THE DISTRIBUTIONAL CONSEQUENCES OF PROGRESSIVE TAXATION, WHEN COMPLEMENTARITY BETWEEN SKILLS IS IMPORTANT

Ulrik Nødgaard[*]

Introduction

The countries of the European Union are all characterised by having a progressive tax system that redistributes income from persons with high incomes to persons with lower incomes. As earnings are closely related to educational qualifications the progressive tax systems do *de facto* redistribute from the highly skilled to the low skilled persons with little formal education.

The analysis of the distributional consequences of changes in the progression of taxation of wage income is normally done through so-called distributional tables that – based on a sample of the population – show the changes in after-tax income in a given year assuming no change in labour or relative wages. In essence, these calculations ignore that the burden of progressive taxes might not be borne entirely by the highly-skilled.

However, such static calculations are at odds with the vast empirical literature that shows that the labour supply of high wage earners does respond to changes in marginal tax rates. For instance, Blomquist and West finds that the Swedish tax reform in 1991, which led to a significant drop in the marginal tax rates of high wage earners led to an increase of 7 per cent in the labour supply of that group.

Furthermore, the assumption of unchanged relative wages is problematic, as several empirical studies have shown that the relative wages of different types of education is quite sensitive to the relative supply, see for instance Katz and Murphy (1992).

In section 1 of this paper we construct a simple model that will allow us to take into account these effects and calculate the distributional consequences when such dynamic responses are taking into account. In section 2 we use the model to illustrate the quantitative importance of taking into account the effects on relative wages. Finally, the implications for economic policy are presented in section 3.

1. A simple model

In this section a simple model is presented, which will be used to illustrate how potentially misleading simple static calculations can be.

---

[*] Ministry of Economic and Business Affairs, Denmark.

We look at an economy in which there are two types of households: N_L households that supply unskilled labour, L, and N_H households that supply highly educated labour, H.

Redistribution takes place through a proportional income tax t on the highly skilled persons. The revenue on this tax is then used to provide an income transfer, T, to the unskilled. Hence, the budget constraint says that: $N_L \cdot T = t \cdot w_H \cdot H \cdot N_H$, where w_H is the wage of the highly skilled persons.

The utility of the highly skilled persons is a function of consumption and leisure, U(1–H, C_H), where H is the labour supply of the skilled persons, while C_H is consumption. The level of consumption is determined by the after-tax income. Utility maximization gives rise to the following labour supply function:

$$\tilde{H} = \varepsilon(\tilde{w}_H - \tilde{t}) \tag{1}$$

where a variable with a tilde represents the percentage change (except for t where $\tilde{t} = dt/(1-t)$), and ε is the (uncompensated) labour supply elasticity.

The labour supply of the unskilled is, due to the need for simplicity, assumed constant.[1] Hence, the utility of the low skilled persons can be measured by the income including transfers.

Firms use low-skilled and highly-skilled labour in the production: $Y = F(N_L \cdot L, N_H \cdot H)$. Profitmaximization give rise to the following (inverted) demand curves for the two types of labour:

$$\tilde{w}_H = \frac{-(1-S_H)}{\sigma}\tilde{H} \tag{2a}$$

$$\tilde{w}_L = \frac{S_H}{\sigma}\tilde{H} \tag{2b}$$

where S_H is the income share of the highly-skilled and σ is the elasticity of substitution between the two types of labour. Furthermore, the number of households of each type is assumed constant, *i.e.* we ignore potential effects on the level of education coming from a change in tax progression.

Inserting (1) into (2) we get the labour supply and the wage of the highly-skilled as a function of (change in) the taxation of the highly-skilled:

$$\tilde{w}_H = \frac{1}{1+\sigma/((1-S_H)\varepsilon}\tilde{t} \tag{3a}$$

---

[1] This assumption is only acceptable in the context of the specific policy experiment that we consider in this paper, *i.e.* an increase in the tax on the highly skilled persons.

$$\tilde{H} = \frac{-1}{(1-S_H)/\sigma + 1/\varepsilon}\tilde{t} \tag{3b}$$

The real wage of the low-skilled follows by inserting (3b) into (2b):

$$\tilde{w}_L = \frac{-S_H/\sigma}{(1-S_H)/\sigma + 1/\varepsilon}\tilde{t} \tag{4}$$

