Essays on Economic Growth and Imperfect Markets

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5 EFFICIENT PROGRESSIVE TAXES AND EDUCATION SUBSIDIES

5.1 Introduction

A system of progressive income taxes is not always looked at favourably. An important objection is that the system discourages hard work and efforts to be efficient and innovative. What's more, it is a burden on precisely those who are highly productive and are most likely to successful in these efforts. In smaller countries this objection is compounded by the concern that system of progressive taxes is a disadvantage when competing for mobile factors. Highly productive and successful workers may choose to flee a country so as to evade a relatively high tax burden. Firms may also choose to leave the country since they do not want to compensate workers for this high burden (at a high income levels).

These objections against progressive taxes live among conservatives but are also raised by some left-wing politicians. They share the concern about the distortionary effects. Besides, a system of progressive income taxes is not always an effective instrument to redistribute income. The combination of progressive tax rates and deductions gives sometimes virtually the same result as a flat tax rate. Not surprisingly, some left-wing politicians are looking for an alternative (third) way to achieve equality. They tend to focus less on ex-post redistribution through progressive taxes but instead focus more on ex-ante redistribution through empowerment. To achieve equal opportunities on education and employment for all, some -- long-term unemployed, youth in underprivileged areas -- need extra support. The hope is that education provides them with skills and empowers them to take advantage of new opportunities, so that they can gain a fair share of the cake.

A policy that wants to provide equal opportunities for all, is likely to entail extra support for some groups but must still build on a system of progressive income taxes. In an imperfect labour market wages are not given to employers and employees but are set by one of the parties or are the result of bargaining between the two parties. In such a market a progressive tax system restrains excessive wage demands and in this way reduces the problem of unemployment. This paper emphasize wages-setting by trade unions. The role of trade unions varies widely from country to country and should be -- and perhaps already is -- a reason for lasting differences in national tax systems. Furthermore, the paper will argue that education subsidies should compensate the negative effect that progressive taxes may have on schooling and training. Often, the subsidies allow the tax system to be more progressive.

In the literature the moderating effects of progressive taxes on wage demands have been demonstrated both theoretically and empirically. This literature starts with the view that involuntary unemployment

is an inevitable equilibrium outcome. In this view labour markets perform poorly as a result of asymmetric information or imperfect competition. Typically, the prediction is that a more progressive tax system discourages wage demands, at a given replacement rate, and reduces unemployment. Hoel (1990) studies progression and its effects on wages and employment in the context of efficiency wages and Koskela and Vilmunen (1996) in the context of trade unions. The theoretical, negative effect of a marginal tax rate in excess of the average rate on wages is consistent with the data of a few countries. For example, it has been found for Italy, the Netherlands and the UK (see Sartor, 1987, Graafland and Huizinga, 1996, and Lockwood and Manning, 1993, respectively).

Even though in models of imperfect labour markets a system of progressive income taxes helps to reduce unemployment, increasing tax progression is not necessarily improving welfare. A system of progressive taxes may reduce unemployment, but may also frustrate efforts to raise productivity. For a progressive tax system does not discriminate between, on the one hand, wage increases as a result of market imperfections and, on the other hand, wage increases owing to effort or investment raising labour productivity. For example, if efficiency wages play a centre role, the effect of a progressive tax system is not only to reduces the income difference between employed and unemployed workers and in this way unemployment but also to reduce the effort of the employed workers. Therefore employment in terms of numbers may rise but at the same time employment in terms of efficiency units may not rise or even fall.

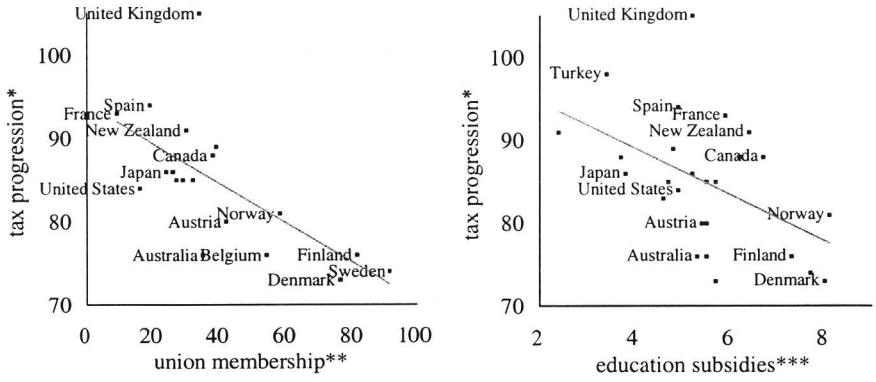
Another negative side-effect of progressive taxes pertains to efforts to acquire skills. A system of progressive taxes distorts the choice between leisure and productive activities, i.e. working or schooling. In theory education subsidies can completely neutralize the negative effect of progressive taxes on education, but in reality they cannot nullify this side-effect. Accepting that the government cannot fully control through subsidies private efforts to acquire better skills, a trade-off appears. On the one hand a system of progressive income taxes boosts employment, but on the other hand it also discourages efforts to acquire skills. This paper studies the determinants of the optimal policy mix. A combination of steep marginal tax rates, relative to the average rates, and generous education subsidies becomes more favourable the larger the power of trade unions to set wages, the better the ability of the government to steer private efforts to educate, and the higher the preference for income equality (between the employed and the unemployed). A government can better reduce tax progression and increase education subsidies when the rate of return on investment in education rises or when the wedge between the private and the social rate of return becomes larger (while keeping the social rate of return constant).

This paper connects three elements: trade unions, progressive taxes and education subsidies. A cursory look at the data suggests that these three elements are indeed closely related. Figure 5.1 documents differences in tax progression within a group of 21 OECD-countries. In both panels the coefficient of residual income progression features. It applies in the case of a single person, earning 167% of the average production wage in 1996. This coefficient measures the elasticity of after-tax income with respect to before-tax income. The tax system is progressive if this elasticity is less than one, and it is regressive if this elasticity is higher than one. The panel on the left-hand plots the coefficient of residual income progression against union density in 1994. It shows a negative relation between the two. This shows that the more dominating the position of trade unions the more progressive the system of personal income taxes becomes. This article provides a normative justification for this combination of (exogenous) union density and (endogenous) tax progression. It might serve as a starting point for a positive explanation. Besides, it adds to this combination public expenditure on education. The idea is that a system of progressive income taxes discourages efforts to acquire skills and that education subsidies can partly offset the negative effect of progressive taxes on these efforts.

The panel on the right-hand side in Figure 5.1 shows that various countries adopt various combinations of public expenditure on education and tax progression. It plots for 21 OECD countries education expenditure in 1994 and the coefficient of residual income progression in 1996. The panel on the right-hand side shows large differences within the group of rich countries. At one end of the spectrum is Denmark, where the government spends about 8% of GDP on education and where the tax system is highly progressive. At the other of the spectrum is Turkey where expenditure on education is slightly more than 3% of GDP and the tax system is practically linear. It reveals a negative relation between public expenditure education and progression. This is partly a result of the policy mix in Scandinavia, where the governments provide significant subsidies to education and at the same time choose for relatively progressive taxes.

Figure 5.1 *Union density, tax progression and education subsidies*

several OECD -countries in the mid-nineties



* change in the after-tax wage, % of a change in the before-tax wage.

** union membership, % of total employment, in 1994.

*** public expenditure, % of gross domestic product, in 1994.

source: see Appendix A.

In this paper we analyse the idea that a system of progressive taxes is or should be a compromise between the effort of the government to reach full employment in a non-competitive labour market and the effort to promote investment in human capital and economic growth. In section 2 we set out a simple model allowing to illustrate this trade-off. Two features of the model are essential. On the one hand, trade unions try to raise the wage above its market-clearing level, leading to unemployment. On the other hand, identical workers invest to acquire skills. In section 3 and 4 we analyse optimal government policy -- with and without perfect information –, to reduce unemployment and simultaneously to encourage investment in human capital by selecting marginal and average rates of income taxes as well as the rate of subsidy to education. The next section also considers the role of (income) equality and unemployment benefits. Section 6 considers actual policies in various OECD countries. With the conclusions from the theoretical

approach in mind, it looks for patterns in policy mixes. Section 7 summarizes the main results and concludes.

5.2 Trade unions, employment and human capital

To focus on wage setting and human capital investment the production side of the model is simple and straightforward. Capital and labour produce one homogeneous good, used for consumption and investment. Production technology is standard and features constant returns to scale. Firms invest in physical capital, and workers invest in human capital. The economy is a small and open; the interest rate equals the one that prevails on the global capital markets. Aggregate labour supply is also exogenous and given. The goods and capital market is perfectly competitive, whereas the labour market is not. Trade unions at the industry level set the wage and restrict the supply of workers.

Production, investment and consumption take place simultaneously and only once, but a sequence of decisions or events is imposed:

1 the government sets taxes and subsidies;

2 firms invest in capital goods;

3 trade unions set the wage;

4 workers learn whether they are employed and, if they are, invest in acquiring skills.

