primary data are taken from various recent issues of the OECD's *Education at a Glance*, to which we will refer as EAG.

For Greece there is no data, so we set the value of σ for this country equal to the average of Portugal and Spain.

For the case of upper secondary schooling, we proceed in the same way after estimating the overall survival rate (which the OECD does not provide) as the ratio between the gross graduation rate in a given year and the net enrollment ratio in secondary education at age 15 three years earlier. The first of these variables, which is defined as the ratio of upper secondary graduates to the total population of the theoretically relevant age, measures the output of graduates, while the second one approximates the intake of students in early years of this cycle. The data and the results are shown in Table A.4. For the UK there are no data on graduation rates, so we assume that σ has the same value as in Ireland.

Finally, the value of $S'(X_0)$ used in our calculations is the weighted average of the estimated values of σ at the upper secondary and university levels, with weights of 2/3 and 1/3 respectively.

Table A.4: Estimates of upper secondary survival rates

	graduation rate	*enrollment at 15*	*whole cycle*	*duration*	*yearly prob.*	*years per grade*	*adjusted duration*
			Σ	d	σ	$1/\sigma$	D
Austria	0.7	0.94	0.745	4	0.929	1.076	4.306
Belgium	0.79	0.97	0.814	3	0.934	1.071	3.212
Denmark	0.96	0.98	0.980	4	0.995	1.005	4.021
Finland	0.91	1	0.910	3	0.969	1.032	3.096
France	0.85	0.96	0.885	3	0.960	1.041	3.124
Germany	0.92	0.98	0.939	3	0.979	1.021	3.064
Greece	0.83	0.92	0.902	3	0.966	1.035	3.105
Ireland	0.76	0.97	0.784	3	0.922	1.085	3.254
Italy	0.79	0.86	0.919	5	0.983	1.017	5.086
Netherlands	0.95	0.99	0.960	2	0.980	1.021	2.042
Portugal	0.56	0.9	0.622	4	0.888	1.126	4.504
Spain	0.67	0.94	0.713	4	0.919	1.088	4.353
Sweden	0.71	0.97	0.732	3	0.901	1.110	3.329
UK		1		3	**0.922**	**1.085**	**3.254**
average EU14					*0.946*	*1.058*	*3.554*

- *Sources:* Theoretical durations are from de la Fuente and Doménech (2002, Table 4). Gross graduation rates from EAG 2003 (Table A1.1 with data corresponding generally to 2001), and net enrollment rates from EAG 2000 (Table C1.3, with data for 1998).

Notes: for Austria and the Netherlands, the total (unduplicated) graduation rate is missing; we add up graduation rates across programme types, which may introduce some double counting. For Greece we use graduation rates for 1998 taken from EAG 2000 because the 2003 figures give very low graduation rates that seem implausible. For Portugal, we also use EAG 2000, as graduation data are missing in EAG 2003. For the UK there is no data on graduation rates, so we assume that σ has the same value as in Ireland.

Appendix 4: Computing expenditures on education

As noted in the text, the direct cost of schooling variables (μ, μ_s, μ_g and μ_g'). are weighted averages of costs per student at the secondary and tertiary levels measured as a fraction of APW earnings. The primary data are taken from various recent issues of the OECD's *Education at a Glance (*EAG).

a. Secondary education

Table A.5 summarizes the available data on educational expenditure at the secondary level. Column [1] shows total expenditure per student (in public and private educational institutions) in 1997 measured as a percentage of GDP per capita and column [2] shows the share of this expenditure that is publicly financed. Multiplying [1] by [2] we obtain public expenditure per student (column[4]) and private expenditure as a residual (column [3]). The data refer mostly to 1997 and the main source is the 2000 edition of *Education at a Glance* (EAG 2000). Exceptions are highlighted in bold type and discussed in the notes to the table and in the following paragraph.

For most countries, the data on the share of government financing given in column [2] refer to the initial source of funds. For the countries shown in bold type, however, the data come from a different issue of EAG and refer to final expenditure after transfers from the public to the private sector (i.e. describe who pays in the end, and not where the money originally came from). For the UK, however, EAG gives the share of private (final) expenditure which is financed by public transfers. Hence, we subtract these transfers from private spending and add them to public expenditure before computing the government's share in the financing of educational institutions. For Finland, EAG reports that the amount of such transfers is "negligible." For the remaining countries there is no information on subsidies, and we implicitly assume they are zero. Since private final expenditure is extremely low in Portugal the resulting mistake will be insignificant. For Greece, however, the margin of error is considerably larger. To indicate this, we use bold italics for this country in columns [3] and [4]. As in the text, we will use this character type to identify results that are based on incomplete information when this is not expected to be a source of substantial errors, and plain bold type to identify results where the error caused by incomplete data is potentially important for the calculations.