Taking a log-linear approximation to the government budget constraint, we find that the change in the income transfer to the low skilled is determined by change in the tax rate and changes in the endogenous tax base:

$$\tilde{T} = \frac{1-t}{t}\tilde{t} + \tilde{w}_H + \tilde{H} \tag{5}$$

As the low-skilled by assumption has an inelastic labour supply the change in welfare for this group is simply a weighted average of the (change in) the real wage and the (change in) the income transfers:

$$\Delta welfare = \alpha_w \tilde{w}_L + (1-\alpha_w)\tilde{T} \tag{6}$$

where α_w is the share of wage income in total income. Inserting the solutions from equation (3), (4) and (5) into (6), we can write the change in welfare of the low skilled persons, as a function of the parameters of the model:

$$\begin{aligned}\Delta welfare = &\left\{\left[\alpha_w \frac{-S_H/\sigma}{(1-S_H)/\sigma + 1/\varepsilon}\right] + \right. \\ &\left. + (1-\alpha_w)\left[\frac{1-t}{t} + \frac{1}{1+\sigma/(1-S_H)\varepsilon} + \frac{-1}{(1-S_H)/\sigma + 1/\varepsilon}\right]\right\}\tilde{t}\end{aligned} \tag{7}$$

Using this equation, we are now able to decompose the change in the welfare of low skilled persons when the tax on the highly-skilled is raised.

The first effect (corresponding to the first square bracket) is that the reduction of the labour supply of the highly-skilled will reduce the demand for low-skilled labour and hence depress the wage of the low-skilled. In what follows this will be called the "complementarity" effect. This effect is strong when the labour supply of the highly-skilled is very elastic or when the degree of substitution between the two types of labour is limited.

The second effect (corresponding to the second square bracket) reflects the effects of the income transfers. In general, the sign of this effect is indeterminate as

the reduction in the tax base could be sufficiently so strong, that it more that outweighs the effect of the increase in the tax rate. However, the likelihood of such a Laffer effect is dampened by the fact that the wage of the highly-skilled will increase as their labour supply is reduced, hence partly counteracting the negative effects on the tax base.

A few special cases can illuminate the intuition behind equation (7). If the labour supply of the highly-skilled is completely inelastic ($\varepsilon \rightarrow 0$) we get the ordinary "static" effect on the welfare of the low-skilled:

$$\Delta welfare = (1-\alpha_w)\frac{1-t}{t}\tilde{t}$$

This is the effect that normally is being calculated by the economic ministries and serves as a basis for the debate of the distributional consequences of raising the progressive taxes.

Another special case arises when the two types of labour are perfect substitutes ($\sigma \rightarrow \infty$). In this case, the relative wages will be unaffected by the higher tax and hence the change in welfare will amount to:

$$\Delta welfare = (1-\alpha_w)\left[\frac{1-t}{t} - \varepsilon\right]\tilde{t}$$

On the other hand, if the technology is of the Leontief form ($\sigma \rightarrow 0$) where the two types of labour is being used in the same proportions no matter what the relative wage is, we get:

$$\Delta welfare = \left[\alpha_w \frac{-S_H}{1-S_H} + (1-\alpha_w)\frac{1-t}{t}\right]\tilde{t}$$

In this case it is actually quite possible that the low skilled persons will experience a reduction in welfare when redistribution is increased. The "complementarity" effect and the tax base effect can dominate the initial positive effect.

2. Quantitative results

In this section we use the simple model presented in the previous section to quantify how different the distributional consequences can be when changes in relative wages are taken into account. More precisely, we ask: How misleading are the conventional static calculations for reasonable assumptions regarding the elasticity of labour supply and the degree of substitution between low-skilled and highly-skilled labour?

Specifically, we will look at the distributional effects of raising the tax on the highly skilled persons under two sets of assumptions:

1) No effect on labour supply and relative wages

2) Elastic labour supply and endogenous determination of relative wages.