This sequence has two major implications. The decision over investment precedes the one over the wage. Irreversibility of investment is essential for the ability of trade unions to determine the wage and gives rise to a hold-up problem.[37] The decision over taxes and subsidies precedes all other decisions. The government cannot fool the other agents; it cannot announce a set of taxes and subsidies and implement a different set.

The various decisions will be addressed consecutively, in reverse order. The policy aspects, the choice of taxes and subsidies by the government will be treated in sections 3 and higher.

Education and human capital

Workers derive utility from consumption of goods. As there is no future they do not save, and consumption equals income. A representative worker earns net income y_i which can be increased by investing in human capital h_j. This investment is modeled as an effort i_j which is a disutility. Because of

[37] Compare Grout (1984) and van der Ploeg (1987).

unemployment, workers are not certain of a job. They learn whether they are employed before they have to decide on their investment in human capital. We focus on employed workers first; the case of the unemployed is considered later.

Utility is given by $U_j = y_j(1-i_j)$. Investment effort i_j is expressed as a discount to utility. The cost of effort could also be regarded a fraction of income. After tax income y_j equals gross wages w_j less taxes $t(w_j)$ plus an education subsidy $S(i_j)$, that is $y_j = w_j - t(w_j) + S(i_j)$. The subsidy is proportional to effort and invariant to individual wages. We can write income in a more condensed manner as $y_j = y(w_j, S(i_j))$, where the tax system is now implicitly in the y-function. For a representative, employed worker j utility then becomes

$$U_j = y\left(w_j, S(i_j)\right)(1 - i_j) \ . \tag{5.1}$$

The difference between before-tax wage income and after-tax income $(w_j - y_j)$ equals the net tax burden (taxes less subsidies).

A workers can increase his earnings by investing in human capital. The wage rate per efficiency unit (ω) is given to the individual worker. Total wage for an individual worker is proportional to human capital h_j, thus $w_j = \omega h_j$. The learning technology is given by

$$h_j = h_o \, i_j^{\beta} \, \bar{i}^{\,\tilde{\beta}} \ . \tag{5.2}$$

The coefficient β is the elasticity of human capital with respect to education. We allow for a positive human capital externality, represented by the term $\bar{i}^{\,\tilde{\beta}}$, where $\bar{i}$ is the average investment effort by all workers. Since effort is bounded ($i \leq 1$) human capital is bounded as well ($h \leq h_o$).

The government has two instruments to influence the human capital decision: the education subsidy S and the tax system. For the moment we assume that education effort and human capital are perfectly observable to the government. Later we will drop this assumption and consider the consequences of imperfect observability of effort and human capital. Via the subsidy the government can encourage workers to invest in human capital. Taxation may have a negative effect on education, as it reaps part of the higher earnings through a higher tax burden. We assume that the tax system is characterised by a constant coefficient of residual income progression ε, *i.e* the elasticity of the after-tax income with respect to the before-tax (wage) income:

$$\varepsilon = \frac{\partial y_j}{\partial w_j}\frac{w_j}{y_j} = \frac{1-\tau_m}{1-\tau_a}, \tag{5.3}$$

where τ_m and τ_a are the marginal tax rate ($\partial\tau(w_j)/\partial w_j$) and the average tax rate ($\tau(w_j)/w_j$) respectively, with $\tau(w_j)$ representing net taxes, $\tau(w_j) = t(w_j) - S(i_j)$. Income taxes are progressive if the marginal rate exceeds the average rate and the residual income elasticity is less than unity, $\varepsilon<1$.

Investment in human capital derives from maximising utility (5.1) subject to the human capital function (5.2). The first-order condition is

$$\left[\frac{\partial y_j}{\partial w_j}\frac{\partial w_j}{\partial h_j}\frac{\partial h_j}{\partial i_j} + \frac{\partial y_j}{\partial S(i_j)}\frac{\partial S(i_j)}{\partial i_j}\right](1-i_j) - y_j = 0 . \tag{5.4}$$

The term between brackets represents the impact of education on income, through higher human capital (first term) and through higher subsidies (second term). The final term features the disutility of education effort. The first term (human capital effect) can be rewritten in terms of elasticities β and ε using the human capital function (5.2) and the definition of residual income progression above (5.3). The second term (subsidy effect) can be reduced using a linear subsidy, *e.g.* $S(i_j) = \zeta i_j$. Then, the partial derivative $\partial S(i_j)/\partial i_j$ ($=\zeta$) is constant and given to the individual worker. On the aggregate level, subsidies equal ζi. For the subsequent analysis it is convenient to write the subsidy as a fraction of (average) after-tax income, $s = S/y$ ($= \zeta i/y$). Whether the education subsidy is expressed as a fraction of income (s) or as a rate per unit of effort (ζ) is arbitrary from the policy perspective. Finally, using $\partial y_j / \partial S(i_j) = 1$, the first order condition can be written as

$$\left[\varepsilon\beta\frac{y_j}{i_j} + \frac{sy}{i}\right](1-i_j) - y_j = 0 . \tag{5.5}$$

Rewriting this equation and applying symmetry of sectors and workers ($i_j = i$ and $y_j = y$) gives the following expression for effort (dropping the index j)

$$i = \frac{e+s}{1+e+s}, \tag{5.6}$$

where e ($= \varepsilon\beta$) is the elasticity of income with respect to education effort. So, how much workers invest in their human capital is determined by two factors:

- elasticity of income with respect to education effort (e), which depends on the (individual) learning efficiency β and residual income progression ε,
- education subsidies as a fraction of income (s).

Both factors have a positive impact. Investment effort is zero in the extreme case where e is zero (100 per cent marginal tax rate, ε=0) and when there are also no subsidies to encourage education effort (s=0). Otherwise, investment is positive and smaller than one. Note that the learning externality ($\tilde{\beta}$) does not influence the individual education decision; it does, however, affect the level of human capital and therefore wages.

Wages and employment

Monopoly trade unions dominate the labour market. They set wages, trying to maximize welfare of their members. Wage negotiations take place at sectoral level; wages and employment in other sectors are taken as given by the trade unions. Also investment is considered exogenous. The firm's decision to invest precedes the determination of wages, so that capital stock is fixed when the negotiations start. So, capital is flexible ex ante and fixed ex post. As a result unions face a trade off between the level of wages and the volume of employment. They face a downward sloping demand curve for labour. How much weight is put on employment depends on the general state of unemployment in the economy. If there is large unemployment, it will be harder to find a job outside the home sector, and unions will become more prudent in wage demands. Therefore, higher unemployment will shift the balance from wages to employment, producing a moderating effect on wages set by trade unions.

To model this negative, moderating effect of unemployment on wage demands, the allocation of jobs among workers is assumed to take two rounds. First, workers hope to get a job in their own sector. If they succeed they receive utility U. However, due to union behaviour this will not be possible for all workers, and the unfortunate ones flow to other sectors. If they find a job there, they receive equal utility to workers in their home sector (U). However, for those who remain without a job in the second round either, there will be lower utility (U_o), as they stay unemployed and have to turn to the informal economy. Obviously, the probability of success in the second round depends heavily on the general state of unemployment (u). If there are few jobs available in other sectors, workers and unions will think twice before putting jobs at risk by high wage claims in their home sector.

Besides the state of unemployment, trade unions take account of three other factors when negotiating on wages. First of all, the slope of the labour demand curve: The bargaining power of unions decreases if labour demand becomes more elastic. Let α represent the inverse of the constant wage elasticity of employment, with $\alpha = -[(w/L)(\partial L/\partial w)]^{-1}$ and $0<\alpha<1$. Then bargaining power and wage

demands will decrease as elasticity becomes smaller (α up). Secondly, the trade off between income and employment is affected by the tax system. Progressive taxes (ε<1) discourages wage increases and thus shifts the trade-off for a trade union in favour of employment: the gain of wage increases is reduced whereas the loss in terms of jobs remains unaffected. Finally, the outside option in the event the worker remains unemployed (U_o) matters.

In the appendix we present a model which explicitly solves the relationship between wage setting and unemployment on a consistent basis for all sectors in the economy. Here it suffices to present the solution of this model:

$$\frac{U-U_o}{U} = \alpha\varepsilon/u \ , \tag{5.7}$$

where wages are included in utility of employed workers U. We assume $U>U_o$ and $\alpha\varepsilon<u$, and obviously $0<u<1$. This result formulates 'wage setting' in terms of desired distance in utility between employed and unemployed workers. This distance will be larger, and therefore wages higher, as α and ε are greater and unemployment is smaller.

Since the wage rate is exogenous in a small open economy, as will be discussed in the next section, it is useful to invert this equation into a relation for unemployment, as a function of α, ε and the distance in utility.

$$u = \alpha\varepsilon\frac{U}{U-U_o} \ . \tag{5.8}$$

The idea underlying this result is that, to maintain a certain level of wages (and U), unemployment has to be bigger when α, ε and U_o are higher in order to avoid upward pressure on wage demands by trade unions.