For Germany, EAG (2000) reports a share of public expenditure of only 76%. It also indicates, however, that in this country "nearly all private expenditure is accounted for by contributions from the business sector to the dual system of apprenticeship at the upper secondary level"(p. 62).[43] Since we are interested in the cost of education to households, we will treat enterprise contributions as public expenditure. As no specific figure is given for enterprise contributions, we will assume a share of "public" expenditure (including business contributions) of 97%, which is the value observed in Austria.

[43] We thank L. Wössmann for pointing this out.

Table A.5: Expenditure per student as a percentage of GDP per capita
Secondary level

	total	*%gov't*	*private*	*public*
Austria	36%	97.0%	1.1%	34.9%
*Belgium**	29%	94.0%	1.7%	27.3%
Denmark	28%	98.0%	0.6%	27.4%
Finland	25%	**99.4%**	0.1%	24.9%
France	31%	95.0%	1.6%	29.5%
Germany	28%	**97.0%**	***0.8%***	***27.2%***
Greece	19%	**90.2%**	***1.9%***	***17.1%***
Ireland	19%	97.0%	0.6%	18.4%
Italy	**29%**	100.0%	0.0%	29.0%
Netherlands	23%	96.0%	0.9%	22.1%
Portugal	29%	**99.9%**	0.0%	29.0%
Spain	27%	88.0%	3.2%	23.8%
Sweden	27%	100.0%	0.0%	27.0%
UK	23%	**88.2%**	2.7%	20.3%
avge. EU14	*26.64%*	*95.7%*	*1.09%*	*25.55%*

- *Sources and notes:*

[1] EAG 2000 (Table B4.2 with data for 1997). We use "all secondary" rather than "upper secondary" because these data are available for more countries. The one exception is Italy. The data for this country refer to 1998 and are taken from EAG 2001.

[2] These data are only available for tertiary studies and for all other levels combined, so we use the second category. The main source is EAG 2000 (Table B2.1 with data for 1997). For this year, the data refer to the initial source of funds. For Finland, Greece, Portugal and the UK (shown in bold type), the source is EAG 2002 (Table B4.2 with data for 1999). As noted in the text, these data refer to shares in final expenditure.

(*) The data for Belgium refer to the Flanders region.

b. Higher education

Columns [1] to [4] in Table A.6 replicates Table A.5 for the case of higher education to obtain preliminary estimates of total, private and public expenditure per student as a percentage of GDP per capita. As above, the available data on the government's share refer to final expenditures for the countries shown in bold type in column [2] and to the initial source of funds for the rest. In Finland, the share of private expenditure financed by public transfers is negligible. For the other countries there is no information on this variable but, given the small size of overall private final expenditure, the potential error caused by our implicit assumption that such transfers are zero is small.

The preliminary figures given in Table A.6 have to be adjusted to eliminate the cost of research carried out in universities and to reflect public transfers to students that are intended to help defray living expenses and other non-tuition costs. (Notice that our preliminary public expenditure figures already incorporate tuition grants since the share of government reflects the initial source of funds destined for educational institutions). The data required for these adjustments are given in Columns [5] to [7] of Table A.6. Column [5] shows the share of R&D expenditure in total spending on tertiary-level educational institutions. Column [6] shows public subsidies to households to cover student living costs and non-tuition expenses, measured as a percentage of GDP per capita.

Bold entries in Table A.6 indicate missing observations that have been estimated in various ways. We have imputed to those countries for which the share of R&D is missing the values observed in close neighbours or in countries with similar income levels (see the notes to the table). When data on subsidies are not available, an approximation has been constructed using related information from a different issue of EAG which is shown in column [7]. This column gives an estimate of the amount of public subsidies for living costs and other non-tuition expenses measured as a fraction of government direct expenditure on tertiary educational institutions. The numerator is financial aid to students (scholarships and other grants) net of the amount earmarked for the payment of tution fees when available. The bold entries in column

[6] are obtained by multiplying [7] by direct government expenditure on educational institutions..