Assume that initially the tax rate on the highly-skilled is 50 per cent and that it is raised to 60 per cent, so that $\tilde{t} = 0.2$. It immediately follows from the public budget constraint that this will – in the absence of endogenous changes in the tax base – increase the income transfer to the low-skilled by 20 per cent, cf. equation (5). Assuming that the income transfers initially are approximately 20 per cent of the total income of the low-skilled (*i.e.* we assume that α_w = 0.8), the total income or welfare of the low skilled persons will increase by 4 per cent (see Table 1).

In order to calculate the distributional consequences taking into account the effects on labour supply and relative wages, we need to make specific assumptions regarding the elasticity of labour supply and the degree of substitution between the two types of labour.

The most recent Danish study indicates that the average (uncompensated) elasticity of labour supply in the range of 0.1, c.f. Frederiksen *et al.* (2001). Hence, we will use an elasticity of 0.1 in our "conservative" baseline. However, the survey made by Fuchs *et al.* (1998) indicates that economists in general believe the elasticity of labour supply to be 0.2. Hence, we also include a "incentive" scenario where the elasticity is assumed to be 0.2.

Table 1

Effects on an Increase in the Tax Rate from 50 to 60 per cent

Percentage change	(I) Conventional static calculation	(II) "Conservative" baseline	(II) "Incentive" scenario
t	20.0	20.0	20.0
T	20.0	18.3	16.9
H	0	–2.0	–3.8
w_H	0	0.3	0.8
w_L	0	–1.1	–3.1
Welfare	4.0	2.7	0.9
Change in welfare as a percentage of change in welfare in the static calculation		68	23

Regarding the degree of substitution between low-skilled and highly-skilled labour this will depend upon where the line is drawn between these two types of labour. When looking at college and non-college workers it has been quite normal to assume an elasticity of substitution of 1.4 based on the time series study in Katz and Murphy (1992). However, as noted by Hamermesh (1994): "The strength of substitution between highly educated and raw labor is unclear". Hence, in the so-called incentive scenario we assume an elasticity of substitution equal to 1 corresponding to a Cobb-Douglas technology.

Taking into account the dynamic responses has tremendous effect on the distributional consequences, see again Table 1. The welfare gain for the low-skilled from the increase in redistribution is lowered from 4 to only 2,7 per cent under the "conservative" assumptions, and the gain drops to only 0,9 per cent in the equally realistic "incentive" scenario.

As the results appear to be sensitive to the assumptions made regarding main parameters it might be advisable to do sensitivity analysis. In Figure 1 below the relationship between the elasticity of labour supply and the welfare gain to the low skilled persons is shown.

The degree of substitution between the two types of labour is also critical, see Figure 2.