In summary, unemployment will decrease when:

- the tax system becomes more progressive (ε down),
- wage elasticity of labour demand increases and the bargaining power of the trade unions declines (α down),
- the (relative) difference between employed and unemployed workers in terms of utility increases ($U-U_o/U$ up).

For the moment we assume that 'outside' utility U_o is given, for example by the income unemployed workers would earn in the informal economy. In section 5 we will introduce unemployment benefits as a fall-back position.

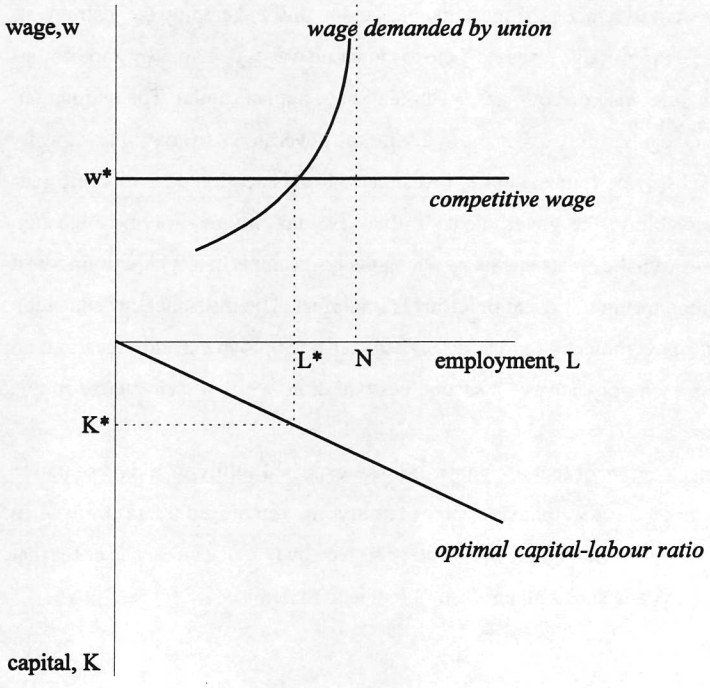
This result (5.8) can be simplified by assuming $U_o = 0$, that is, utility of unemployed workers is negligible, hence $u = \alpha\varepsilon$. We will start from this 'basic' case in the subsequent section 4. In section 5 we will relax this assumption when discussing the impact of the outside option and in particular unemployment benefits on optimal tax progression and education subsidies.

Production and employment

In a small open economy the world interest rate determines the rate of return on capital and thus the ratio of capital to labour. In turn, the capital-labour ratio determines the wage rate (in efficiency units). Perfect capital mobility thus puts a constraint on the wage rate: it cannot exceed a certain, international competitive level without frustrating investment in physical capital. This constraint on the wage together with the first-order condition for wage setting by trade unions (5.8) determine the equilibrium combination of wage rate, employment, capital stock and production. Figure 5.2 illustrates the equilibrium. In the upper panel the horizontal line represents this 'competitive wage' condition, whereas the upward sloping curve represents wage setting by trade unions. The latter reflects that a trade union will ask higher wages if the general state of employment improves and the labour market becomes more tense.

Since firms are aware of the wage-setting process, they will choose the capital stock, and therefore labour demand, such that the ensuing wage equals the competitive wage, the ensuing employment equals the expected employment and the rate of return on the investment matches the world interest rate. In other words, the lower panel in Figure 5.2 shows that for a small, open economy the optimal capital-labour ratio is determined on global output and capital markets and, consequently, the capital stock varies proportionally with employment in efficiency units.

Figure 5.2 *Equilibrium determining wages, employment and the capital stock*



In the specific case of zero outside utility, U_o=0, the wage setting curve becomes vertical. Wages are infinitely sensitive to unemployment at the equilibrium rate ($u = \alpha\varepsilon$). Any deviation from this equilibrium unemployment rate would lead to a wage spiral across sectors. As a result the model is dichotomized: the wage (in efficiency units) is determined on international markets, and unemployment follows from trade union behaviour.

5.3 First-best policy when education in fully observable

The economy is inefficient for two reasons. First, the private return on investment in education is biassed downward as a result of the externality in the process of learning ($\tilde{\beta}$ in equation 5.2). Individual workers do not take into account that their effort also helps others to improve their skills. For this reason workers choose too little investment in human capital. Second, trade unions try to push the wage above its

competitive level. The resulting unemployment is perhaps optimal for an individual trade union maximising its members' utility, it is certainly not optimal from a social point of view.

The government may want to remedy the inefficiencies and to this end employ the instruments of taxes and education subsidies. Progressive taxes can help to moderate wages demands by trade unions and boost employment. However, it also discourages accumulation of human capital. The optimal tax progression depends highly on the possibility or impossibility for the government to control learning by other instruments, *e.g.* by a subsidy on human capital investment. In this section education effort is assumed to be perfectly observable to the government. In this case, tax progression and education subsidies constitute a perfect set of policy instruments by which the government can achieve a first-best solution. In the next section monitoring of education effort is imperfect. The instrument of education subsidies becomes blunt and the government faces a trade-off between unemployment and education. To show that the government can then only achieve a second-best solution, we first characterise in this section the first-best solution.

Consider a utilitarian government that aims to maximise expected utility of a representative worker. Expected utility of a worker V is a weighted average of utility when employed U and utility when unemployed U_o: $V=(1-u)U+uU_o$. Utility of employed workers is given by $U=y(.)(1-i)$ and exceeds that of unemployed workers, $U > U_o$.[38] The social planner's problem is to maximise

$$V = (1-u)\omega h(1-i) + uU_o , \tag{5.9}$$

subject to the human capital function (5.2). Net income y is written here as ωh, where ω is the - internationally - given wage per efficiency unit and h the amount of human capital. It is assumed that there is no other government expenditure besides education subsidies. The sum of taxes and subsidies is then zero and after-tax income equals the wage.

The solution for optimal investment and unemployment is straightforward. Since $U > U_o$, optimal unemployment is zero. Besides, the optimal effort to acquire skills takes into account the externality in the process of learning. The first-order conditions can be summarised as

$$u^* = 0 , \tag{5.10}$$

[38] Since domestic capital income is fixed, its impact on utility can safely be neglected.

$$i^* = \frac{\beta+\tilde{\beta}}{1+\beta+\tilde{\beta}} . \qquad (5.11)$$

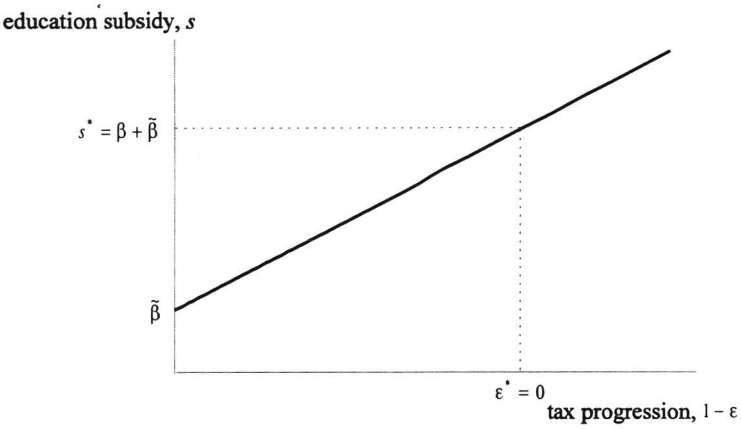
This is an unconstrained optimum that can be attained by choosing proper values for the instruments e (=$\varepsilon\beta$) and s. Consider the private solutions for i and u (equations 5.6 and 5.8). Zero unemployment can be reached by reaping off any gains from higher wages, hence e^*=0. This requires a marginal tax rate of 100 per cent (ε=0), so that there is no incentive left to increase wages at all. The optimum for education subsidy is $s^* = \beta+ \tilde{\beta}$. The subsidy must compensate for the 100 per cent tax rate (hence β) as well as for the externality (hence $\tilde{\beta}$).

Admittedly, this solution with a 100 per cent marginal tax rate is extreme. It hinges on the assumption of purely exogenous labour supply. What we would like emphasise here, however, is the relationship between tax progression and education subsidies. From the private solution for education effort (5.6) we obtain that optimal education effort (5.11) is realised by the following setting of the policy instruments,

$$s+e = \beta+\tilde{\beta} . \qquad (5.12)$$

This condition implies a positive relationship between education subsidies s and tax progression 1-ε (note that $e = \varepsilon\beta$), which is shown in Figure 5.3. In the absence of tax progression (1-ε=0) the subsidy should just compensate for the human capital externality $\tilde{\beta}$. If progression increases, the subsidy should also increase to offset the discouraging effect of taxes on education. In the optimum, with $\varepsilon = 0$, the optimal subsidy is given by $s^* = \beta+\tilde{\beta}$.