Table A.6: Expenditure per student as a percentage of GDP per capita
Tertiary level: i) preliminary estimates and data for adjustments

	total	*%gov't*	*private*	*public*	*sh. R&D*	*subsidies*	*sh. subs.*
Austria	43%	**98.7%**	0.6%	42.4%	**0.381**	6.62%*	
*Belgium**	33%	90.0%	3.3%	29.7%	0.367	**5.62%**	0.189
Denmark	29%	99.0%	0.3%	28.7%	0.272	17.42%	
Finland	35%	**97.4%**	0.9%	34.1%	0.356	7.02%	
France	34%	88.0%	4.1%	29.9%	0.156	1.82%	
Germany	43%	93.0%	3.0%	40.0%	0.381	4.67%	
Greece	29%	**99.9%**	0.0%	29.0%	0.227	**1.02%**	0.035
Ireland	39%	79.0%	8.2%	30.8%	0.164	7.44%	
Italy	**28%**	82.0%	5.0%	23.0%	**0.241**	**2.73%**	0.119
Netherlands	45%	97.0%	1.4%	43.7%	0.393	7.78%	
Portugal	**28%**	98.0%	0.6%	27.4%	**0.227**	1.28%	
Spain	32%	77.0%	7.4%	24.6%	0.241	1.46%	
Sweden	64%	91.0%	5.8%	58.2%	0.480	22.72%	
UK	40%	88.0%	4.8%	35.2%	0.359	6.92%	
avge. EU15	*37.3%*	*91.3%*	*3.23%*	*34.05%*	*0.303*	*6.75%*	

- *Sources and notes:* (*) The data for Belgium refer to the Flanders region.*:*

[1] The source is EAG 2000 (Table B4.2 with data for all tertiary programmes in 1997) except in the cases of Italy and Portugal. The Italian data refer to 1998 and are taken from EAG 2001. The information for Portugal is from EAG 2002 and refers to 1999.

[2] The main source is EAG 2000 (Table B2.1 with data for tertiary education in 1997). For this year, the data refer to the initial source of funds. For Austria, Finland and Greece (shown in bold type), the source is EAG 2002 (Table B4.2 with data for 1999). As in the previous table, these data refer to shares in final expenditure.

[5] EAG 2002 (Table B6.2 with data for tertiary education in 1999). Since no data are available for Austria, Italy and Portugal, we assign to these countries the values observed in Germany, Spain and Greece, respectively.

[6] EAG 2000 (Table B3.2 with data for 1997, except for Germany, where it is for 1996). No data are available for Belgium, Greece and Ireland. The figures given for these countries are estimated as explained in the text using [7].

(*) For Austria, there is no breakdown between subsidies earmarked for the payment of tuition fees and the rest. We assume that all subsidies are for living costs, as the data in Table A.2 suggests that the government pays directly for the bulk of the costs of educational institutions.

(**) The information available in EAG includes the fraction of total transfers (including those for tuition costs) that corresponds to student loans. We assume that only 25% of the amount of the loan is a subsidy and that this subsidy finances tuition and non-tuition costs in the same proportion. To correct the original figure for non-tuition transfers, we reduce it by one fourth of the share of loans in total transfers.

[7] EAG 2002 (Table B5.2 with information for tertiary education in 1999).

Table A.7 shows the adjusted estimates of private, public and total expenditure per student at the tertiay level measured as a percentage of GDP per capita. Adjusted total expenditure is obtained by subtracting R&D spending from the uncorrected total. Adjusted public expenditure is raw public expenditure minus research expenditure (which we attribute exclusively to the government) plus transfers to students for non-tuition costs. Adjusted private expenditure is gross private expenditure minus subsidies for non-tuition costs. Bold italics are used for total and public costs in Austria, Italy and Portugal because, as noted above, there is no data on research expenditure by universities. Finally, the column labeled *adjusted public'* is calculated by adding subsidies to the adjusted total costs. This variable tries to approximate the public cost per student of an increase in enrollments totally financed by the government under the assumption that the current level of non-tuition related transfers is maintained.