Figure 1

The Elasticity of Labour Supply and the Welfare Gain for the Unskilled

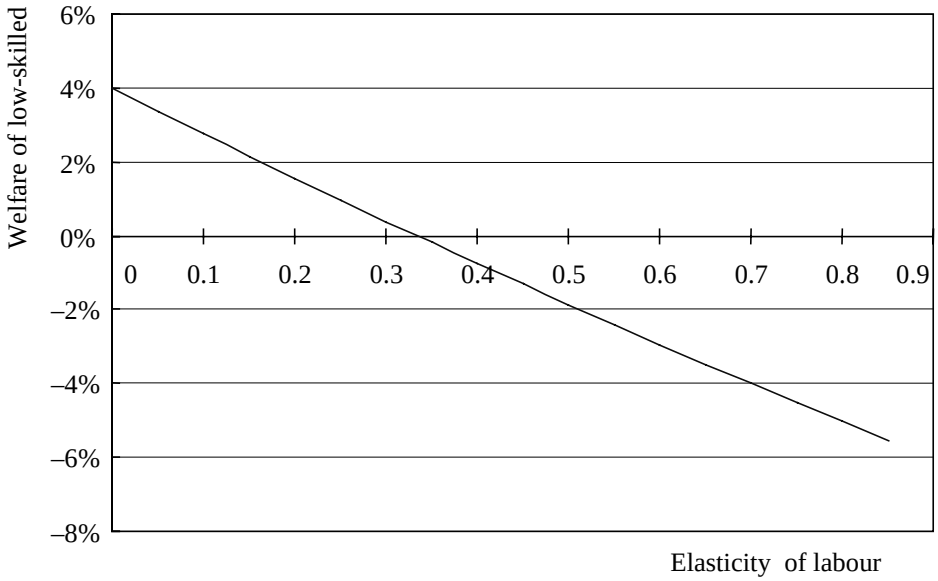
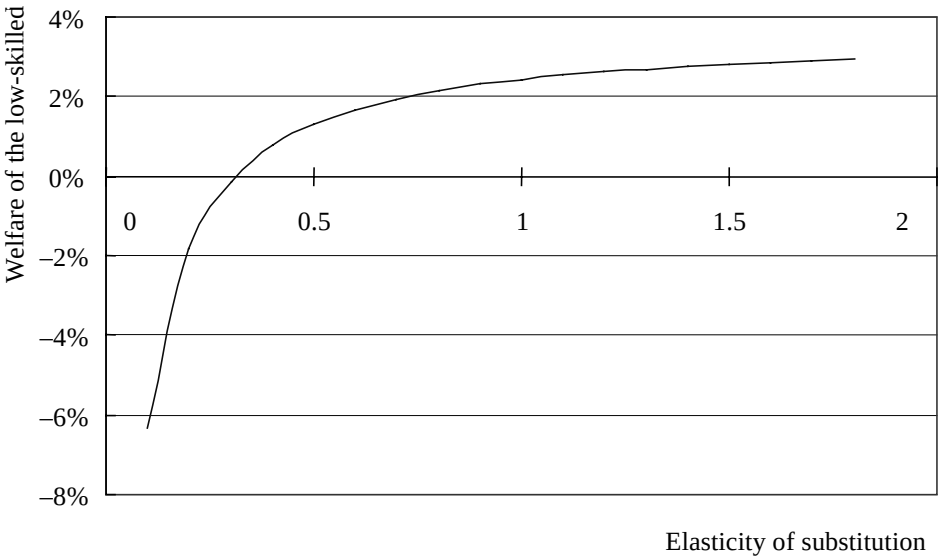


Figure 2

The Elasticity of Substitution and the Welfare Gain for the Low-Skilled



When substitution is very difficult, it is possible that the increased redistribution might actually leave the low-skilled worse off. They are carrying a large part of the burden of the increased taxation of the highly-skilled.

3. Implications for economic policy

The analysis has one central message: One should be cautious in the use of distributional calculations made under the assumption of no change in behaviour and relative prices. This was also the conclusion made by Hubbard (1999), who discussed the incidence of consumption and capital taxes.

This paper extends the analysis to study the incidence of progressive taxes on labour income. In particular, the analysis shows that the distributional consequences of progressive taxation can be significantly overestimated, if one ignores the effects on the relative wages coming from a reduction in the labour supply of the highly-skilled. Under realistic assumptions regarding the key parameters, the "true" distributional effects (*i.e.* the welfare gain for the low-skilled) is only 25-65 percent of the welfare gain to the low-skilled calculated under the assumption of no behavioural responses and unchanged relative wages.

Hence, we should make sure that we do not overestimate the redistributive powers of progressive taxes. Clearly, this point becomes even more important if the international mobility of the highly skilled persons increase in the coming years.

REFERENCES

Blomquist, S. and M. Eklöf (2001), "Tax Reform and Labour Supply in Sweden: Were Low and High Skill Individuals Affected Differently?", in M. Buti, H. Wijkander and P. Sestito (eds.), *Taxation, Welfare and the Crisis of Unemployment in Europe*.

Fuchs, V. *et al.* (1998), "Economists' View About Parameters, Values and Policies: Survey Results in Labor and Public Economics", *Journal of Economic Literature.*

Frederiksen, A. *et al.* (2001), "Overtime work, Dual Job Holding and Taxation", Working Paper, University of Århus, Denmark.

Hamermesh, D. (1994), *Labour Demand*, Princeton University Press.

Hubbard, G. (1999), "On the Use of Distributional Tables in the Tax Policy Process", in J. Slemrod (ed.), *Tax Policy in the Real World.*

Katz, L. and K.M. Murphy (1992), "Changes in Relative Wages 1963-87: Supply and Demand Factors", *Quarterly Journal of Economics*.