Figure 5.3 *Optimal education subsidies and tax progression*



5.4 Optimal policy when education is imperfectly observable

Individual effort on training and education is hard to observe for government. That income is observable does not help much since there are many reasons for income differences. This does not mean that the government cannot affect private, individual efforts to learn at all. It can influence effort indirectly, for example by subsidising complementary activities or costs. It is useful to distinguish between formal and informal education. The latter type is not observable, let alone malleable, whereas the first type is observable for the government, and is under (complete) control by means of subsidies or other policy instruments. Investment of the contractible type may be thought to include expenditure on a wide variety of educational goods and services. These goods and services may range from buildings to books or computers and from teachers to pencils. The government often subsidises expenditure on educational goods and services and frequently provides these goods and services for free. Investment of the non-contractible type may be thought to include various individual actions. Individuals must choose for education rather than for work, must choose a type of education or must devote time and effort to study. These actions are hard to monitor and not contractible. Assuming some complementarity between the two types of education, the government can indirectly encourage informal education by stimulating formal education. Since the relation between the two is not invariable, this way of influencing (informal) education is imperfect.

In this section we will study a situation in which the government cannot completely control private efforts to acquire skills and is constrained in this way when trying to achieve an optimum through progressive taxes and education subsidies. The first best solution is no longer attainable; the government must strike a balance between reducing unemployment on the one hand and stimulating education on the other hand.

Unobservable investment in education

Here we expand the model, set out in the previous section, by introducing a distinction between two types of investment: private efforts i_P and formal education i_G. The government cannot observe the first type of investment in human capital. At least, a contract (between a worker and the government) cannot include this variable or a proxy for this variable, because a court cannot verify it. In other words, the government cannot influence investment of the first type directly, whereas it can affect investment of the second type by subsidizing it. Typically, we will refer to the first type as informal or private education (i_G), and to the second type as formal or public education (i_P). Both types of effort sum up to total effort i,

$$i = i_P + i_G \,. \tag{5.13}$$

Employers are able to observe efficiency of individual workers, so that they can pay a proper wage per efficiency unit. Wages per worker are given by $w_j = \omega h_j$. Since wage income increases with the level of human capital workers have an incentive to invest in new and better skills. Human capital depends on both types of education. For a representative worker j it can be written as

$$h_j = h_o \left(i_{Pj}^{\sigma} i_{Gj}^{1-\sigma} \right)^{\beta} \left(i_P^{\sigma} \, i_G^{1-\sigma} \right)^{\tilde{\beta}} \,. \tag{5.14}$$

The first multiplicative term between brackets, with the β coefficient, is the effect of private efforts by the worker, whereas the second multiplicative term between brackets, with $\tilde{\beta}$, represents the externality of the process of learning, both formal and informal. σ denotes the elasticity of human capital with respect to informal education, and $1-\sigma$ the elasticity with respect to formal education. The sum of these elasticities is normalised to unity. One interpretation is that σ measures the extent to which efforts are observable; if $\sigma=1$ effort is not observable at all, while if $\sigma=0$ we are back in the case of perfect monitoring again (with now $i_G = i$).

We can rewrite the human capital function using m for the fraction of private effort, $m = i_P / i$, and $1-m$ ($= i_G / i$) for the fraction of formal education, so that

$$h_j = h_o i_j^{\beta} i^{\beta} \left[\left(m_j^{\sigma} (1-m_j)^{1-\sigma} \right)^{\beta} \left(m^{\sigma} (1-m)^{1-\sigma} \right)^{\beta} \right]. \qquad (5.15)$$

When comparing this function with the function for human capital in the previous section, it becomes clear the only difference is the (multiplicative) term between square brackets. In other words, the new human capital function is the product of the old human capital function and the term between square brackets: $h^{new} = h^{old}[...]$. Another difference between the current and the former section is of course that s now stands for subsidies on formal education as a fraction of income, $s = S(i_G)/y$ $(= \zeta\, i_G / y)$.

The allocation of total effort over observable and unobservable investment depends on their relative productivity (elasticity σ) and education subsidy s:

$$m = \frac{i_P}{i} = \frac{e}{e+s}\sigma . \qquad (5.16)$$

The share of informal education m rises, and that of formal education $(1-m)$ falls, if the elasticity σ increases and if the subsidy s becomes smaller relative to the elasticity of income with respect to education (e).

The distinction between two types of investment does not alter the market solution for total effort (5.6). The reason is for the new and the old human capital function the elasticity of human capital h_j with respect to total effort i_j is the same, namely β. Also, it does not alter the market solution for wages or, more precisely, unemployment (5.8).The distinction does not affect the trade-off between income and employment for a trade union.

The first-best solutions follow from maximising social welfare (5.9), with $U_{ij}=0$, subject to the new human capital function (5.15). The outcome for unemployment and total education are the same as in section 3 (equations 5.10 and 5.11). For the structure of education we obtain

$$m^* = \frac{i_P^*}{i^*} = \sigma . \qquad (5.17)$$

Not surprisingly, the optimal shares of informal and formal education derive from their relevant elasticities.

Table 5.1 summarizes the results for the variables u, i and m.

Table 5.1 *Market and first-best outcome for the main variables*

	market solution		first-best outcome	
unemployment u	$\frac{\alpha}{\beta}e$	(5.8)	0	(5.10)
human capital investment i	$\frac{e+s}{1+e+s}$	(5.6)	$\frac{\beta+\tilde{\beta}}{1+\beta+\tilde{\beta}}$	(5.11)
share of private education m	$\frac{e}{e+s}\sigma$	(5.16)	σ	(5.17)

Insufficient instruments

Imperfect control over efforts has the effect that the government is no longer able to achieve the first-best optimum. In addition to unemployment and total investment in education, policy should now also target the structure of education (m). The government has three policy targets (u,i,m), and only possesses two instruments (s and e).

Looking at the market solutions in Table 5.1 it is obvious that the first-best optimum is out of reach of the government. Specifically, zero unemployment requires e=0, optimal total investment $s+e=\beta+\tilde{\beta}$, and optimal structure of education s=0 (from 5.16 and 5.17). It is impossible to satisfy each of these conditions simultaneously. For example, it is possible to achieve zero unemployment and optimal total education ($e=0$, $s=\beta+\tilde{\beta}$), but only at the cost of a distorted structure of education; there would be too much formal education and too little informal education.

The consequence is that the government must settle for less than full employment, adequate investment in the human capital and an optimal mix of private and public education. It is forced to find a compromise, using only two instruments: tax progression and education subsidies.

Second-best optimum

We proceed by deriving optimal tax progression and education subsidies in the constrained optimum. Optimal policy results from maximising a utilitarian social welfare function under the constraint of the market solutions for unemployment (u) and education (i and m). We take utility of unemployed workers to be exogenous and negligible (U_o=0). In a later section we will drop the assumption of a zero outside option and introduce unemployment benefits. In the case that U_o=0 the problem for the government is to choose the policy instruments e and s such that they maximise total utility

$$V_{U_0=0} = (1-u)\omega h(1-i) \tag{5.18}$$

subject to the human capital function (5.15) and subject to the optimality conditions for trade unions and workers (5.8, 5.6 and 5.16). Both e and s have positive effects on total education effort i, $\partial i/\partial e>0$ and $\partial i/\partial s>0$, but their impact on the allocation between observable and unobservable effort is of opposite sign, $\partial m/\partial e>0$ and $\partial m/\partial s<0$. The share of unobservable effort varies negatively with subsidies on formal education, and positively with income progression (ε, and thus e) whenever $s>0$. That is, more income progression helps to restore the balance between informal and formal education, when there is already bias towards formal education as a result of subsidies. Taking the first-order derivatives of (5.18) with respect to s and e we can solve the first-order conditions, for s

$$\left(\frac{i^*}{1-i^*}-\frac{i}{1-i}\right)\frac{\partial i}{\partial s}\frac{1}{i}+\left(\frac{m^*}{1-m^*}-\frac{m}{1-m}\right)\frac{\partial m}{\partial s}\frac{(\beta+\tilde{\beta})(1-\sigma)}{m}=0$$

$$\frac{(\beta+\tilde{\beta})-(e+s)}{1+e+s}-(\beta+\tilde{\beta})\frac{\vec{\sigma s}}{(e+s)(1-\sigma)+\sigma s}=0 \tag{5.19}$$

and for e

$$\left(\frac{i^*}{1-i^*}-\frac{i}{1-i}\right)\frac{\partial i}{\partial e}\frac{1}{i}+\left(\frac{m^*}{1-m^*}-\frac{m}{1-m}\right)\frac{\partial m}{\partial e}\frac{(\beta+\tilde{\beta})(1-\sigma)}{m}+\left(\frac{u^*}{1-u^*}-\frac{u}{1-u}\right)\frac{\partial u}{\partial e}\frac{1}{u}=0$$

$$\frac{(\beta+\tilde{\beta})-(e+s)}{1+e+s}\frac{e}{e+s}+(\beta+\tilde{\beta})\frac{\vec{\sigma s}}{(e+s)(1-\sigma)+\sigma s}\frac{s}{e+s}-\frac{\alpha e}{1-\alpha e}=0 \tag{5.20}$$

These two conditions determine optimal policy $\{e, s\}$ for the government. The first equality in (5.19) stipulates the fundamental trade off in education policy. For a given income progression (e) the optimal subsidy is inevitably a compromise between the will to stimulate investment in education and the objective of an optimal structure of education. The government must accept that there is too little investment in education compared with the first-best solution ($i<i^*$) and a distorted structure with too little informal education relative to formal education ($m<m^*$). A higher subsidy helps to reduce the distortion in total effort i (the first term), but only at the cost of a larger distortion in the structure of education m (the second term). The structure of education is distorted for any positive s, that is $m < m^*$ (see Table 5.1). The costs of these distortions increase as the distance between actual and first-best solution becomes greater (the terms between brackets). The second line in (5.19) gives the solution in terms of e and s. For any positive s (and hence $m<m^*$) this result shows that the level of education is sub optimal ($i < i^*$), since $e+s<\beta+\tilde{\beta}$.