Table A.7: Expenditure per student as a percentage of GDP per capita
Tertiary level: iii) adjusted estimates

	adjusted total	*adjusted private*	*adjusted public*	*adjusted public'*
Austria	***26.64%***	-6.06%	***32.70%***	***33.26%***
Belgium	20.90%	-2.32%	23.22%	26.52%
Denmark	21.10%	-17.13%	38.23%	38.52%
Finland	22.54%	-6.11%	28.66%	29.57%
France	28.68%	2.26%	26.42%	30.50%
Germany	26.64%	-1.66%	28.30%	31.31%
Greece	22.41%	-0.99%	23.40%	23.43%
Ireland	32.61%	0.75%	31.86%	40.05%
Italy	***21.25%***	2.31%	***18.94%***	***23.98%***
Netherlands	27.33%	-6.43%	33.76%	35.11%
Portugal	***21.64%***	-0.72%	***22.36%***	***22.92%***
Spain	24.28%	5.90%	18.39%	25.75%
Sweden	33.27%	-16.96%	50.23%	55.99%
UK	25.62%	-2.12%	27.75%	32.55%
avge. EU14	*25.35%*	*-3.52%*	*28.87%*	*32.10%*

- *Note:* the adjusted estimates shown in columns [8] to [10] are calculated as follows:
  adjusted total = total * (1 - sh. R&D), i.e. [8] = [1] * (1 - [5])
  adjusted private = private - subsidies, i.e. [9] = [3] - [6]
  adjusted public = public - (sh.R&D*total) + subsidies, i.e. [10] = [4] - ([1]*[5]) + [6]
  adjusted public' = adjusted total + subsidies, i.e [11] = [8] + [6]

c. Total expenditure

We average expenditure per student across educational levels, using a weight of 2/3 for secondary schooling and of 1/3 for higher education. The results are shown in Table A.8, which gives average expenditure per student as a percentage of GDP per capita. For the rate of return calculations we will want to express total expenditure per student as a fraction of APW gross earnings. To obtain the values of μ, μ_s, μ_g and μ_g' shown in Table 9 in the text, we multiply the figures shown in columns [1]-[4] of Table A.5 by the ratio of GDP per capita to APW gross earnings, which is shown in column [5]. This ratio is calculated using data for 1999 taken from the country chapters of the OECD's *Benefit Systems and Work Incentives 1999* and from the 2002 edition of *Education at a Glance* (Table X2.2).

Entries in bold italics in columns [1] to [4] of Table A.8 are carried over from previous tables. The entry for Portugal in column [4] of Table 9 in the text is shown in bold type because Portuguese APW earnings are atypically low relative to GDP per capita. As a result, Portuguese expenditure per student will appear to be rather high when normalized by APW wages. Since we are not sure that reported Portuguese APW earnings are an adequate indicator of average wages and since their use will have a noticeable effect on the rate of return calculations, the values of the cost variables reported in Table A.5 for Portugal, as well as the APW wage, W_o, will be shown in bold type to indicate that these data may be misleading.

Table A.8: Expenditure per student as a % of GDP per capita
Weighted average of secondary and (adjusted) tertiary levels

	total	*Private*	*public*	*public'*	*GDPpc/APW earnings*
Austria	***32.88%***	-1.30%	***34.18%***	***35.09%***	1.075
Belgium	26.30%	0.39%	25.91%	28.17%	0.816
Denmark	25.70%	-5.34%	31.04%	31.51%	0.832
Finland	24.18%	-1.94%	26.12%	26.52%	0.947
France	30.23%	1.79%	28.44%	30.83%	1.084
Germany	27.55%	0.01%	27.54%	29.10%	0.773
Greece	20.14%	***0.91%***	***19.23%***	20.48%	1.071
Ireland	23.54%	0.63%	22.91%	26.02%	1.156
Italy	***26.42%***	0.77%	***25.65%***	***27.33%***	0.957
Netherlands	24.44%	-1.53%	25.97%	27.04%	0.876
Portugal	***26.55%***	-0.22%	***26.77%***	***26.97%***	**1.488**
Spain	26.09%	4.13%	21.97%	26.58%	0.983
Sweden	29.09%	-5.65%	34.74%	36.66%	1.026
UK	23.87%	1.10%	22.77%	26.18%	0.852
avge. EU14	*26.21%*	*-0.45%*	*26.66%*	*28.46%*	*0.995*

Note: Weighted average of the values shown in Tables A.1 and A.4 with weights of 2/3 and 1/3 respectively. (For *public'* we use column [1] of Table A.1 and column [4] of Table A.4). In the case of Germany, the public expenditure shown in column [3] includes enterprise contributions to vocational training programmes. The contribution of this item to combined or total educational expenditure per student amounts to 3.03% of APW gross earnings.

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