A trade off also appears for income progression (e) where the positive effects on education (both on i and m) must be balanced against the negative effect on unemployment. Again the cost of the distortions depend on the distance with the first best optimum (between brackets, note that u^*=0). The first two terms give the beneficial effects of income progression on the level and the structure of education. These terms are positive whenever education is suboptimal and the structure of education is distorted towards formal education (due to s>0). Finally, the third term represents the impact of e on employment. This effect is negative as a higher e encourages higher wage claims by trade unions, at the cost of less employment. Since the first two terms are positive for any s>0, it follows directly that e>0, and therefore that the government should allow for some unemployment.

Also in the constrained equilibrium there is a positive relationship between tax progression (1-ε) and education subsidies s (see also equation 5.12 and Figure 5.3). That is, the education subsidy must be higher if taxes are more progressive in order to compensate for the disincentive to invest in education. The relation between s and e (from equation 5.19) can be written as

$$s = \frac{(1-\sigma)\left((\beta+\tilde{\beta})-e\right)}{1+\sigma(\beta+\tilde{\beta})} . \tag{5.21}$$

For σ=0 this reduces to the expression in the case of perfectly observable education (equation 5.12).

Solution for optimal policy

After some manipulation the two optimality conditions give the following closed-form solutions for optimal policy $\{e, s\}$,

$$e = \frac{(\beta+\tilde{\beta})\sigma}{\alpha+\sigma[\beta+\alpha(\beta+\tilde{\beta})]} \tag{5.22}$$

$$s = \frac{\alpha(\beta+\tilde{\beta})(1-\sigma)}{\alpha+\sigma[\beta+\alpha(\beta+\tilde{\beta})]} \tag{5.23}$$

Substitution in (5.6) and (5.16) yields for the level and the structure of education

$$i = \frac{\beta+\tilde{\beta}}{1+\beta+\tilde{\beta}}\left(1 - \frac{\alpha\sigma}{\alpha+\beta\sigma}\right) \tag{5.24}$$

and

$$m = \sigma\left(1 - \frac{\alpha(1-\sigma)}{\beta\sigma+\alpha(1-\sigma)}\right) . \tag{5.25}$$

The first multiplicative terms (before the brackets) in these two equations correspond to the first-best solutions for i and m: $i^* = (\beta+\tilde{\beta})/(1+\beta+\tilde{\beta})$ and $m^* = \sigma$ (see equations 5.11 and 5.17). It follows immediately that $i < i^*$ and $m < m^*$ if $\sigma > 0$, that is, whenever private efforts to acquire skills are imperfectly observable.

In the case of partly unobservable investment in education, $\sigma > 0$, the tax system does not have a 100 per cent marginal tax rate to collect all labour income, $e>0$, but is not sufficient to yield optimal education either, $e<\beta+\tilde{\beta}$. Optimal policy further requires positive subsidies for formal education, $s>0$. Since it has a distortionary effect, the subsidy rate will always be smaller than the subsidy rate in the case of perfect observable education,

$$e > e^* (= 0) \quad \text{and} \quad s < s^* (= \beta+\tilde{\beta}) . \tag{5.26}$$

How much the instruments (and the targeted variables) deviate from the first-best policy depends on a number of parameters. In Table 5.2 we have derived the effect of exogenous parameters on the policy instruments as well as the market outcome for unemployment and education.

Table 5.2 *Effects of exogenous parameters on policy and other variables*

		union power	return on education	externality	monitoring of education
		α	$\beta+\tilde{\beta}$	$\tilde{\beta}/(\beta+\tilde{\beta})$	σ
tax progression	$1-\varepsilon$	+	-	-	-
education subsidy	s	+	+	+	-
unemployment rate	u	+	+	+	+
total education	i	-	+	-	-
private education	m	-	+	-	+
social welfare	$V_{U_w=0}$	-	+	-	-

In this table we distinguish between the effect of total, social return of investment in education $\beta+\tilde{\beta}$, including the externality, and the (relative) difference between the social and private rate of return, $\tilde{\beta}/(\beta+\tilde{\beta})$, as a consequence of the externality.

More union power

Most results in Table 5.2 are straightforward. A smaller wage elasticity of employment (α up) means lower costs of higher wages in terms of employment, thereby increasing bargaining power of trade unions and encouraging wage demands by trade unions. As a result, unemployment will increase (u up). An optimal response of the government is to counteract more bargaining power of trade unions by making taxes more progressive (ε down). Besides, the negative effect of more progressive taxes on human capital investment requires more education subsidies. On balance, both total education i and the share of private education will decrease. Also, social welfare (= expected utility of a representative worker) will decrease. This is to be expected, since a higher α just implies a larger distortion in the wage setting process.

Higher return on education

Next, consider productivity of investment in education, $\beta+\tilde{\beta}$. The equations (37) and (38) show that an increase in productivity ($\beta+\tilde{\beta}$ up) leads to a activating education policy with higher subsidies (s up) and less progressive taxes ($1-\varepsilon$ down). As a result, education is stimulated (i up), and especially private education thrives (m up). The reverse side of the medal is that unemployment increases as well (u up). On balance, larger productivity is beneficial for welfare.

Larger externality of education

When the externality in the process of learning and education becomes more important ($\tilde{\beta}/(\beta+\tilde{\beta})$ up), investment in education tends to fall (i down). To compensate for this negative effect, the government

will decrease tax progressivity (1-ε down) and raise subsidies (*s* up). This cannot avoid, however, that total investment in education goes down, even though the share of private education increases (*m* up). In response to less progressive income taxes unemployment rises (*u* up). Evidently, the larger distortion in education is partly mitigated at the expense a larger distortion on the labour market and an increase in unemployment. On balance, the increased distortion in education affects welfare negatively.

Worse monitoring of education efforts

Finally, consider how the structure of education affects the optimal policy mix. Note that σ can be interpreted as a lack of information on education efforts. If σ=0, only observable formal education is productive, whereas if σ=1 only unobservable, informal education matters. When education become less observable (σ up) the distortion in the structure of education becomes worse. The optimal policy mix shifts towards less subsidies and less tax progression. Private education becomes more important (*m* up), and total investment falls (*i* down). However, the price of less progressive income taxes is higher unemployment (*u* up). The government cannot avoid the twin problem of more unemployment and less investment in education. Again, welfare goes down because one of the distortions becomes more important.

5.5 Unemployment benefits

In this section we shall reconsider the simplifying condition that the outside option for workers is negligible, $U_o = 0$. More specifically, we analyse the case that the government dislikes inequality between the unemployed and the employed and provides an unemployment benefit. The outside option is no longer exogenous, but is a policy instrument in the hands of the government. Even though the government dislikes inequality, it cannot eradicate the difference between unemployed and employed workers. When the government raises the unemployment benefit, it also raises the outside option for trade unions. They will start to ask for higher wages. In response unemployment will rise, aggravating the tax burden on employed workers. The government can try to contain the distortionary effect of higher unemployment benefits by enlarging the tax base, through encouraging investment in human capital or by making the income tax system more progressive.

In this section we expand the model to account for unemployment benefits and their effect on income taxes and education subsidies. Introducing unemployment benefits implies two changes in the

model that show up in the social welfare function. We will discuss these changes before analysing the effects of unemployment benefits.

Assume that the unemployment benefit is such that utility of unemployed workers (U_o) is a fraction b of utility of employed workers (U), thus $U_o = bU$. This fraction is thus a replacement rate in terms of utility. The government can freely set this replacement rate: it is a policy instrument.

When deciding upon the replacement rate the government employs a social welfare function. The function in this section is somewhat different from the one in earlier sections. One reason is the redistribution from employed to unemployed workers. The utilitarian welfare function V breaks down into the welfare function in previous sections $V_{U_o=0}$,with a negligible outside option for unemployed workers, and the (relative) difference between before- and after-tax wage income of employed workers $w\text{-}y/w=1\text{-}\tau_a$: $V = V_{U_o=0}(1-\tau_a)$. The difference between before-tax and after-tax wage income, $w-y$, is equal to the contribution (net of subsidies received) of employed workers to the government budget. This contribution pays entirely for the unemployment benefits, y_o,

$$(w-y)(1-u) = u y_o \,, \tag{5.27}$$

where $y_o (= U_o)$ is the unemployment benefit. The replacement rate determines the level of this benefit, $y_o = bU = by(1\text{-}i)$. Using this in the government budget constraint (5.27) gives for the relative difference between before- and after-tax wage income

$$1-\tau_a = \frac{w-y}{w} = \frac{1}{1+\dfrac{u}{1-u}b(1-i)} \,. \tag{5.28}$$

The average tax burden increases when unemployment increases and the tax base becomes smaller. In turn, the unemployment rate depends on two policy variables (see equation 5.8): more tax progression leads to less unemployment and a higher replacement rate to more unemployment. The replacement rate also has a direct upward effect on the tax burden. Finally, the tax burden increases when investment in human capital diminishes. The reason is that less investment in education leads to a lower wage rate and, since the level of unemployment benefits does not decrease as much as the wage rate, the tax burden on employed workers rises.

There is another reason that the social welfare function in this section is different from the one in earlier sections. In this section we assume that the government dislikes inequality between the unemployed and the employed, whereas in earlier sections a pure utilitarian social welfare function has been employed in which each worker is given equal weight. Now, the new social welfare function W is

the product of the old, utilitarian social welfare function V and a term $1+\varphi b$ ($\varphi>0$) that captures the preference for an equal distribution: $W = V(1+\varphi b)$. According to the extra term the government gives a positive weight to utility of the unemployed vis-à-vis the employed.

The social welfare function in this section breaks down into three multiplicative terms

$$W = V_{U_0=0}(1-\tau_a)(1+\varphi b) , \tag{5.29}$$

where the first term $V_{U_0=0}$ is the 'old' social welfare function in the absence of unemployment benefits (equation 5.18), the second term $1-\tau_a$ is the result of redistribution from employed to unemployed workers and the third term $(1+\varphi b)$ captures the preference for equality.

The government can improve the position of the unemployed by raising the level of unemployment benefits, but must take into account the negative effect on after-tax income of the employed. In case of a purely utilitarian government ($\varphi=0$) this negative effect dominates, so that a corner solution arises with $b=0$. Therefore, the government must have a taste for equality ($\varphi>0$) to choose a positive replacement rate, $b>0$.

The first-order condition for unemployment benefits is little informative and is suppressed. It gives the obvious result that given the progression coefficient ε and the subsidy rate s the replacement rate b increases if the preference for equality becomes stronger and φ increases. More interesting is how the optimum for the subsidy rate and for the progression coefficient changes in the presence of unemployment benefits. The first-order conditions show that terms are added to the original conditions (5.19) and (5.20) in section 4:

$$\frac{\partial V_{U_0=0}}{\partial s} + V_{U_0=0}\left[\frac{u}{1-u}b(1-\tau_a)\right]\frac{\partial i}{\partial s} = 0 , \tag{5.30}$$

$$\frac{\partial V_{U_0=0}}{\partial e} + V_{U_0=0}\left[\frac{u}{1-u}b(1-\tau_a)\right]\frac{\partial i}{\partial e} - V_{U_0=0}\left[(1-i)b(1-\tau_a)\right]\frac{\partial(u/1-u)}{\partial e} = 0 . \tag{5.31}$$

Evidently, if the replacement rate is negligible and $b=0$, the new terms are zero, and the old first-order conditions are still valid. However, if the replacement rate is positive and $b>0$, the government adjusts the subsidy rate and the progression coefficient to broaden the tax base. The first condition shows that for a given progression coefficient the introduction of unemployment benefits is a positive reason for higher education subsidies and more investment in education (since $\partial i/\partial s>0$). The second condition has two extra terms, that are of opposite sign (remember that $\partial i/\partial e>0$ and $\partial u/\partial e>0$). The first extra term

reflects that less tax progression leads to more investment in education, whereas the second extra term shows that it is bad for unemployment. The latter effect dominates. Thus, introducing unemployment benefits implies, given the subsidy rate, more progressive income taxes. The reason is that unemployment benefits tend to raise unemployment and in this way raise the need for less powerful unions and more progressive taxes.

So far we have only considered own partial derivatives. We have asked: what is the effect of introducing a positive but small replacement rate on the subsidy rate s, given the progression coefficient ε, and vice versa? However, to establish the effect of a stronger preference for equality and higher unemployment benefits we cannot rely on a partial-equilibrium analysis. Since the cross-derivatives in the first-order conditions are not easy to establish, we have to resort to simulations. Table 5.3 shows the results. The simulations broadly confirm the partial-equilibrium analysis. A stronger preference for equality (φ up) leads to a higher replacement rate (b up) and consequently more progressive income taxes (ε down) and higher subsidies on education (s up). More equality between employed and unemployed comes at a price. To begin with, unemployment rises (u up) when the replacement rate increases. That the tax system becomes more progressive, is not enough to check union wage demands and to stop unemployment from rising. Moreover, investment in education falls (i down). More tax progression reduces the incentive to invest, and rising education subsidies do not compensate for this negative effect on human capital formation. Finally, the structure of education changes in favour of public investment and the expense of private efforts to acquire skills (m down).

In summary, taxes become more progressive to mitigate the negative consequences of more equality and a higher replacement rate (for the level of unemployment) and, similarly, education subsidies become higher to mitigate the negative consequences of more tax progression (on investment in education).

Table 5.3 *Preference for equality and its effect on policy instruments*
Simulation results

preference for equality, φ	0	0.25	1	∞
utility of unemployed, b (% of utility of employed)	0.0	47.9	70.6	82.1
progression coefficient, ε (%)	83.3	69.1	52.2	37.5
education subsidy, s (% of after-tax income)	4.2	6.2	8.5	10.5
unemployment, u (% of labour force)	8.3	13.3	17.8	20.9
investment in education, i (%)	27.3	25.3	22.7	20.3
private education, m (% of total education)	59.3	54.5	47.4	39.3

Exogenous parameters: $\alpha = 0.1$; $\beta = 0.4$; $\tilde{\beta} = 0.1$; $\sigma = 0.667$.

5.6 The empirical determinants of public education expenditure

The theoretical approach in the previous sections concludes that under many circumstances progressive taxes and education subsidies tend to go hand in hand. Particularly, a dominant role in the process of wage bargaining for trade unions provides an important reason for combining high progression and high subsidies. Whereas the previous sections have had a normative perspective on government policies, this section considers actual policies in various OECD countries. With the conclusions from the theoretical approach in mind, we look for patterns in policy mixes. A clear-cut relation between public expenditure on education, progression of income taxes and union membership emerges; a simple regression analysis suggests that the practice of policy-making is not at odds with the conclusions from the theoretical approach.

To uncover patterns in policy mixes we resort to regression analysis. However, a casual look at the available data is already instructive. The data come from different sources and publications, but are often provided by the OECD.[39] Figure 5.1 (see Introduction) plots for 21 OECD countries education

[39] An overview of the sources is presented in Appendix A.

expenditure in 1994 and the coefficient of residual income progression in 1996 for a single person, earning 167% of the average production wage. It reveals a negative relation between public expenditure education and progression. This is partly a result of the policy mix in Scandinavia, where the governments provide significant subsidies to education and at the same time choose for relatively progressive taxes. The negative relation disappears when the sample does not include the four Scandinavian countries.

To uncover the role of trade unions Figure 5.1 also plots for 18 OECD countries the coefficient of progression and union membership, as a fraction of the total labour force, in 1994. Typically, countries opt for higher progression in tax system the higher membership is. An exception to this rule is the United Kingdom. Here, membership amounts to about 30% of the labour force -- not far from the unweighted OECD average of 40% --, but the tax system is regressive, at least for an average one-person household earning 167% of the average production wage.

A sample of 21 countries or less is not large. Using time series does not entirely resolve this problem. The definition of public expenditure on education appears to change often, complicating a comparison over time. Besides, time series at a regular basis are often not available. For example, data about union membership are available for only four times in the past twenty-five years. A similar problem arises for data about replacement rates. Therefore, we opt for pooling data for 15 countries at the beginning of the eighties (1981) and data for 21 countries in the middle of the nineties (1995).

The data about the national tax systems are hardly a problem. The OECD publishes for different types of households and for several years, starting in 1978, the marginal and average tax rates. It is thus straightforward to derive the coefficient of residual income progression. The regression analysis uses only one coefficient, that applies to a single person earning 167% of the average production wage. Using just one measure to characterize progression in tax systems is not restrictive. The results do not change significantly if a coefficient for a different type of household -- different with respect to composition or income -- is employed instead. The reason is that there is a close relation between different measures for progression. Even conceptually different measures will give similar results.[40]

The regression analysis uses four exogenous variables to explain public expenditure on education: union membership, a replacement rate, other government consumption and the population up to the age of 15. The theoretical approach in the previous section considers two of these four variables;

[40] We use a measure for progression based on a marginal tax rate and an average tax rate for a particular type of household. An alternative measure is to consider average tax rates for two types of households, that are similar in composition but different with respect to income. The correlation between the two measures is very high. This shows that one measure may fairly characterize national tax systems so far as progression is concerned.

higher union membership, implying more wage-setting power for unions, and a higher replacement rate are expected to raise subsidies to education. Including the other two variables helps to control for other factors that for an empirical analysis could be relevant. The effect of more public consumption is not entirely clear. More consumption could crowd out education subsidies, since taxes to finance public expenditure are distortionary and therefore limit the size of the government. Equally, more consumption could reflect a stronger believe in the public competence to intervene in the private economy and therefore imply more education subsidies. The effect of demography, however, is crystal clear. A younger population and a higher share of the population up to 15 is expected to raise public expenditure on education. Table 5.4 briefly characterizes the relevant variables.

Table 5.5 presents the results of the regression analysis. The first column shows that each variable, except other government consumption, has a significant effect on education subsidies. Public expenditure on education is systematically and positively related with union membership, the replacement rate and demography. The data support earlier conclusions about optimal combinations of income taxes and education subsidies. At the least, the results in the first column are compatible with the view that a higher membership and more powerful trade unions require more progressive income taxes and, in turn, higher education subsidies.[41]

[41] Noteworthy is that a different proxy for bargaining power of unions produces a different result: union coverage, the number of workers (members and non-members) represented by a union during the wage negotiations, does not have a significant, positive effect on education subsidies. This is not an obvious result since the two variables -- the number of members and the number of represented workers -- seem a good indication for the bargaining power of trade unions. In addition, the OECD (1997) reports that density and coverage have different impact on for example the unemployment rate and the employment rate. Anyway, the different results with different proxies calls for a cautious interpretation of the results.

Table 5.4 *Summary Statistics*

	Mean	Standard Deviation	Maximum	Minimum
36 observations				
education expenditure (% of GDP)	5.7	1.3	8.1	2.4
coefficient of progression (%)	84.9	7.2	105.0	70.9
unemployment (% of labour force)	7.6	3.8	20.2	2.2
union membership (% of labour force)	42.0	21.0	91.0	9.0
replacement rate	31.8	15.1	63.0	2.0
government consumption (% of GDP)	12.9	3.7	21.6	4.4
demography (population up to 15, % of total population)	19.9	2.6	25.4	15.3

Source: OECD, various publications (see Appendix A)

Similar equations have been estimated for 1995 and 1981 separately. The second and the third column of the table show the results. The second column does not differ a great deal from the first column. However, the results in the third column make clear that -- not surprisingly -- 15 observations are not sufficient to obtain precise, statistically significant estimates. Nevertheless, the coefficients do not change much. Only the coefficient associated with demography drops markedly.

The first three columns concern reduced-form equations. According to the discussion in earlier sections the effect of union membership on education subsidies is indirect, through its effect on progression of income taxes. The fourth and the fifth column show the results of structural equations, employing the identifying restrictions that union membership does not affect education subsidies directly. The difference between the two columns is the estimation technique. The equation in the fourth column has been estimated by the usual method of OLS whereas the one in the fifth column uses instrumental variables. Both columns show that less progression (a higher coefficient of progression) implies less government expenditure on education. They also show considerably different coefficients. Accounting for endogeneity of progression doubles the estimated impact of this variable. Besides, evidence for a direct, positive effect of the replacement rate on education expenditure, disregarding its indirect effect through its impact on tax progression, becomes weak. Clearly, the coefficient of progression is an important determinant of government expenditure on education, but exactly how important is not easy to tell. This depends on whether one is willing to accept that tax progression is affected by the replacement rate and, more generally, that policy-making is endogenous.

The last two columns again concern reduced-form equations. Here the four exogenous variables ought to explain the coefficient of progression (the sixth column) and unemployment (the seventh column). The results back the earlier conclusions that higher union membership and a higher replacement rate should bring a more progressive income tax system. However, in the theoretical model the chain of arguments runs from wage-setting power to progression via unemployment. The expectation is that demands for higher wage by workers can only be reconciled with the interest of firms by a higher unemployment rate. This is not borne out by the data. The replacement rate thus has the expected positive effect on unemployment, but union membership does not have a positive effect on unemployment. Instead, the latter effect is negative, albeit insignificant.

Table 5.5 *Regression results*

	Education subsidies (% of gross domestic product)					Coefficient of income progression[1]	Unemployment rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Union membership % of total labour force	0.035***	0.031**	0.038**			-0.248***	-0.039
	(0.009)	(0.012)	(0.015)			(-0.039)	(-0.039)
Replacement rate % of average wage income	0.023**	0.029*	0.018	0.024***	0.008	-0.100*	0.067*
	(0.011)	(0.015)	(0.02)	(0.011)	(0.014)	(-0.052)	(0.034)
Other government consumption % of gross domestic product	0.036	0.056	0.001			0.21	0.166
	(0.053)	(0.85)	(0.099)			-0.347	(0.151)
Demography population up to 15, % of total population	0.146**	0.167*	0.062	0.087	0.120	-0.103	0.092
	(0.07)	(0.083)	(0.156)	(0.090)	(0.100)	(-0.347)	(0.401)
Coefficient of progression single, 166% of average production wage				-0.076***	-0.166***		
				(-0.033)	(-0.034)		
number of observations	36	21	15	36	36	36	36
R^2	0.51	0.59	0.42	0.34	0.13	0.55	0.16
adjusted R^2	0.43	0.49	0.19	0.25	0.02	0.47	0.03
Standard Error of Regression	1.00	0.98	1.17	1.18	1.33	5.3	3.74
Mean of Dependent Variable	5.7	5.6	5.8	5.7	5.7	84.9	7.6

The regression equations include two constants, one for each year. These are not shown in the table. Between brackets are White's Heteroskedasticity-Consistent Standard Errors. *, **, and *** denote statistical significance at the 10%, the 5% and the 1% level respectively.

[1] for a single person earning 166% of the average production wage

5.7 Concluding remarks

A system of progressive income taxes does not differentiate between various causes of income changes or income differences. This article focuses on two of these causes. On the hand, trade unions aim to increase income of their members by restricting the supply of labour and raising the wage. On the other hand, workers aim to increase their income by investing to acquire skills. Progressive taxes interfere with both aims. They reduce upward wage pressure and in this way boost employment and production. The problem is that they also diminish incentives to accumulate human capital and in this way reduce productivity of workers and production. The optimal progression of income taxes should balance both the positive and negative effect. However, a system of progressive taxes is not the only instrument a government can use to stimulate accumulation of human capital. A government can rely also on direct subsidies on investment in education. Unfortunately, as a consequence of imperfect monitoring education subsidies cannot avoid that progressive income taxes reduce the private incentive to invest in skills. A government must inevitably face the dilemma that taxing labour income entails.

The optimal response of the government to the dilemma is to find a combination of progressive taxes and education subsidies that weighs unemployment against underinvestment in education and that weighs an inadequate level of education against an inadequate mix of private and public education. A combination of steep marginal tax rates, relative to the average rates, and generous education subsidies becomes more favourable the larger the power of trade unions to set wages, the better the ability of the government to steer private efforts to educate, and the higher the preference for income equality (between the employed and the unemployed). However, a government can better reduce tax progression and increase education subsidies when the rate of return on investment in education rises or when the wedge between the private and the social rate of return becomes larger (while keeping the social rate of return constant).

An empirical analysis for several OECD countries and the theoretical approach give similar results. A policy mix of high education subsidies and relatively progressive income taxes is found in countries where union membership is significant and the replacement rate is high. Thus, education subsidies and progressive taxes go hand in hand. From a theoretical perspective, this is an optimal combination in countries where trade unions have a strong position and try to push the wage above its market-clearing level.

The paper does not and cannot reflect the full, theoretical and practical complexity of income tax systems or education systems. The analysis could include that the risk of becoming unemployed has

a deterrent effect on investment in education. Young people seem reluctant to take loans in order to invest in education. They rather choose to work or to settle for less demanding and time-consuming training. A prominent reason is the fear that they might become unemployed and might not be able to pay back those loans. Also, the analysis should perhaps allow for other government expenditure, that may crowd out public expenditure on education, and for an elasticity of substitution between the two types of investment in education that differs from unity.

Appendix A Data sources

Sources and definitions

name	***education subsidies***
source(s)	OECD (1996), *Life long learning for all*, Paris; Table 1.12
	OECD (1997), *Education at a Glance - OECD Indicators*, Paris
	OECD (1997), *Implementing the jobs study: Member country experiences*, Paris (for Belgium 1994 on page 91, Table 28)
definition	public expenditure on education, % of GDP
years	1980, 1994
remarks	
name	***trade union density / union membership***
source(s)	OECD (1997), *Employment Outlook*, July, Paris
definition	number of trade union members, % of number of wage- and salary-earners
years	1980, 1994
remarks	For Greece and Ireland data are unavailable and the unweighted average for the rest of the countries has been used.
name	***replacement rate***
source(s)	OECD (1994), *The OECD jobs study: evidence and explanations, Part II; The adjustment potential of the labour market*, Paris
definition	benefit entitlements after tax, % of previous earnings after tax
years	1981, 1991
remarks	
name	***other government consumption***
source(s)	Government consumption: CPB (WildCat)
	Education subsidies: see above
definition	Government consumption excluding public expenditure on education, % of GDP
years	1981, 1994
remarks	
name	***demography***
source(s)	OECD (1997), *Labour force statistics 1976-1996*, Paris
definition	population up to 15, % of total population
years	1981, 1995
remarks	-
name	***coefficient of income progression***
source(s)	OECD (1997), *Tax/Benefit position of employees 1995-1996*, Paris
	OECD (1995), *The OECD jobs study: taxation, employment and unemployment*, Paris
definition	elasticity of after-tax income to before-tax income for a single person earning 167% of the average production wage (APW)
years	1981, 1996
remarks	The data for 1981 are derived by averaging two elasticities: one at 133% of APW and one at 200% of APW

name	***unemployment rate***
source(s)	CPB (WildCat)
definition	unemployment , % of population (standardized)
years	1981, 1994
remarks	-

Countries in sample

middle of the nineties	*beginning of the eighties*
Australia	Australia
Austria	Belgium
Belgium	Canada
Canada	Denmark
Denmark	Finland
Finland	France
France	Germany
Germany	Italy
Greece	Japan
Ireland	Netherlands
Italy	New Zealand
Japan	Spain
Netherlands	Sweden
New Zealand	United Kingdom
Norway	United States
Portugal	
Spain	
Sweden	
Switzerland	
United Kingdom	
United States	

Appendix B The moderating effect of unemployment on wage demands

The standard monopoly union model does not take into account that the level of unemployment is important for the fall-back position of workers and thus for the wage that trade unions ask for. Layard, Nickell and Jackman (1991) adjust the standard model to include a role for unemployment in the wage-setting process. They do not provide a satisfying, theoretical foundation for this role in the context of the static model; they impose the long-term properties of a dynamic model on the static model. Here, we hope to provide a theoretical justification in the context of the static and otherwise standard model for including unemployment in the fall-back position of workers.

The allocation of jobs takes two rounds. First, workers hope to get a job in their own sector and attain the utility level U. Those that do not succeed in the first round, get a second chance in other sectors. If workers are unfortunate in this second round as well, they become unemployed and attain utility level U_o ($<U$). The probability of success in other sectors depends on the general state of unemployment (u). We will now discuss these two rounds elaborately.

First round

A trade union in sector k sets the wage w_k (per efficiency unit) and in this way determines employment L_k in this sector. All workers are member and, typically, employment will be smaller than membership N_k, $L_k < N_k$. In the first round jobs are allocated randomly among union members. The number of vacancies is only a fraction $1-u_k$ (with $u_k = (N_k - L_k)/N_k$) of membership. Moreover, not all vacancies are filled by unions members; only a given fraction $1-\delta$ of the available jobs will be occupied by them. The rest of the available jobs goes (in the second round) to outsiders. In a broader sense, the fraction $1-\delta$ could be regarded as an indicator for the preferential treatment of union members. The higher $1-\delta$ is, the more privileged union members are.

Consider wage-setting by trade unions more closely. A representative union maximizes expected utility V_U of a representative worker in an arbitrary sector (all sectors are similar, therefore we drop the sector index k):

$$V_U = (1-\delta)(1-u)U + [1-(1-\delta)(1-u)]U_a \ . \qquad \text{(A1)}$$

The term $(1-\delta)(1-u)$ is the probability that a member gets a job. Here U is utility of the fortunate workers that find a job in the first round; it is given by utility function (5.1) for optimal education effort i (equation 5.6). U_a is expected utility of the unfortunate workers that have to find a job in the second

round. Since there is a risk that they will not find a job at all, the expected utility in the second round is lower than in the first round, $U_a<U_j$. The determinants of U_a will be discussed below. For the moment it is sufficient that U_a is given for the trade union when determining the wage.

A union faces a downward sloping labour demand function. Let α represent the inverse of the constant wage elasticity of employment, with $\alpha = -[(w/L)(\partial L/\partial w)]^{-1}$ and $0<\alpha<1$. Then, obtain by maximizing the union's welfare function (A1), using the utility function (5.1) and the definition of tax progression (5.3), the first-order condition for the wage

$$\varepsilon U - \frac{1}{\alpha}(U - U_a) = 0 \,. \tag{A2}$$

The first term is the positive income effect of higher wages, whereas the second term represents the negative effect of job losses in the first round. Since the utility level U is positively and monotonously associated with the wage w, and assuming that $\varepsilon\alpha < 1$, it follows that the better the outside option U_a the higher the wage w is. Rewriting (A2) shows this more clearly

$$U = \frac{1}{1 - \alpha\varepsilon} U_a \tag{A2'}$$

The term $1/(1-\alpha\varepsilon)$ is the mark-up over the outside option of the union's members. It is a measure for the union's bargaining power.

Second round

To obtain a solution for wages and/or employment we must consider the fall-back position U_a. This is the utility of a worker who does not get a job in the 'home' sector in the first round. It depends on the job opportunities in the second round. The remaining vacancies after the first round (δL) will be available in the second round. In this new round these jobs will be randomly distributed over all jobless workers $\delta L+(N-L)$.

Those jobless workers that find a job in other sectors receive the same wage w and reach the same utility level U as they would have in the home sector. This is a natural assumption to make since there is no distinction between workers who are hired in the first round and those hired who are hired immediately afterwards, in the second round. After this last round job opportunities for workers in the formal economy are exhausted. Utility of these workers falls down to an exogenous level U_o.

Given this set-up the fall-back position can be written as

$$U_a = (1-q)\,U + q\,U_0\ , \tag{A3}$$

where $1-q$ denotes the probability of a successful job hunt in other sectors. The probability that unemployed workers after the first round find a job in the second round is the ratio of the number of available jobs (δL) and the number of job-seekers ($\delta L+N-L$), hence using $1-u = L/N$:

$$1-q = \frac{\delta L}{\delta L + N - L} = \frac{\delta(1-u)}{u+\delta(1-u)}. \tag{A4}$$

The outside option for union members in the first round thus becomes,

$$U_a = \frac{\delta(1-u)}{u+\delta(1-u)}\,U + \frac{u}{u+\delta(1-u)}\,U_o. \tag{A5}$$

Substituting this expression in the first-order condition (A2) for the wage gives a formula for the rate of unemployment u,

$$u = \frac{\delta\alpha\varepsilon}{\dfrac{U-U_o}{U} - (1-\delta)\alpha\varepsilon} \tag{A6}$$

Several factors determine the unemployment rate in this model of trade unions. Unemployment decreases when:

- the tax system becomes more progressive (ε down),
- wage elasticity of labour demand increases and the bargaining power of the trade unions declines (α down),
- the job security (preferential treatment) of union members in the 'home' sector becomes less (δ up)[42],
- the (relative) difference between employed and unemployed workers in terms of utility increases ($U-U_o/U$ up).

[42] The decisive reason behind this effect of δ on u is that unemployed members -- after the first round -- have a higher probability of finding a job in a different sector the higher δ is. In other words, if δ increases, the outside option for a union member improves and unemployment must rise to reconcile the fixed competitive wage and the higher wage that unions will ask for.

Relation with the main analysis

To understand why the set-up with two rounds is relevant for our main analysis, let us consider two extreme cases. If $\delta=0$, all vacancies are filled in the first round and in fact there is no second round. After the first round unemployed workers immediately fall back to the exogenous utility level, $U_a = U_o$. The model thus reduces to a standard monopoly union model. In this case a mechanism is missing that can equate the optimal wage for trade unions with the competitive wage in a small open economy. In Figure 5.2 another horizontal line would appear. Therefore, we must conclude that the standard monopoly union model ($\delta=0$) does not yield a meaningful equilibrium. Therefore, this case is not interesting to pursue.

Instead, we focus on the other extreme case, $\delta \uparrow 1$. In this case all union members have to find a job in two rounds. The expression for the unemployment rate then simplifies to

$$u = \alpha\varepsilon\frac{U}{U-U_o} . \qquad \text{(A7)}$$

In this relatively simple expression the main determinants of unemployment in equation (A6) survive. In setting the wage, the union takes account of the wage-elasticity α, residual income progression ε and the general state of unemployment. The corresponding wage- setting curve is upward sloping. We can further simplify the analysis by assuming zero outside utility, $U_o=0$, in which case the wage-setting curve becomes vertical (see Figure 5.2). Wages are infinitely sensitive to unemployment then. Any deviation from this equilibrium unemployment rate leads to a wage spiral across sectors. As a result the model is dichotomized: the wage rate is determined by international competitiveness, and the (un)employment rate by trade union behaviour.